

# Interface Conditions in Child Language: A View from Mandarin Chinese

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## Declaration

The research presented in this thesis is my original work and it has not been submitted for a higher degree in any other institution. In addition, I certify that all information sources and literature used are indicated in the thesis. The research presented in this thesis has gained ethics from Macquarie University (HE27JUN2008-D05919).

Some of the material in this thesis has already been accepted for publication. Chapter 2 is based on the two publications as in (1) and (2). Chapter 4 is based on the publication as in (3). Chapter 5 is based on the publication as in (4).

- (1) Zhou, P., & Crain, S. (2010). Focus identification in child Mandarin. *Journal of Child Language*, 37, 965-1005.
- (2) Notley, A., Zhou, P., Crain, S., & Thornton, R. (2009). Children's interpretation of focus expressions in English and Mandarin. *Language Acquisition*, 16, 240-282.
- (3) Zhou, P., & Crain S. (in press). Children's knowledge of the quantifier *dou* in Mandarin Chinese. *Journal of Psycholinguistic Research*.
- (4) Zhou, P., & Crain, S. (2009). Scope assignment in child language: Evidence from the acquisition of Chinese. *Lingua*, 119, 973-988.

The second paper "Children's interpretation of focus expressions in English and Mandarin" was co-authored by Anna Notley, Stephen Crain and Rosalind Thornton, and only the Mandarin experiments were completed by myself and contribute to this thesis.

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## **Thesis summary**

Knowing a language includes knowledge of several basic components – syntax, semantics, pragmatics and phonology. Each of these components has its own properties, but they also interact with one another. The interactions between these different levels of linguistic knowledge are called interface conditions. In recent years, the study of interface conditions has attracted increasing interest in both theoretical linguistics and psycholinguistics, since knowing how different linguistic representations interact is crucial to understanding how the language processing system operates in the human brain.

This thesis by publication investigates the interface conditions as they are manifested in child language. Specifically, we look at how different levels of linguistic knowledge contribute to children's interpretation of three interface phenomena: focus interpretation, *wh*-quantification and scope assignment. The investigation of each interface phenomenon centres on the following questions.

- (i) What's the nature of linguistic representations underlying children's understanding of this interface phenomenon?
- (ii) To what extent do these representations differ from those of adults?
- (iii) What developmental processes underlie the differences between children and adults?

Data from child Mandarin is reported to address these questions. Mandarin Chinese has some special properties, which are less observable in most other languages. This makes Mandarin particularly insightful for evaluating certain aspects of language development, including interface conditions. The reasons for this will be explained throughout the thesis.

The thesis is structured as follows. Chapter 1 provides the introduction. Chapter 2 looks at focus identification in child Mandarin, concentrating on whether children adhere to

syntactic constraints in computing the meanings of focus structures. Chapter 3 explores the role of prosody in the resolution of ambiguities by Mandarin-speaking children, focusing on children's use of phonological information (i.e., pitch accent and intonation) to arrive at an adult-like interpretation. Chapter 4 examines *wh*-quantification in child Mandarin, focusing on whether children are sensitive to the licensing environments for the non-interrogative use of *wh*-words. Chapter 5 investigates scope assignment in child Mandarin, focusing on whether Mandarin-speaking children access both interpretations for sentences with a universal quantifier and negation. Chapter 6 summarizes the major findings of these studies and discusses their implications for current issues in the field of language acquisition.







# **Introduction**



## Introduction

Knowledge of language includes several basic components – syntax, semantics, pragmatics and phonology. Each of these components has its own properties, but these components also interact with one another. The interactions between different levels of linguistic knowledge are called interface conditions<sup>1</sup>. In recent years, the study of interface conditions has attracted increasing interest in both theoretical linguistics and psycholinguistics, since knowing how different linguistic representations interact is crucial to understanding how language is learned, and how it is processed in the human brain.

This thesis explores the interface conditions in child language. There are several reasons for studying how the interface conditions are represented in child language. First, it is a crucial but poorly understood aspect of child language development. For a child to learn a language, he/she must learn to integrate different levels of linguistic representations, in addition to computing the internal representations within each basic level. By four or five years of age, children have mastered the basic knowledge of their native language. But we know little about how they integrate different levels of linguistic representations as they are comprehending or producing language. For example, we would like to know the answers to the following questions: Do children have adult-like representations? If not, how do they develop the mappings between different levels of linguistic knowledge to arrive at adult-like representations?

Studying the interface conditions in child language also promises to shed light on how language operates in the brain. It's generally agreed that adults are able to compute and

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<sup>1</sup> In the literature the term “interface conditions” has been used to denote either (i) the interactions between different sub-components of language, or (ii) the interactions between language and non-linguistic cognitive systems (Chomsky, 1995; Jackendoff, 2002). Some researchers use “grammar-internal interfaces” and “grammar-external interfaces” to distinguish the two types of interactions (Sorace & Serratrice, 2009; Tsimpli & Sorace, 2006; White, 2009). In this thesis, the term “interface conditions” refers to the interactions between different sub-components of the language faculty.

integrate different levels of linguistic knowledge rapidly and effortlessly to arrive at an intended interpretation of the input. But these abilities represent the final state of the development of the language faculty, and the final state will have been formed using considerable experience in the production and comprehension of language. In contrast to what we know about the final state, we know little about when children become proficient at computing and integrating different levels of linguistic knowledge in order to arrive at an intended interpretation. Tracing the development of the interface conditions in children promises to help us understand how different levels of linguistic knowledge operate at the initial state, how they develop, and how different sources of information become so easy to integrate, at least for adult language users.

Finally, studies of interface conditions in child language could inform the study of Specific Language Impairment (SLI), a condition in which children have difficulties in language, often with no apparent general cognitive deficits. By comparing how different levels of linguistic knowledge interact in children with typical language development, as compared to children with SLI, we can better understand the source of the deficits, i.e., whether the deficits stem from problems within each basic level (e.g., syntactic knowledge, semantic knowledge, or phonological knowledge), or if the deficits stem from difficulties in establishing the mappings between different levels (e.g., syntax-semantics interface, syntax-phonology interface, or semantics-phonology interface).

To investigate the interface conditions in child language, we will examine specific linguistic phenomena. So, the question of how different levels of linguistic knowledge interact in child language is reformulated as “how different levels of linguistic knowledge interact to contribute to children’s interpretation of specific linguistic phenomena.” In this thesis, I focus on three phenomena: focus interpretation, *wh*-quantification and scope assignment. I use data from child Mandarin that bears on both general and language-specific issues in language

development. Mandarin Chinese has some special properties in all of the linguistic phenomena I will discuss. This makes Mandarin Chinese particularly significant for theories of language development. In the following sections, I will point out how these phenomena are expressed in Mandarin Chinese, and what makes Mandarin special.

### **Focus interpretation in Mandarin Chinese**

The study of focus has been an important area of linguistic inquiry in the past 40 years. There is now a considerable literature discussing the properties of focus (e.g., Breul, 2004; Jackendoff, 1972; Krifka, 1991; Rochemont, 1986; Rooth, 1985). It is generally agreed that the interpretation of focus structures involves different levels of linguistic knowledge: syntax, semantics and pragmatics, as well as phonology. Consider sentence (1), for example.

(1) Only [John]<sub>F</sub> ate an apple.

The focused element is indicated by F-brackets. In sentence (1), the focus particle *only* associates with the subject noun phrase (NP) *John*, so (1) means that of a set people present in the context, it was John and nobody else who ate an apple. The corresponding Chinese sentence is given in (2).

(2) Zhiyou Yuehan chi-le pingguo.

only John eat-ASP apple

‘Only John ate an apple.’

a. Only [John]<sub>F</sub> ate an apple.

b. \*Only John [ate an apple]<sub>F</sub>.

c. \*Only John ate [an apple]<sub>F</sub>.

(3) Yuehan zhi chi-le pingguo.

John only eat-ASP apple

‘John only ate an apple.’

a. John only [ate an apple]<sub>F</sub>.

b. John only ate [an apple]<sub>F</sub>.

c. \*[John]<sub>F</sub> only ate an apple.

The focus particle *zhiyou* corresponds to English *only*. Syntactically, the focus particle *zhiyou* ‘only’ associates with the elements in its c-command domain<sup>2</sup> (e.g., Jackendoff, 1972; Reinhart, 2004, 2006). Therefore, when *zhiyou* appears in presubject position, as in (2), it can only associate with the subject NP *Yuehan* ‘John’, as illustrated in (2a), since *Yuehan* ‘John’ is the only element in its c-command domain. It cannot associate with the entire verb phrase (VP) *chi-le pingguo* ‘ate an apple’ or with the object NP inside the VP *pingguo* ‘apple’. These prohibitions are indicated in (2b) and (2c) respectively. When the focus particle *zhiyou* ‘only’ occurs in preverbal position, as in (3), it is often reduced to *zhi*<sup>3</sup> ‘only’. In that position, *zhiyou* ‘only’ can associate with the entire VP *chi-le pingguo* ‘ate an apple’, as in (3a), or with an element within the VP, i.e., the object NP *pingguo* ‘apple’, as in (3b). But it cannot associate with the subject NP *Yuehan* ‘John’, as indicated in (3c), since *Yuehan* ‘John’ is outside the c-command domain of the focus particle *zhiyou* ‘only’.

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<sup>2</sup> Two definitions of c-command relation are generally accepted. One is Reinhart’s (1976), that is, node A c-commands node B if neither A nor B dominates the other and the first branching node which dominates A dominates B; and the other is Aoun and Sportiche’s (1983), namely, A c-commands B, iff every maximal projection dominating A dominates B, and A does not dominate B.

<sup>3</sup> *Zhiyou* and *zhi* are variants of the same focus particle. *Zhiyou* can be used to modify focused elements in subject position as well as in the predicate phrase. For example, Mandarin speakers can say *Zhiyou yuehan chi-le pingguo* ‘Only John ate an apple’ and *Yuehan zhiyou chi-le pingguo* ‘John only ate an apple’. Mandarin speakers tend to omit the second morpheme of *zhiyou*, i.e., *you*, when the focus particle occurs in preverbal position. So Mandarin speakers can express the meaning ‘the only thing John ate is an apple’, either by saying *Yuehan zhiyou chi-le pingguo* ‘John only ate an apple’ or by saying *Yuehan zhi chi-le pingguo* ‘John only ate an apple’. There are, however, no differences in interpretation between *zhi* or *zhiyou* in this position.



Semantically, focus particles partition the semantic structure of the sentences into two meaning components, a presupposition and an assertion (Horn, 1969). The presupposition states that the property denoted by the predicate applies to the focused element, whereas the assertion states that this kind of property doesn't apply to any member of the contextually established alternative sets being contrasted with the focused element. Consider (2), for example, repeated here as (4).

(4) Zhiyou Yuehan chi-le pingguo.

only John eat-ASP apple

'Only John ate an apple.'

a. Presupposition: John ate an apple.

b. Assertion: Everyone other than John didn't eat an apple.

Suppose there are three people in the context, *John*, *Mary* and *Bill*. For sentence (4) to be true, the property of eating an apple must apply to the focused element *John*, as indicated in (4a), and must not apply to any of the alternatives to the focused element, *Mary* and *Bill*, as in (4b). In other words, the property of eating an apple must be true of *John* and must be false of *Mary* and *Bill*.

In this thesis, we look at how Mandarin-speaking children understand focus structures like this. For a child to understand this structure, he/she first has to identify the correct focus associated with the focus particle. Once the focus is identified, then the relevant sets can be computed, i.e., the focused element and the contrastive set. In other words, two steps are required in order to understand focus structures. The first step is to identify the focus, and then to compute the relevant presupposition and assertion. So we want to see whether children

use syntactic constraints (e.g., ‘c-command’) to find the correct focus and then compute the meanings of the sentences. This is the syntax-semantics interface.

By looking at focus interpretation in child Mandarin, we can investigate another interface, namely the interface between syntax and phonology. Sentence (5) is used to illustrate.

(5) *Zhiyou Yuehan de pingguo shi hongde.*

only John DE apple is red

‘Only John’s apple is red.’

a. Only [John’s apple]<sub>F</sub> is red.

b. Only [John]<sub>F</sub>’s apple is red.

The focus particle *zhiyou* ‘only’ in (5) can either associate with the entire subject NP *Yuehan de pingguo* ‘John’s apple’, as in (5a), or with an element inside the subject NP, i.e., the modifier of the subject NP *Yuehan* ‘John’, as in (5b), since both elements are in the c-command domain of the focus particle. As a consequence, the sentence is ambiguous, in the absence of additional information about which element is the intended focused element.

When the focus particle *zhiyou* ‘only’ associates with the subject NP *Yuehan de pingguo* ‘John’s apple’, the sentence conveys the meaning that John’s apple is red and nothing else (in the established discourse context) is red. When *zhiyou* ‘only’ associates with the modifier *Yuehan* ‘John’, the sentence conveys the meaning that John’s apple is red and no one else’s apple (in the established discourse context) is red. Phonological cues can be used to distinguish between these two interpretations. Specifically, a pitch accent on the head noun *pingguo* ‘apple’, as in (6), encourages the interpretation that John’s apple is red and nothing else (in the established discourse context) is red; and a pitch accent on the modifier *Yuehan*

‘John’, as in (7), encourages the interpretation that John’s apple is red and no one else’s apple (in the established discourse context) is red.

(6) Zhiyou Yuehan de PINGGUO<sup>4</sup> shi hongde.

only John DE apple is red

‘Only John’s APPLE is red.’

(7) Zhiyou YUEHAN de pingguo shi hongde.

only John DE apple is red

‘Only JOHN’s apple is red.’

Our goal is to see whether children use phonological cues like pitch accent to distinguish between the two interpretations. This is accomplished at the syntax-phonology interface.

### **Wh-quantification in Mandarin Chinese**

Mandarin Chinese differs from English and many other languages in the range of interpretations that can be assigned to *wh*-words. More specifically, *wh*-words in Mandarin Chinese exhibit quantificational variability. In addition to an interrogative reading, as indicated in (8a) and (8b)<sup>5</sup>, *wh*-words such as *shenme* ‘what’ and *shei* ‘who’ can also have an indefinite reading, as illustrated in (9a) and (9b), and they can have a universal reading, as illustrated in (10a) and (10b) (Cheng, 1991, 1994, 2009; Huang, 1982b; Li, 1992; Lin, 1996; 1998).

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<sup>4</sup> Throughout, pitch accent is indicated by capitals.

<sup>5</sup> One of the most important (and probably most familiar) typological features of Mandarin *wh*-questions is that, whereas many other languages like English form their *wh*-questions by moving a *wh*-phrase to a clause-initial position, Mandarin *wh*-questions are formed by leaving a *wh*-phrase in situ. So Mandarin Chinese is known as a *wh*-in-situ language (Huang, 1982a, 1982b; Huang, Li, & Li, 2009).

(8) a. Yuehan chi-le shenme?

John eat-ASP what

‘What did John eat?’

b. Yuehan kandao-le shei?

John see-ASP who

‘Who did John see?’

(9) a. Ruguo ni xiang chi shenme, wo gei ni mai.

if you want eat what I give you buy

‘If you want to eat something, I’ll buy it for you’

b. Ruguo shei qifu ni, ni gaosu wo.

if who bully you you tell me

‘If someone bullies you, you let me know.’

(10) a. Yuehan shenme dou meiyou chi.

John what all not eat

‘John didn’t eat anything.’

b. Yuehan shei dou meiyou jian.

John who all not see

‘John didn’t see anyone.’

Let us look more closely at the variability in the interpretation of Mandarin *wh*-words. In sentences (8a) and (8b), the *wh*-words *shenme* ‘what’ and *shei* ‘who’ are interpreted as interrogative words. In sentences (9a) and (9b), the *wh*-words *shenme* ‘what’ and *shei* ‘who’ appear in the antecedent of *if*-conditionals. This is one of the licensing environments for the

existential *wh*-indefinites<sup>6</sup>, and thus *wh*-words that appear in this position are interpreted as having the approximate meaning of the corresponding English existential indefinites *something* and *someone* respectively. Finally, in sentences (10a) and (10b), the *wh*-words are bound by the universal quantifier *dou*<sup>7</sup>, thereby rendering the combination of *shenme+dou* and *shei+dou* as universally quantified NPs corresponding to English *everything* and *everyone* respectively. With negation, the two sentences express negated universal statements, meaning “John didn’t eat anything” and “John didn’t see anyone”.

These examples illustrate that the interpretation of *wh*-words in Mandarin Chinese is sensitive to the linguistic environments in which they occur. This is why we say that *wh*-words exhibit quantificational variability. Although *wh*-words are normally interpreted as interrogative words, when they occur in certain specific contexts, as in the antecedent of conditionals, in yes-no questions, in the scope of epistemic adverbs, and in the scope of a universal quantifier, these same words are interpreted as non-interrogative indefinites. This phenomenon lies at the interface between semantics and discourse.

So the goal is to find out whether young Mandarin-speaking children are sensitive to the licensing environments for the non-interrogative use of *wh*-words. If not, how do they eventually acquire the non-interrogative use of *wh*-words? Note that in learning the interpretation of *wh*-words, what children learn is that the same word functions as an interrogative word in certain linguistic contexts, but it is interpreted as a non-interrogative indefinite in some other linguistic contexts. It is not the distribution of the *wh*-word that is at issue for young children, but its interpretive properties. So how do young children establish the connection between the semantic interpretation of *wh*-words and the linguistic contexts in

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<sup>6</sup> There are some other linguistic environments in which the existential indefinite reading of *wh*-words is licensed, for instance, in the scope of the epistemic adverb *keneng* ‘possibly’, as in (1), and in yes-no questions, as in (2). Readers are referred to Lin (1998) and Xie (2007) for detailed information.

(1) *Keneng shei qifu Yuehan.*

possibly who bully John

‘Possibly someone bullied John.’

(2) *Yuehan xiang chi shenme ma?*

John want eat what Q

‘Did John want to eat something?’

<sup>7</sup> The properties of this quantifier *dou* will be discussed in the following chapters. For the moment, it is simply treated as a universal quantifier which binds the *wh*-words to its left.

which they occur? As far as we know, few studies have looked at children's knowledge of the licensing mechanism of *wh*-indefinites in Mandarin Chinese.

Studying children's knowledge of *wh*-quantification can also provide insight into the nature of the semantics-phonology interface. In example (9), *wh*-words are obligatorily interpreted as indefinites. But in sentences like (11), the *wh*-word *shenme* 'what' can be interpreted either as an interrogative word or as an indefinite.

(11) Yuehan meiyou chi shenme shuiguo.

John not eat what fruit

- a. What kind of fruit didn't John eat?
- b. John didn't eat any fruit.

Negative sentences with a *wh*-word like (11) are ambiguous in Mandarin Chinese. When the *wh*-word *shenme* 'what' is interpreted as an interrogative word, the sentence poses a question, as in (11a): "What kind of fruit didn't John eat?" Alternatively, when the same *wh*-word is interpreted as an indefinite, the sentence makes a statement, as in (11b): "John didn't eat any fruit". Phonological cues can be used to distinguish between the two interpretations. A rising intonation on the *wh*-phrase *shenme shuiguo* 'what fruit' indicates the question reading, whereas a level intonation (the absence of rising intonation) on the same *wh*-phrase signals the statement reading. Notice that in this structure the same *wh*-phrase can be used to perform two different speech acts: posing a question vs. making a statement. Which it is depends on intonation. So we take advantage of this special property of Mandarin Chinese to look at whether young Mandarin-speaking children can use intonational cues to resolve ambiguities involving different speech acts. As far as we know, there have been no previous studies, in any language, looking at the role played by phonology in children's resolution of ambiguities

involving speech acts. And in order to investigate children's knowledge of the dual property of *wh*-words, i.e., an interrogative word vs. a non-interrogative indefinite, we devised a new experimental methodology, which we called Question-Statement task.

### **Scope Interpretation in Mandarin Chinese**

Scope relations between logical expressions is another interface phenomenon. Consider sentence (12), for example.

(12) Every horse did not jump over the fence.

This sentence is ambiguous. The universal quantifier *every* and negation *not* can each take scope over the other. Thus the sentence can mean either that (i) none of the horses jumped over the fence, or (ii) not all of the horses jumped over the fence. This difference in interpretation is referred to as a 'scope phenomenon'. It is said that the 'none' reading arises when *every* takes scope over *not* (EVERY > NOT), and the 'not all' meaning arises when *not* takes scope over *every* (NOT > EVERY).

In contrast to English, Mandarin Chinese has been argued to exhibit scope rigidity, in the sense that scope is determined exclusively by the surface structural relations between quantificational expressions (Aoun and Li, 1989; Huang, 1982; Lee, 1986). Therefore, the Mandarin sentence (13), corresponding to the English example (12), is unambiguous. In sentence (13), the universal quantifier *mei* 'every' c-commands the expression for negation *meiyou* 'not' in overt syntax, so the only reading available in Mandarin Chinese is the EVERY > NOT reading, i.e., 'none of the horses jumped over the fence'. The NOT > EVERY reading, i.e., 'not all of the horses jumped over the fence', is judged by many linguists to be unavailable in Mandarin Chinese. This is another syntax-semantics interface.

(13) Mei-pi      ma      dou meiyou tiaoguo      liba.

every-CL horse all not-have jump-over fence

‘Every horse didn’t jump over the fence.’

This difference between English and Mandarin Chinese makes it especially interesting to look at Mandarin-speaking children’s knowledge of scope phenomena. In this thesis, we focus on children’s interpretation of sentences involving the universal quantifier and negation. Previous research has shown that English-speaking children have access to both interpretations (i.e., the EVERY > NOT reading and the NOT > EVERY reading) for sentences with the universal quantifier and negation like (12) (Gualmini, 2004, 2005/2006; Musolino & Lidz, 2002, 2006). So we want to know how Mandarin-speaking children interpret sentences with a universal quantifier and negation like (13). Do they only access the EVERY > NOT reading, as Mandarin-speaking adults do? If not, which means that Mandarin-speaking children access both readings, this will raise a learnability issue. Because the EVERY > NOT reading asymmetrically entails the NOT > EVERY reading; whenever the former is true, the latter is also true, but not vice versa (i.e., if none of the horses jumped over the fence, then it is true that not all of the horses jumped over the fence, but not vice versa). This means that the NOT > EVERY reading will never be falsified for children who permit this reading, since adults will consistently produce sentences like (13) in scenarios corresponding to the EVERY > NOT reading, and when the EVERY > NOT reading is true, the NOT > EVERY reading is also true. In order to jettison the NOT > EVERY reading from their grammars, children would need to become cognizant of the fact that adults refrain from using (13) in scenarios that match the NOT > EVERY reading. As far as we know, children do not keep records of such ‘negative’ experiences. How, then, can children expunge the non-



adult NOT > EVERY reading in order to converge on the adult grammar? We anticipate that this learnability issue might arise in Mandarin-speaking children's interpretation of such sentences, which we will discuss later.

## **Research aims**

In summary, this thesis explores how different levels of linguistic knowledge interact to contribute to children's understanding of three interface phenomena: focus interpretation, *wh*-quantification and scope assignment. The investigation of each interface phenomenon centres around three related questions.

- (i) What's the nature of linguistic representations underlying children's understanding of this interface phenomenon?
- (ii) To what extent do these representations differ from those of adults?
- (iii) What developmental processes underlie the differences between children and adults?

## **Organization of the thesis**

This concludes the introduction. The remainder of the thesis is organized as follows. Chapter 2 looks at focus identification in child Mandarin, focusing on whether children use syntactic constraints to find the correct focus and then compute the meanings of focus structures. Chapter 3 explores the role of prosody in Mandarin-speaking children's ambiguity resolution, focusing on whether children can use phonological information (i.e., pitch accent and intonation) to arrive at an adult-like interpretation. Chapter 4 examines *wh*-quantification in child Mandarin, focusing on whether children are sensitive to the licensing environments for the non-interrogative use of *wh*-words. Chapter 5 investigates scope assignment in child Mandarin, focusing on whether Mandarin-speaking children access both interpretations for sentences with a universal quantifier and negation. Chapter 6 summarizes the major findings

of our study and discusses the implications of these findings for issues of language development.

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## Focus identification in child Mandarin

**This chapter is based on two papers which have been accepted for publication:**

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The second paper "Children's interpretation of focus expressions in English and Mandarin" was co-authored by Anna Notley, Stephen Crain and Rosalind Thornton, and only the Mandarin experiments were completed by myself and contribute to this thesis.



## Abstract

In this study, we investigated how Mandarin-speaking children and adults interpret focus structures like *Zhiyou Yuehan chi-le pingguo* ‘Only John ate an apple’ and *Shi Yuehan chi-de pingguo* ‘It is John who ate an apple’. We found that children tended to associate focus particles *zhiyou* ‘only’ and *shi* ‘be’ with the verb phrase (VP), whereas adults uniquely associated them with the subject noun phrase (NP). To account for this difference, we propose that children initially treat focus particles like *zhiyou* and *shi* as sentential adverbs, and thus associate them with the VP. In order to assess our proposal, we then looked at whether children can access the adult-like interpretation, using contextual cues (i.e., children were presented with a context in which focus on the subject NP was emphasized) as well as syntactic cues (i.e., children were presented with a focus structure in which negation was positioned between the focus particle and the VP). It was found that children are able to use both types of cues to access the adult-like interpretation. The findings have an important bearing on language learnability, since both contextual and syntactic information can assist children in accessing the adult-like interpretation.

*Keywords:* Focus particle; Sentential adverb; Contextual information; Syntactic information; Learnability



## **Focus identification in child Mandarin**

### **Introduction**

The study of focus has been an important area of linguistic inquiry in the past 40 years. There is now a considerable literature discussing the properties of focus (e.g., Breul, 2004; Jackendoff, 1972; Krifka, 1991; Rochemont, 1986; Rooth, 1985). It is generally agreed that the interpretation of focus structures involves multiple levels of linguistic knowledge: syntax, semantics and pragmatics, as well as phonology. Therefore, children's emerging knowledge of focus structures could offer insights into the development of these different levels of linguistic knowledge. In this paper, we investigated how Mandarin-speaking children understand contrastive focus. Two main questions were discussed: (i) Whether or not Mandarin-speaking children have adult-like knowledge of focus interpretation; (ii) If they don't have adult-like knowledge, then what are the sources of observed differences?

The paper is structured as follows. First we introduce two contrastive focus constructions in Mandarin Chinese. Then we review previous studies on children's understanding of focus structures. Finally, we present four experiments investigating how Mandarin-speaking children and adults interpret these two focus constructions.

### **Contrastive focus in Mandarin Chinese**

Kiss (1998) distinguished two types of focus, which she termed identificational focus and information focus (cf. Rochemont, 1986). What Kiss called identificational focus is more commonly known as contrastive focus, so we will use this more conventional term.

According to Kiss (1998), the focused elements in the *only*-construction and the cleft construction express contrastive focus, which presents an exhaustive identification performed on a set of contextually given entities, whereas the information focus simply conveys new,

nonpresupposed information without expressing exhaustive identification. Information focus also receives a pitch accent. Sentences (1), (2) and (3) are used to illustrate.

(1) Only [John]<sub>F</sub> ate an apple.

(2) It is [John]<sub>F</sub> who ate an apple.

(3) [JOHN]<sub>F</sub> ate an apple.

The foci in (1) and (2) express exhaustive identification, which means that of a set of people present in the context, it was John and nobody else who ate an apple. The focus in (3), on the other hand, merely presents JOHN as nonpresupposed information, without suggesting that JOHN was the only person who ate an apple. In the remainder of this section, we discuss the syntactic and semantic properties of the corresponding Chinese *only*-construction and cleft construction, as illustrated in (4) and (5).

(4) Zhiyou Yuehan chi-le pingguo.

only John eat-ASP apple

‘Only John ate an apple.’

(5) Shi Yuehan chi-de pingguo.

be John eat-DE apple

‘It is John who ate an apple.’

The focus particle *zhiyou* in (4) corresponds to the English *only*. Syntactically, the focus particle *zhiyou* associates with the elements in its c-command domain (e.g., Jackendoff, 1972; Reinhart, 2004, 2006). This means that when *zhiyou* appears in presubject position as in (4), it can only associate with the subject NP *Yuehan* ‘John’, as illustrated in (6a), since *Yuehan*

‘John’ is the only element in its c-command domain. It cannot associate with the entire VP *ate an apple*, or with the object NP inside the VP *an apple*. These prohibitions are indicated in (6b) and (6c) respectively. When the focus particle *zhiyou* occurs in preverbal position, as in (7), it is often reduced to *zhi*<sup>1</sup>. In that position, *zhi* (or *zhiyou*) can associate with the entire VP, as in (7a), or with an element within the VP, i.e., the object NP *an apple* in (7b). But it cannot associate with the subject NP *John*, as indicated in (7c), since *John* is outside the c-command domain of the focus particle *zhiyou*.

(6) *Zhiyou Yuehan chi-le pingguo.*

only John eat-ASP apple

‘Only John ate an apple.’

- a. Only [John]<sub>F</sub> ate an apple.
- b. \*Only John [ate an apple]<sub>F</sub>.
- c. \*Only John ate [an apple]<sub>F</sub>.

(7) *Yuehan zhi chi-le pingguo.*

John only eat-ASP apple

‘John only ate an apple.’

- a. John only [ate an apple]<sub>F</sub>.
- b. John only ate [an apple]<sub>F</sub>.
- c. \*[John]<sub>F</sub> only ate an apple.

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<sup>1</sup> *Zhiyou* and *zhi* are variants of the same focus particle. *Zhiyou* can be used to modify focused elements in subject position as well as in the predicate phrase. For example, Mandarin speakers can say *Zhiyou yuehan chi-le pingguo* ‘Only John ate an apple’ and *Yuehan zhiyou chi-le pingguo* ‘John only ate an apple’. Mandarin speakers tend to omit the second morpheme of *zhiyou*, i.e., *you*, when the focus particle occurs in preverbal position. So Mandarin speakers can express the meaning ‘the only thing John ate is an apple’, either by saying *Yuehan zhiyou chi-le pingguo* ‘John only ate an apple’ or by saying *Yuehan zhi chi-le pingguo* ‘John only ate an apple’. There are, however, no differences in interpretation between *zhi* or *zhiyou* in this position.

Semantically, focus particles partition the semantic structure of the sentences into two meaning components, a presupposition and an assertion (Horn, 1969). The presupposition states that the property denoted by the predicate applies to the focused element, whereas the assertion states that this kind of property doesn't apply to any member of the contextually established alternative sets being contrasted with the focused element. Consider (4), for example, repeated here as (8).

(8) Zhiyou Yuehan chi-le pingguo.

only John eat-ASP apple

'Only John ate an apple.'

a. Presupposition: John ate an apple.

b. Assertion: Everyone other than John didn't eat an apple.

Suppose there are three people in the context, *John*, *Mary* and *Bill*. For sentence (8) to be true, the property of eating an apple must apply to the focused element *John*, as indicated in (8a), and must not apply to any of the alternatives to the focused element, *Mary* and *Bill*, as in (8b). In other words, the property of eating an apple must be true of *John* and must be false of *Mary* and *Bill*.

In Mandarin Chinese, cleft constructions of the sort illustrated in (5) are another kind of contrastive focus structures. They are usually referred to as *shi...de* constructions. There has always been controversy on the analysis of the properties of *shi* and *de* in this construction. The details will not be our concern here. For an overview, please see Lee (2005a, 2005b). In this paper we will treat *shi* as the focus particle (e.g., Huang, 1982; Lee, 2005a; Teng, 1979) and *de* as an aspect marker<sup>2</sup> (e.g., Huang, 1982; Shi, 1994). To form a Chinese cleft sentence

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<sup>2</sup> *De* in the *shi...de* construction can be treated equally as the aspect marker *le*, which means in all the *shi...de* constructions used in this paper *de* can be replaced by *le*. We use *de* simply because the Chinese cleft is often

is simply to insert the focus particle *shi* directly in front of the constituent in focus. Unlike their English counterparts, it involves no overt dislocation of the focused element in the syntax, as illustrated in the following sentences.

(9) Shi Yuehan zuotian chi-de pingguo.

be John yesterday eat-DE apple

‘It was John who ate an apple yesterday.’

(10) Yuehan shi zuotian chi-de pingguo.

John be yesterday eat-DE apple

‘It was yesterday that John ate an apple.’

(11) Yuehan zuotian shi chi-de pingguo.

John yesterday be eat-DE apple

‘It was eat an apple that John did yesterday.’

As can be seen in the above sentences, we can simply put the focus particle *shi* immediately preceding the focused element without changing the order of the constituents in the entire sentence (Huang, 1982; Xu, 2004). Once the focus particle is removed, all of them are reduced to a non-cleft, as shown in (12).

(12) Yuehan zuotian chi-de pingguo.

John yesterday eat-DE apple

‘John ate an apple yesterday.’

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referred to as the *shi...de* construction in the literature. So we are just following the common practice of using *de* instead of *le*.

On the other hand, note how different their English counterparts in (9)-(11) are from each other in their surface form. Syntactically, then, Chinese clefts and English clefts differ. Chinese cleft constructions are more like *only*-constructions, in the sense that the focus particle associates with the element in its c-command domain in both structures. However, Chinese and English clefts convey similar semantic function (Lee, 2005a). Sentences (2) and (5), repeated here as (13) and (14), are used to illustrate.

(13) It is John who ate an apple.

- a. Presupposition: x ate an apple.
- b. Assertion: x = John; everyone else didn't eat an apple.

(14) Shi Yuehan chi-de pingguo.

be John eat-DE apple

'It is John who ate an apple.'

- a. Presupposition: x ate an apple.
- b. Assertion: x = John; everyone else didn't eat an apple.

The presuppositions, as in (13a) and (14a), are existential propositions which state that someone (indicated by the variable x) has the property mentioned in the predicate, i.e., eating an apple. In the assertions, (13b) and (14b), the focused element *John* has replaced the variable x in the presupposition, and a negative assertion is made about the alternative possible values of the variable, that is, the individuals in the context being contrasted with *John*. In other words, for sentences (13) and (14) to be true, it must be true that John ate an apple and must be false that anyone other than John ate an apple.

To sum up, in both the *zhiyou*-construction and the *shi...de* construction, the focus particle associates with the element in its c-command domain. When computing the meaning,

both constructions can be decomposed into two conjoined propositions, the presupposition and the assertion. In this study, we investigated how Mandarin-speaking children understand these two constructions. For a child to understand these two focus structures, he/she first has to identify the correct focus associated with the focus particle using c-command constraint. Once the focus is identified, then the relevant sets can be computed, i.e., the focused element and the contrastive set. In other words, two steps are required in order to understand focus structures. The first step is to identify the focus, and then to compute the relevant presupposition and assertion. So children may make errors at either of the two steps. In the next section, we review previous studies on children's understanding of focus structures.

### ***Only and zhiyou in child language***

Crain, Ni & Conway (1994) investigated how three- to six-year-old children understand English *only*-constructions. They used a picture verification task, in which children were asked to judge whether or not each test sentence was an accurate description of a picture. For example, children were asked whether or not sentences like (15) and (16) were accurate descriptions of a picture in which a cat was holding a flag, a duck was holding a flag and a balloon, and a frog was holding a balloon.

(15) Only the cat is holding a flag.

(16) The cat is only holding a flag.

The results showed that the majority of the children accepted both (15) and (16) as true descriptions of the picture. Similar results were obtained by Philip & Lynch (2000). In their experiment, both children and adults were asked to judge whether or not sentence (17) was an

accurate description of a picture in which a dog was holding an octopus and a starfish, and two cats were holding nothing.

(17) Only the dog is holding an octopus.

It was found that adults judged the sentence to be a true description of the picture, whereas over one third of the children judged it to be false, and they justified their responses by making reference to the fact that the dog was also holding a starfish<sup>3</sup>. Using a similar task, Yang (2002) investigated how Mandarin-speaking children interpret *zhiyou*-constructions like (18) and (19). She found that four- to six-year-old Mandarin-speaking children interpreted (18) as having the same meaning as (19).

(18) Zhiyou xiaonanhai ti-zhe shuitong.

only boy carry-ASP bucket

‘Only the boy is carrying a bucket.’

(19) Xiaonanhai zhi ti-zhe shuitong.

boy only carry-ASP bucket

‘The boy is only carrying a bucket.’

These findings lead Crain et al. (1994) to formulate, as a descriptive generalization, that children are initially VP-oriented, in the sense that they tend to associate the focus particle (i.e., English *only*, Chinese *zhiyou*) with the VP regardless of its surface position in

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<sup>3</sup> The data from this study can also be used as evidence for Crain et al.’s (1994) proposal, as pointed out by the reviewer. That is, if children interpret sentences with *only* as having the same meaning as their counterparts without *only*, as Paterson et al. (2003) proposed, then children should be expected to accept (17) as a true description of the picture in which a dog was holding an octopus and a starfish, and two cats were holding nothing, because children interpret (17) as *The dog is holding an octopus*, which is true in the picture. However, over one third of the children judged it to be false by pointing out that the dog was also holding a starfish.



the sentence. However, an alternative account was advanced by Paterson, Liversedge, Rowland & Filik (2003). According to these researchers, children interpret sentences with *only* as having the same meaning as their counterparts without *only*; in other words, the claim is that children only mentally represent the presupposition meaning component of sentences with *only*, and not the assertion. On this account, the reason why children accepted both (15) and (16) as true descriptions of the picture in Crain et al. (1994), is not because they are VP-oriented, but rather because they compute the sentence with *only* in the same way as they compute the corresponding sentence without *only*, namely, *the cat is holding a flag*. This is a plausible account of some of the data, since *the cat is holding a flag* is a true description of the picture of a cat holding a flag, a duck holding a flag and a balloon, and a frog holding a balloon.

In summary, the two proposals diverge on how to account for children's non-adult interpretation. On one account, children's non-adult interpretation is attributed to errors in identifying the correct focus (Crain et al., 1994), whereas the other account attributes children's non-adult responses to a failure to compute the assertion associated with the contrast sets (Paterson et al., 2003)<sup>4</sup>. To adjudicate between the two proposals and to bring further clarity to our understanding of children's emerging knowledge of focus structures, we conducted three experiments investigating how Mandarin-speaking children and adults interpret contrastive focus structures.

## Experiment 1

In this experiment, we investigated how Mandarin-speaking children and adults

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<sup>4</sup> In subsequent work, Paterson, Liversedge, White, Filik & Jaz (2005/2006) reached a different conclusion about children's non-adult responses, and one that is more in line with the descriptive generalization advanced by Crain et al. (1994). However, the test materials in Paterson et al. (2005/2006) evoked disproportionate number of erroneous responses from adult controls. This renders the interpretation of the child data problematic, since children's responses too could have been due to some methodological feature of the task.

interpret *zhiyou*-constructions like (4), repeated here as (20), with *zhiyou* in presubject position.

(20) Zhiyou Yuehan chi-le pingguo.

only John eat-ASP apple

‘Only John ate an apple.’

## Method

### *Subjects*

We tested 20 Mandarin-speaking children between the ages of 4;5 and 4;10 (mean age 4;7). They were recruited from the kindergarten at Beijing Language and Culture University. In addition, 20 Mandarin-speaking adults were tested as controls, all postgraduate students at Beijing Language and Culture University.

### *Procedures*

We tested child subjects using the Truth Value Judgement Task. This research technique is designed to investigate which meanings children can and cannot assign to sentences (Crain & Thornton, 1998). The task involves two experimenters – one acting out the stories with toy characters and props, and the other playing the role of a puppet who watches the stories alongside the child subject. At the end of the story, the puppet explains to the child subject what he thinks happened in the story. The child’s task is to decide whether the puppet said the right thing or not. If the child informs the puppet that he was wrong, then he is asked to explain: “what really happened?” The child subjects were introduced to the task individually and then tested individually. They were given two practice items before the actual test, one in which the puppet’s statement was obviously true and one in which it was obviously false, so

that children knew that the puppet could say something wrong. These practice items were also used to familiarize children with the task. Only those children who correctly rejected the puppet's statement were included in the actual test.

The 20 adult subjects were tested on the same stories but using a questionnaire. All the stories were written out and they were asked to indicate, for each story, whether the puppet was right or wrong; and if they judged the puppet to be wrong, they were also asked to justify their answers.

### *Materials*

Two kinds of scenarios were constructed. In one scenario, test sentences like (20) were predicted to be true for adults; and in the other scenario, they were predicted to be false for adults. We will refer to these scenarios as the 'adult-true' and 'adult-false' scenarios, respectively. Test sentences like (20) were presented following either of the two scenarios. Thus subjects were tested in two conditions: (i) *zhiyou*-construction in the 'adult-true' scenario, and (ii) *zhiyou*-construction in the 'adult-false' scenario. There were three trials in each condition, yielding six test items. The following two examples are used to illustrate.

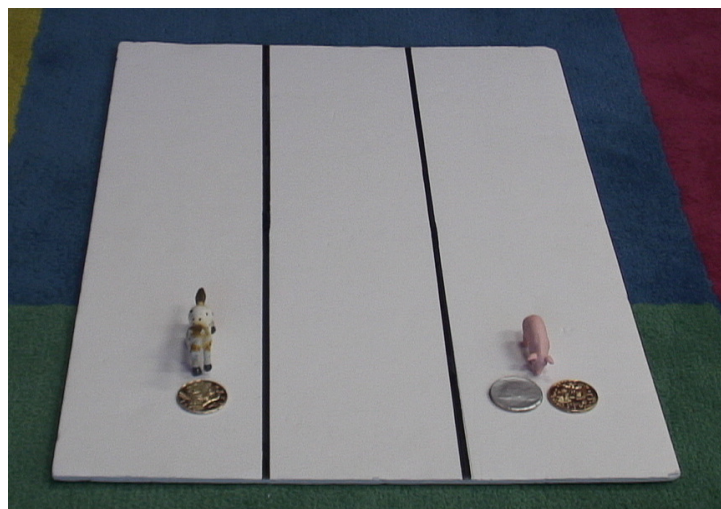


Fig.1. *Zhiyou*-construction, 'adult-true' condition

On a typical trial in the ‘adult-true’ condition, the experimenter acted out the following story: “Mr Horse and Mr Pig are going to have a running race. At the far end of the track, there are three coins – two gold coins and one silver coin. They look very shiny. But only the one who runs faster can get these coins. Mr Pig is not very fast. Mr Horse is a fast runner, but he goes to eat a cake in the middle of the race. After eating a cake, he eats a banana. The food makes him sleepy so he decides to take a nap. When he wakes up, Mr Pig has finished the race. Mr Horse feels so sad that he cannot help crying. But Mr Pig is a nice guy. He takes a gold coin and a silver coin for himself, and leaves the other gold coin to Mr Horse.” Figure 1, which corresponds to the scene at the end of the story, illustrates this condition.

After the story was finished, the puppet described what he thought had happened in the story, using the test sentence in (21).

(21) Zhiyou zhu xiansheng nadao-le yinse yingbi.

only pig sir get-ASP silver coin

‘Only Mr Pig got a silver coin.’

Here is a typical trial in the ‘adult-false’ condition: “Mr Cat and Mr Rabbit are having lunch at Mr Owl’s restaurant. Only two kinds of food are served here, fish and carrots. Mr Cat orders a fish and Mr Rabbit orders a carrot. They soon eat them up. But Mr Rabbit feels like having one more carrot, so he orders another one. When he is about to eat it, he smells a fish-flavour from the carrot. He always thinks that fish taste yucky, so he gives the carrot to Mr Cat. Mr Cat likes this fish-flavoured carrot. He soon finishes it.” Figure 2, which corresponds to the scene at the end of the story, illustrates this condition.



Fig.2. *Zhiyou*-construction, ‘adult-false’ condition

When the story concluded, the puppet presented the test sentence, as in (22).

(22) *Zhiyou mao xiansheng chi-le huluobo.*

only cat sir eat-ASP carrot

‘Only Mr Cat ate a carrot.’

Four filler items were also included. On these items, the puppet produced statements like (23) and (24), which were either obviously true or obviously false.

(23) *Tiaotiaohu zhaodao-le zhu, danshi meiyou zhaodao tuzi.*

Tigger find-ASP pig but not find rabbit

‘Tigger found the pig, but he didn’t find the rabbit.’

(24) *Nanhai he nühai qizhe ma qu mai dongxi le*

boy and girl ride horse go buy thing ASP

‘The boy and the girl rode a horse to go shopping.’

These filler items were included to verify that the child could answer both ‘yes’ and ‘no’ correctly, as well as to obscure the purpose of the experiment. Test and filler items were presented in a pseudo-random order. All the test stimuli are provided in Appendix A.

Before we present the results, let’s turn to the two proposals discussed in the previous section, to see how the present study can be used to adjudicate between the two. As discussed, the two proposals differ in their explanations of children’s non-adult interpretation. One suggests that children interpret the presubject *only* and the preverbal *only* in the same way, because children tend to associate the focus particle *only* with the VP (Crain et al., 1994), whereas the other attributes children’s non-adult interpretation to their difficulty in computing the assertion associated with the contrast set (Paterson et al., 2003). These two proposals will make different predictions about children’s performance in our experiment.

On Crain et al.’s (1994) account, children should be expected to reject the test sentences in both ‘adult-true’ and ‘adult-false’ conditions. Because if children are VP-oriented, they will interpret sentences like (21) and (22) with presubject *zhiyou* as their counterparts with preverbal *zhiyou*, as in (25) and (26), both of which are false in these two conditions. If, on the other hand, Paterson et al.’s (2003) analysis is on the right track, then we should expect children to accept the test sentences like (21) and (22) in both conditions, since they can only compute the presuppositions of the focus structures, as indicated in (27) and (28), both of which are true in these two conditions. A third possibility, of course, is that children have adult-like knowledge of focus structures. If so, then we should see children accept the test sentences in the ‘adult-true’ condition and reject them in the ‘adult-false’ condition.

(25) Zhu xiansheng zhi nadao-le yinse yingbi.

pig sir only get-ASP silver coin

‘Mr Pig only got a silver coin.’

(26) Mao xiansheng zhi chi-le huluobo.

cat sir only eat-ASP carrot

‘Mr Cat only ate a carrot.’

(27) Zhu xiansheng nadao-le yinse yingbi.

pig sir get-ASP silver coin

‘Mr Pig got a silver coin.’

(28) Mao xiansheng chi-le huluobo.

cat sir eat-ASP carrot

‘Mr Cat ate a carrot.’

## Results and discussion

The dependent measure in the study was the proportion of ‘yes’ responses to the puppet’s statements in each condition. Both children and adults gave correct responses on filler items 100% of the time.

A Mann-Whitney Test was used to compare the patterns of responses by children and adults in each condition. A significant difference was found between children and adults in the ‘adult-true’ condition. As expected, Mandarin-speaking adults accepted presubject *zhiyou*-constructions 100% of the time; Mandarin-speaking children, by contrast, only accepted them 10% of the time ( $Z = 5.65$ ,  $p < .001$ ). Children rejected the test sentences 90% of the time. When asked why the puppet was wrong, they all justified their answers by citing the fact that the character in question performed another action besides the one mentioned in the test sentences. Consider (21), for illustration. Children’s stated reason for rejecting (21) in the ‘adult-true’ condition was that Mr Pig also got a gold coin. In the ‘adult-false’ condition, there was no significant difference in the acceptance rates of the test sentences by adults (0%) versus children (13.30%) ( $Z = 2.08$ ,  $p = .11$ ). Both children and adults rejected the test

sentences to a high degree (adults: 100% vs. children: 86.70%), but they rejected them for different reasons. Sentence (22) is used to illustrate. Adults rejected (22) by making reference to the fact that Mr Rabbit also ate a carrot, whereas children rejected the sentence by pointing out that Mr Cat also ate a fish.

Within each group, a Wilcoxon Signed Ranks Test was used to compare the response patterns across the two conditions. For children, no significantly different patterns were observed in the ‘adult-true’ condition versus ‘adult-false’ condition ( $Z = 1.41$ ,  $p = .50$ ); adults, by contrast, exhibited distinct patterns in these two conditions ( $Z = 4.47$ ,  $p < .001$ ), as illustrated in Figure 3.

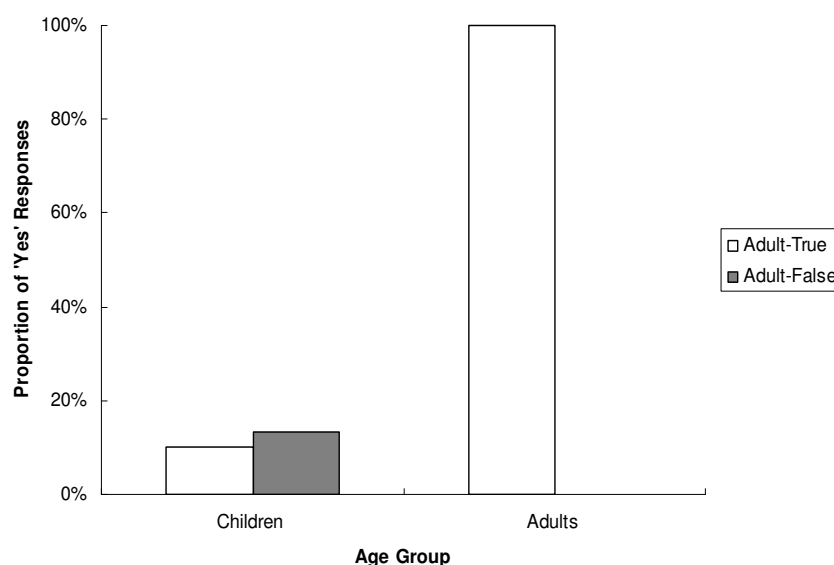


Fig.3. Proportions of ‘yes’ responses to the puppet’s statements in the ‘adult-true’ and ‘adult-false’ conditions by children and adults, Experiment 1

The results from this experiment showed that children rejected presubject *zhiyou*-constructions in both ‘adult-true’ and ‘adult-false’ conditions for the same reason, i.e., because the character in question performed another action besides the one mentioned in the test sentences. This is compelling evidence that Mandarin-speaking children are VP-oriented;



they tend to associate the presubject *zhiyou* with the VP. And it is evidence that children had no difficulty in computing the assertion in both cases. To illustrate, consider sentence (22), repeated here as (29).

(29) *Zhiyou mao xiansheng chi-le huluobo.*

only cat sir eat-ASP carrot

‘Only Mr Cat ate a carrot.’

- a. Presupposition: Mr Cat ate a carrot.
- b. Assertion: Mr Cat didn’t eat anything except a carrot.
- c. Assertion: Everyone other than Mr Cat didn’t eat a carrot.

As noted earlier, when children rejected sentence (29), they justified their rejection by pointing out that Mr Cat ate something else in addition to a carrot, namely a fish. This justification is a clear indication that children were computing the relevant presupposition and assertion, as in (29a) and (29b). Only the assertion they computed was different from that of adults, as in (29c), due to the different focused elements they identified (VP vs. subject NP). These findings support Crain et al.’s (1994) proposal that children initially associate the focus particle with the VP.

In the next experiment, we examined how Mandarin-speaking children and adults understand *shi...de* constructions. As we have discussed, syntactically *shi...de* constructions are more like *zhiyou*-constructions (i.e., the focus particle *shi* has to c-command the focused element), though semantically they are interpreted as English clefts. Therefore, if children are VP-oriented, they should be expected to associate the focus particle *shi* with the VP, as they did with the focus particle *zhiyou*.

## Experiment 2

In this experiment, we investigated how Mandarin-speaking children and adults interpret focus structures like (5), repeated here as (30).

(30) Shi Yuehan chi-de pingguo.

be John eat-DE apple

‘It is John who ate an apple.’

### Method

#### *Subjects*

Twenty Mandarin-speaking children (mean age 4;7, range 4;5 to 4;10) and 20 Mandarin-speaking adults participated in this experiment. None of the subjects had participated in Experiment 1 and there was no significant difference in the age of the child subjects in this experiment and those of Experiment 1 ( $t(38) = 0$ ,  $p = 1$ ).

#### *Procedures*

As in Experiment 1, we tested child subjects using the Truth Value Judgement Task. They were given two practice items before the actual test, one in which the puppet’s statement was obviously true and one in which it was obviously false, so that children knew that the puppet could say something wrong. Adult controls were tested on the same stories but using a questionnaire.

#### *Materials*

The test stimuli used in this experiment were the same as those in Experiment 1 except for the test sentences. *Zhiyou*-constructions were replaced by *shi...de* structures following each

scenario. Test and filler items were presented in a pseudo-random order (see Appendix B for all the test sentences). Sentences (31) and (32) are used to illustrate.

(31) Shi zhu xiansheng nadao-de yinse yingbi.

be pig sir get-DE silver coin

‘It is Mr Pig who got a silver coin.’

(32) Shi mao xiansheng chi-de huluobo.

be cat sir eat-DE carrot

‘It is Mr Cat who ate a carrot.’

As in Experiment 1, test sentences like (31) were presented in an ‘adult-true’ condition, in which Mr Pig got a gold coin and a silver coin, and Mr Horse only got a gold coin. Test sentences like (32) were presented in an ‘adult-false’ condition, where Mr Cat ate a carrot and a fish, and Mr Rabbit only ate a carrot.

## Results and discussion

The dependent measure in this experiment was the proportion of ‘yes’ responses to the puppet’s statements in each condition. The data of one child was eliminated from the final analysis, because she didn’t give correct answers to the filler items. The remaining 19 children and 20 adults answered correctly 100% of the time on the filler items.

A Mann-Whitney Test was used to compare the response patterns between children and adults in each condition. In the ‘adult-true’ condition, adults accepted the test sentences 100% of the time. By contrast, children only accepted them 10.50% of the time. This difference was highly significant ( $Z = 5.56$ ,  $p < .001$ ). Mandarin-speaking children rejected the test sentences 89.50% of the time by citing the fact that the character in question

performed another action besides the one mentioned in the test sentences, i.e., they rejected (31) by pointing out that Mr Pig also got a gold coin. In the ‘adult-false’ condition, no significant difference was found in their acceptance rates (adults: 0% vs. children: 10.50%;  $Z = 1.47$ ,  $p = .23$ ). Both Mandarin-speaking adults and children rejected the test sentences to a high degree (adults: 100% vs. children: 89.50%), but they rejected them for different reasons. Consider (32), for example. Adults rejected it by making reference to the fact that Mr Rabbit also ate a carrot. Children, on the other hand, rejected it for the same reason as in the ‘adult-true’ condition, i.e., because Mr Cat also ate a fish. Within each group, a Wilcoxon Signed Ranks Test was used to compare the response patterns across the two conditions. For children, no significantly different patterns were observed in the ‘adult-true’ condition versus the ‘adult-false’ condition ( $Z = 0$ ,  $p = 1$ ); adults, by contrast, exhibited distinct patterns in these two conditions ( $Z = 4.47$ ,  $p < .001$ ), as displayed in Figure 4.

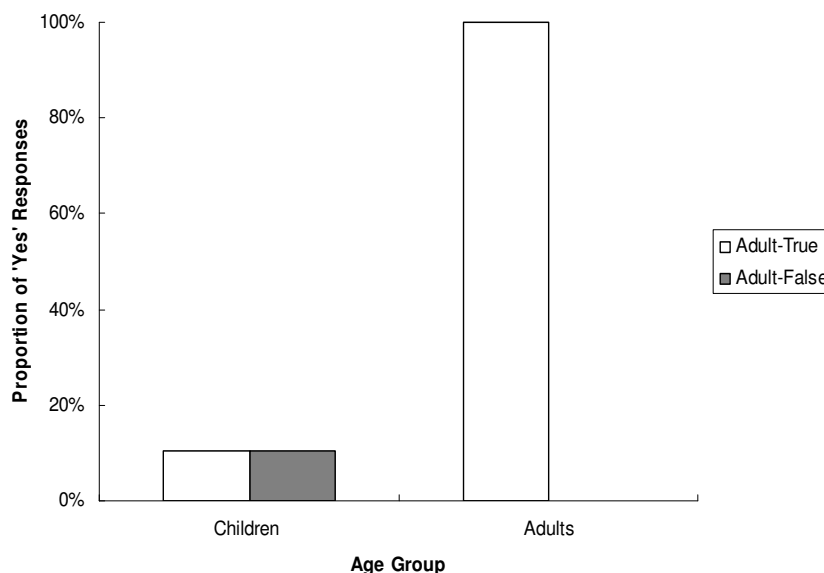


Fig.4. Proportions of ‘yes’ responses to the puppet’s statements in the ‘adult-true’ and ‘adult-false’ conditions by children and adults, Experiment 2

Similar response patterns were obtained in this experiment, as compared to

Experiment 1. In both ‘adult-true’ and ‘adult-false’ conditions, children rejected presubject *shi...de* constructions by citing the fact that the character in question performed another action besides the one mentioned in the test sentences. These results provide further evidence for the proposal by Crain et al. (1994) that children are VP-oriented.

To recap, convergent data were obtained in Experiment 1 and Experiment 2. Mandarin-speaking children and adults differ in the interpretation of focus structures. In both constructions, where adults associated the focus particle with the subject NP, children were found to associate the focus particle with the VP. As discussed earlier, the understanding of focus structures is a two-step procedure. The first step is to identify the focused element associated with the focus particle using the c-command constraint, and then to compute the relevant presupposition and assertion. The findings indicate that children’s problem lies only in the first step. Children produce non-adult responses because they do not associate the focus particle with the same constituent as adults do. The question to raise now is why children tend to associate the focus particle with the VP, instead of the subject NP. What is the source of this VP-orientation? Do they not use the c-command constraint to identify the correct focus associated with the focus particle, since the VP is outside the c-command domain of the presubject focus particle?

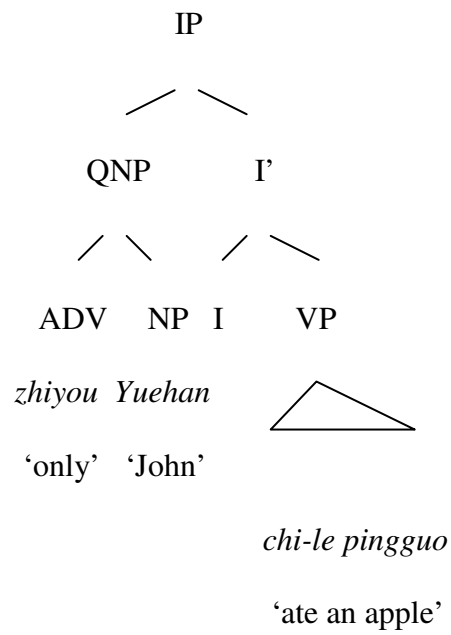
Based on the above findings, we suggest that in adult Mandarin, focus particles *zhiyou* and *shi* can either be used to modify an NP or a VP, depending on the position of the focus particle in the sentence structure. But in child Mandarin, focus particles *zhiyou* and *shi* are normally treated as adverbials. Sentences (4) and (7) are used to illustrate, repeated here as (33) and (34).

(33) a. *Zhiyou Yuehan chi-le pingguo.*

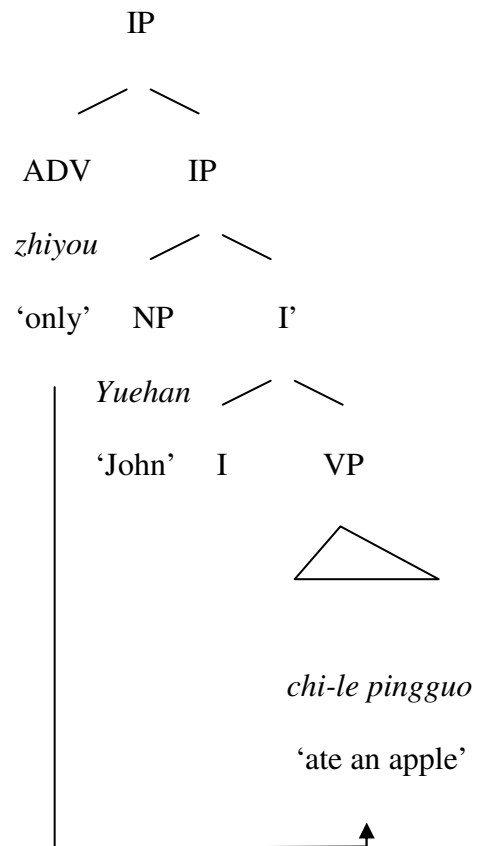
only John eat-ASP apple

‘Only John ate an apple.’

b.



c.

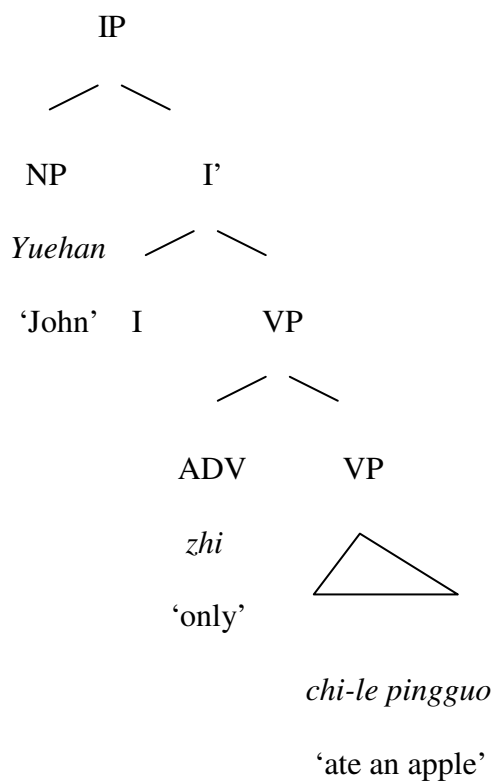


(34) a. Yuehan zhi chi-le pingguo

John only eat-ASP apple

‘John only ate an apple.’

b.



For adults, when the focus adverb *zhiyou* appears in presubject position, as in (33a), it is used to modify the subject NP, as illustrated in the tree diagram (33b), where *zhiyou* c-commands the subject NP *Yuehan* ‘John’, but not the VP. In this case, *zhiyou* is treated as a determiner and forms a constituent with the subject NP *Yuehan* ‘John’, which we have labelled Quantified Noun Phrase (QNP). One source of evidence that they form a constituent comes from the fact that *zhiyou Yuehan* ‘only John’ constitutes a perfectly acceptable fragment

answer to *wh*-questions like (35) and (36)<sup>5</sup> (see Radford (1997: 108) for discussion of this sentence fragment test of constituency).

(35) a. *Zhiyou shei chi-le pingguo?*

only who eat-ASP apple

‘Only who ate an apple?’

b. *Zhiyou Yuehan.*

only John

‘Only John.’

(36) a. *Shei chi-le pingguo?*

who eat-ASP apple

‘Who ate an apple?’

b. *Zhiyou Yuehan.*

only John

‘Only John.’

When *zhiyou* occurs in preverbal position, as in (34a), it is treated as an adverbial, which c-commands and is adjoined to the VP, as indicated in (34b). In contrast to adults, children initially treat *zhiyou* as an adverbial both when it occurs in a presubject position, and when it appears in a preverbal position. When it occurs in a presubject position, the focus structure is represented as in (33c), in which *zhiyou* is adjoined to the whole sentence as a sentential adverbial, rather than a determiner which forms a constituent with the subject NP as in adult language. So, the VP is still in the c-command domain of the pre-subject focus particle *zhiyou*.

Children didn’t violate the c-command constraint.

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<sup>5</sup> A survey of fifteen Mandarin-speaking adults was conducted to evaluate this constituency test, and they all indicated that *zhiyou Yuehan* ‘only John’, as in (35b) and (36b), is perfectly natural as a fragment answer to both (35a) and (36a).



Our motivation for this analysis of the child grammar is based on the observation that many adverbs of quantification, like *sometimes*, *usually*, *funnily*, *interestingly*, and so on, tend to take sentential scope and are not typically associated with the subject NP. If children form the (incorrect) generalization that *zhiyou* is a sentential adverb, then it too will tend to take sentential scope. And the association of sentential adverbs with the VP is attested across a variety of human languages. So our proposal is that children initially analyse focus adverb *zhiyou* in the same way as these typical sentential adverbs and, therefore, tend to associate it with the VP.

But now the question is whether children are able to access the adult-like interpretation in certain contexts (i.e., associating the presubject focus particle *zhiyou* with the subject NP), since in our analysis the focus particle *zhiyou* still c-commands the subject NP *Yuehan* ‘John’, as in (33c), though *zhiyou*, as a quantificational adverb, tends to associate with the VP in child Mandarin. So the next experiment was designed to see whether children can use contextual information to access the adult-like interpretation. Children were presented with contexts in which focus on the subject NP was emphasized.

### **Experiment 3**

#### **Method**

##### *Subjects*

Fourteen children participated in this experiment (mean age 4;6, range 4;5 to 4;9). The children were all participants in Experiment 1 and all exhibited very strong VP-orientation in that experiment.

##### *Procedures*

As in Experiment 1, we tested children using a Truth Value Judgement Task. They were tested on sentences in both ‘adult-true’ and ‘adult-false’ conditions.

### *Materials*

The plots of the stories were similar to those in Experiment 1, but different characters were used so that they would seem different to the children. The crucial difference between Experiment 1 and this experiment lies in the way the test stories were presented. In order to assist the children in accessing the adult-like interpretation (i.e., associating the focus particle with the subject NP), we tried to present the test stories biased towards the question ‘who did something?’ in two ways. Firstly, before the story started, we asked the child and the puppet who they thought would do something in the story. Secondly, at the end of the story, we framed the question to the puppet as ‘who did something?’ rather than ‘what happened in the story?’. The following example is used to illustrate, with elements of the story focusing on the subject NP underlined.

### *Example of ‘adult-false’ subject focused story*

“This is a story about Tigger and Winnie the Pooh. They are going to have a jumping game to see who the better jumper is. They are going to jump over two things, a fence and a house. (Child’s name), who do you think can jump over the two things? [Child answers] Kermit, who do you think can jump over the two things? [Kermit answers: Hmm, I have no idea. Maybe Tigger, or maybe Winnie the Pooh]. Ok. Now let’s see who can jump over them. Winnie the Pooh comes to compete first. He thinks that the fence is too easy for him, so he wants to try the house first. He starts running towards the house, but as he gets closer, he realises that it is much too high for him. So he decides to jump over the fence instead of the house. And finally he makes it. Now it’s Tigger’s turn. He starts with the difficult one, the

house. He is now doing some warm-ups. Ready, go! Wow, what a great jump. He succeeded. What follows is just a piece of cake, he jumps over the fence easily. We know who the better jumper is – Tigger. Ok, now the story is over. Kermit, could you tell me who jumped over the fence?”

At this point Kermit uttered a test sentence like (37), using a *shi...de* construction.

(37) Shi Tiaotiaohu tiaoguo-le        liba.

be    Tigger    jump-over-ASP fence

‘It is Tigger who jumped over the fence.’

As discussed earlier, syntactically *shi...de* constructions behave like *zhiyou*-constructions. We chose *shi...de* constructions instead of *zhiyou*-constructions simply because *shi...de* constructions are judged by adult Mandarin speakers to be pragmatically more felicitous in this situation. Altogether there were six test items (three in an ‘adult-true’ condition, and three in an ‘adult-false’ condition) plus four filler items. Test and filler items were arranged in a pseudo-random order.

## Results and discussion

All 14 children consistently responded correctly to the filler items. The dependent measure was again the proportion of ‘yes’ responses to the puppet’s statements in each condition. In the ‘adult-true’ condition, the children accepted the test sentences 76.20% of the time and rejected them 23.80% of the time. When they rejected the test sentences they pointed out that the character in question performed another action besides the one mentioned in the test sentences. In other words, some children were still associating the presubject focus particle

*shi* with the VP. In the ‘adult-false’ condition, the children accepted the test sentences 0% of the time and rejected them 100% of the time. Children justified their rejections by giving adult-like reasons 61.90% of the time (e.g., Winnie the Pooh also jumped over the fence); and they rejected the test sentences for ‘VP-orientation’ reasons 38.10% of the time (e.g., Tigger also jumped over the house).

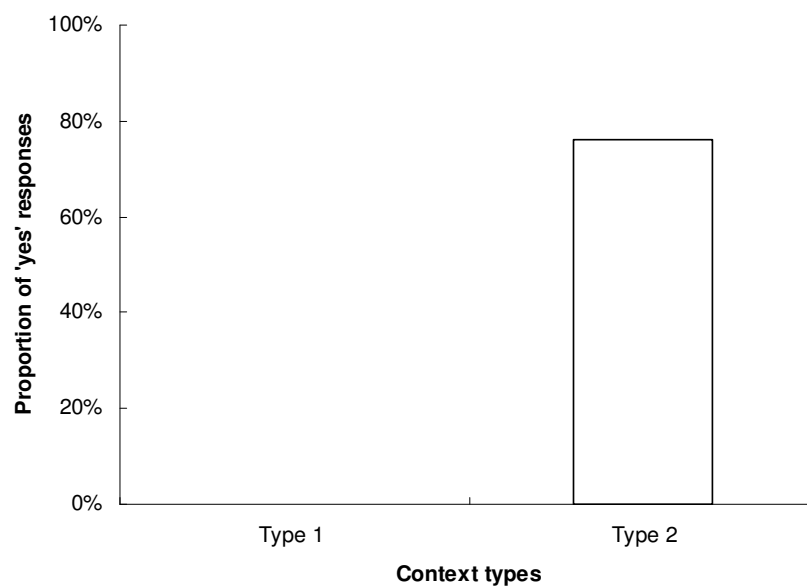


Fig.5. Acceptance rate in the ‘adult-true’ condition across context types, Experiments 1 and 3

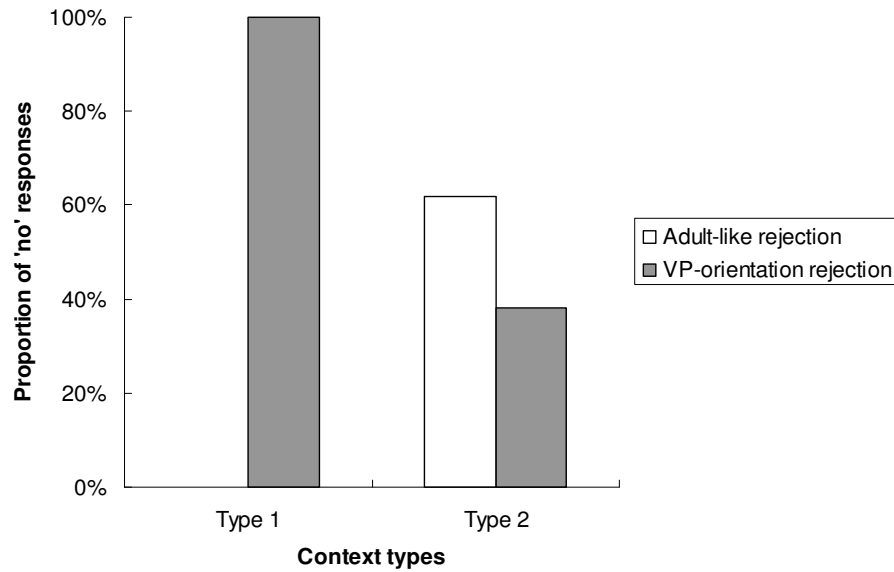


Fig.6. 'Adult-like' and 'VP-orientation' rejections in the 'adult-false' condition across context types, Experiments 1 and 3

A Wilcoxon Signed Ranks Test was used to compare the response patterns of these 14 children in Experiment 1 (Type 1 contexts: non-subject focused) and Experiment 3 (Type 2 contexts: subject-focused). It was found that in the 'adult-true' condition, the acceptance rates of the test sentences significantly increased from Type 1 contexts to Type 2 contexts (0% vs. 76.20%,  $Z = 3.21$ ,  $p = .001$ ), as indicated in Figure 5. In the 'adult-false' condition, there was a significant increase of adult-like rejections from Type 1 to Type 2 contexts (0% vs. 61.90%,  $Z = 2.89$ ,  $p < .01$ ), and a significant reduction of 'VP-orientation' rejections (100% vs. 38.10%,  $Z = 2.89$ ,  $p < .01$ ), as displayed in Figure 6.

The results show that children behaved more like adults when the contexts were biased towards the question 'who did something?', which indicates that the subject-biased stories assisted the children in accessing the adult-like interpretation, associating the focus particle with the subject NP. This is evidence that children can use contextual information to access the adult-like interpretation. However, some children continued to associate the focus particle with the VP, even in these very strong subject-oriented contexts. These findings

suggest that the syntax of focus particles in child language (i.e., focus particles like *zhiyou* and *shi* function as adverbs of quantification) makes their association with the VP as a default value.

In the next experiment, we attempted to provide further empirical support for our analysis of focus particles in child Mandarin. This time we looked at whether children can use syntactic information to access the adult-like interpretation, by using a structure with negation positioned between the focus particle and the VP. We hypothesized that the presence of negation would block the association between the focus particle and the VP, thereby encouraging children to associate the focus particle with the subject NP.

#### **Experiment 4**

According to Relativized Minimality, as proposed by Rizzi (1990, 2001), core linguistic relations are local in the sense that they must be satisfied in a minimal configuration in which they can be satisfied; local relations between two elements are blocked if a third element intervenes and this element has the potential of participating in the relevant relation.

(38) Relativized Minimality Condition (RMC) (Rizzi, 2001: 90)

Y is in a Minimal Configuration with X iff there is no Z such that

- (i) Z is of the same structural type as X
- (ii) Z intervenes between X and Y

The notation of intervention is defined in terms of c-command: Z intervenes between X and Y iff Z c-commands Y and Z does not c-command X. Thus, the RMC has the effect of ruling out the configuration in (39), if Z c-commands Y, Z does not c-command X, and X and Z are of the same structural type.

(39) \*... X ... Z ... Y ...

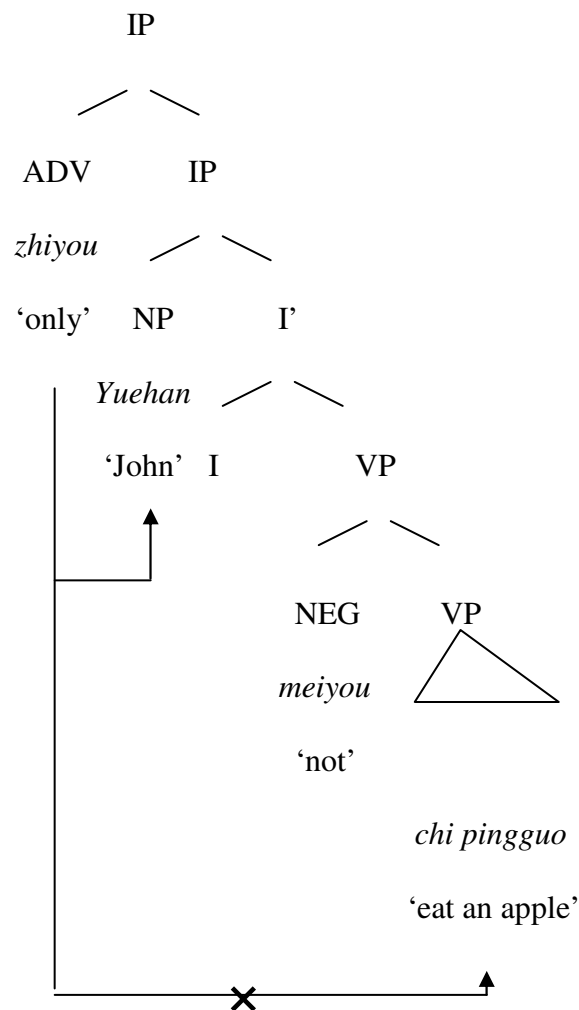
With the RMC as background, Experiment 4 investigated how Mandarin-speaking children and adults interpret focus structures with negation in preverbal position, as in (40a). From Experiments 1, we know that children treat the focus particle *zhiyou* in presubject position as a sentential adverbial and thus tend to associate it with the VP, as indicated in (33c). The addition of negation *meiyou* ‘not’ in preverbal position should, therefore, block this association, since the negation intervenes between the focus particle and the VP, and the negation and the focus particle are of the same structural type, i.e., an adjunct in an A’-position. In this construction, therefore, children may be able to access the adult-like reading, i.e., associating the focus particle with the subject NP, since the only element that remains in its c-command domain and can be associated with is the subject NP. This expected change in the association of the focus particle is graphically depicted in (40b).

(40) a. *Zhiyou Yuehan meiyou chi pingguo.*

only     John     not     eat   apple

‘Only John didn’t eat an apple.’

b.



## Method

### *Subjects*

The subjects in this experiment were 16 Mandarin-speaking children (mean age 4;7, range 4;6 to 4;9) and 16 Mandarin-speaking adults. The age of the child subjects in this experiment didn't differ significantly from those of Experiment 1 ( $t(34) = 1.09$ ,  $p = .28$ ) or those in Experiment 2 ( $t(34) = 1.04$ ,  $p = .31$ ) and none of them had participated in either Experiment 1 or Experiment 2.



### *Procedures*

Child subjects were tested using a Truth Value Judgement Task. They were given 2 practice items before the actual test, one in which the puppet's statement was obviously true and one in which it was obviously false, so that children knew that the puppet could say something wrong. Adult controls were tested on the same stories but using a questionnaire.

### *Materials*

Two types of test sentences were created<sup>6</sup>. One was the sentence structure we discussed above, as illustrated in (40a) (Type 1). The other was the simple *zhiyou*-construction, as in (4), repeated here as (41) (Type 2).

(41) Zhiyou Yuehan chi-le pingguo  
only John eat-ASP apple  
'Only John ate an apple.'

Type 2 sentences were used as a control to see how children understand them in the same scenarios as were used for Type 1 sentences with negation. These two types of sentences were presented following a scenario, which made (40a) false and (41) true. An example is given as follows.

Three dogs (a white dog, a black dog and a brown dog) are going to have a tree climbing contest. They are all very good at tree climbing. This time, they need to climb a big tree and a small tree. They start with the small tree. They all made it to the top easily, as illustrated in Figure 7. Then they come to the big tree. It is much taller than the small tree. The black dog is really a good climber. He touches the top of the tree easily. But the white

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<sup>6</sup> In the actual experiment, there were three types of test sentences, but the third type of test sentences is not relevant to this paper, so we will not discuss it here.

dog and the brown dog have troubles getting into the branches. Each time they lift their front paws, their back paws slide off the branches. No luck: they didn't climb to the top. They failed. Figure 8 illustrates the last scene at the story.



Fig.7. The addition of negation, Experiment 3



Fig.8. The addition of negation, Experiment 3

Since the test sentences involve negation, it is important that our test scenarios satisfy the felicity conditions associated with the use of negation. Crain, Thornton, Boster, Conway, Lillo-Martin & Woodams (1996) proposed the Condition of Plausible Dissent. This condition

is based on Russell's (1948) observation that a negative judgment is appropriate only when the correlative positive judgment has already been made or considered. In the Truth Value Judgement Task, children are asked to say whether sentences are true or false. Following Russell's observation, it is appropriate to ask children for a negative judgment of a sentence only if the corresponding positive judgment has been under consideration at some point of the story. In order to satisfy this condition, the puppet produced a positive lead-in before the test sentences, which corresponded to the first half of the story. In this scenario, the positive lead-in was *San-zhi gou dou pa-shang-le xiaoshu* 'All the three dogs climbed up the small tree'. After the positive lead-in, the puppet explained to the child subject how each individual dog performed, using the test sentences in (42) and (43)<sup>7</sup>.

(42) Zhiyou bai gou meiyou pa-shang da shu.

only white dog not climb-up big tree

'Only the white dog didn't climb up the big tree.'

(43) Zhiyou hei gou pa-shang-le da shu.

only black dog climb-up-ASP big tree

'Only the black dog climbed up the big tree.'

Following each test sentence, the child subject was asked to judge whether the puppet said the right thing about the relevant dog. There were altogether four test scenarios with eight test sentences.

In addition to the test scenarios, each subject also witnessed three control scenarios.

Following each scenario, the puppet produced statements like (44) and (45), which were

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<sup>7</sup> As we mentioned earlier, there were three types of test sentences in the actual experiment, which were used to describe the performance of the three characters in each test scenario. Since the third type of test sentences is not our concern in this study, the corresponding performance of this third character (e.g., the brown dog in the scenario under consideration) will not be discussed here.

either obviously true or obviously false. These items were included to verify that children had no difficulty understanding simple negation, as well as to obscure the purpose of the experiment. The experimenter playing the role of the puppet had a choice between two different statements for each of the control scenarios. One statement was true in the scenario and the other was false. If the child subject had answered ‘yes’ to a given test sentence, the experimenter was instructed to pick the statement for the following control scenario corresponding to a ‘no’ answer, and vice versa. This ensured that the number of ‘yes’ and ‘no’ answers was balanced. All the test stimuli can be found in Appendix C.

(44) Hei mao meiyou mai yu.

black cat not buy fish

‘The black cat didn’t buy fish.’

(45) Bai mao meiyou mai yu.

white cat not buy fish

‘The white cat didn’t buy fish.’

The 16 child subjects were then divided into two groups with eight in each group. One group was presented with *zhiyou*-constructions with preverbal negation, as in (42), followed by simple *zhiyou*-constructions like (43). The other group was presented with the same test sentences in reverse order. Similarly, for the 16 adult controls, two versions of questionnaires were used; one in which the *zhiyou*-constructions with preverbal negation preceded the simple *zhiyou*-constructions, and the other version presenting them in reverse order. The 16 adult subjects were then randomly assigned to each version.

Before we report the results of Experiment 4, we wish to comment further on the properties of the test sentences in this experiment, as compared to those of Experiment 1<sup>8</sup>. Because the test sentences in Experiment 4 involved negation, it is important to ask whether or not these sentences differed appreciably in length from the affirmative sentences in Experiment 1. The concern is that if the negative sentences are longer (due to the additional negative particle), this may have altered the intonation units of the test sentences. That is, both the focus particle *zhiyou* and the subject NP might have been in the same intonation unit in the test sentences in Experiment 4, in contrast to the affirmative sentences in Experiment 1, where the focus particle and the subject NP may have been in different intonation units. If so, children may have been unknowingly led, by prosodic information, to interpret the scope of *zhiyou* differently in the two experiments. Critically, having *zhiyou* and the subject NP in the same intonation unit might have encouraged children to associate them semantically in Experiment 4, in contrast to Experiment 1.

We wish to note, first, that there was only a slight difference in length between the positive and negative sentences in these experiments. Sentences (40a) and (41) are used to illustrate. The positive sentence (41) is *Zhiyou Yuehan chi-le pingguo* ‘Only John ate an apple’ and the negative one (40a) is *Zhiyou Yuehan meiyou chi pingguo* ‘Only John didn’t eat an apple’. The positive sentence lacks the negative marker *meiyou*, but it includes an aspect marker *le*, which is absent in the negative sentence. So the difference in length is a single morpheme. It seems unlikely that such a small difference in length could have consistently resulted in different intonation units. Two further points about prosodic cues are worth making. One is that Mandarin relies more heavily on syntactic structure than on prosodic information to mark the element in focus in sentences with focus particles. For example, consider the sentences *Zhiyou Yuehan chi-le pingguo* ‘Only John ate an apple’ and *Zhiyou*

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<sup>8</sup> The remainder of this section responds to the concerns raised by one of the reviewers about the test materials and procedures used in Experiment 4. We appreciate the opportunity to clarify these points which are relevant for much of the research that investigates children’s interpretation of sentences with focus particles.

*Yuehan meiyou chi pingguo* ‘Only John didn’t eat an apple’. English normally marks focus by phonological prominence, so the subject NP *John* would be stressed in the English counterparts of these sentences. However, phonological prominence is not a strongly favoured strategy in Mandarin, so the focused element *Yuehan* would not typically be prosodically marked in either of these sentences<sup>9</sup>. The second observation regards children’s sensitivity to prosodic cues in associating the focus particle *zhiyou* with different expressions. It has been found that English-speaking children younger than about six years old are not sensitive to prosodic cues in resolving ambiguities involving sentences with the focus particle *only*. This finding was documented in several studies investigating children’s interpretation of dative constructions with the focus particle *only* (e.g., Gualmini, Maciukaite, & Crain, 2002; Halbert, Crain, Shankweiler, & Woodams, 1995). Both observations would appear to reduce the risk that prosodic cues were responsible for children’s different patterns of responses in Experiment 1, as compared to Experiment 4<sup>10</sup>. A related concern is whether or not the experimenter who produced the test sentences might have inadvertently encouraged an association between *zhiyou* and the subject NP, again by providing prosodic cues that this association was intended. In our experiment, the experimenter who produced the test sentences was blind to the experimental hypothesis. He was trained to produce the test sentences using normal intonation, but was not informed about the experimental hypothesis under investigation.

## Results and discussion

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<sup>9</sup> In Mandarin Chinese, phonological prominence of the focused element is optional. When syntactic information can be used to identify the element in focus, Mandarin-speakers tend to use syntactic information. But when syntactic information is not sufficient for identifying the element in focus, phonological information is then used to mark the focus. We will talk more about this in the next chapter.

<sup>10</sup> In the following chapter, we discuss whether Mandarin-speaking children are sensitive to prosodic cues in resolving ambiguities involving the focus particle *zhiyou* ‘only’.

The dependent measure in this experiment was the proportion of ‘yes’ responses to each sentence type produced by the puppet. All the subjects responded correctly to the control sentences 100% of the time.

A Mann-Whitney Test showed that children and adults differed significantly in their acceptance rates of Type 2 test sentences, whereas no significant difference was found in their acceptance rates of Type 1 test sentences. None of the subjects accepted Type 1 test sentences. Both children and adults rejected them (the *zhiyou*-construction with preverbal negation) 100% of the time. And, this time, children and adults rejected them for the same reason, namely that in addition to the character mentioned in the test sentences, another character didn’t perform the relevant action either. In the example scenario, both adults and children rejected (42) by citing the fact that the brown dog didn’t climb up the big tree either. In response to Type 2 test sentences (the simple *zhiyou*-construction), adult accepted them 100% of the time. However, children accepted them only 50% of the time. This difference reached significance ( $Z = 3.22$ ,  $p < .01$ ). As before, when those children who rejected these test sentences were asked why the puppet was wrong, they justified their answers by referring to the fact that the character in question performed another action besides the one mentioned in the test sentences. In the example scenario, they rejected (43) by pointing out that the black dog also climbed up the small tree. Figure 9 illustrates the proportion of ‘yes’ responses to the two types of test sentences by children and adults.

When the child data were examined further by group, a significant effect of the order of presentation was observed. The group of children who were presented with Type 1 test sentences first (Group 1) accepted Type 2 test sentences significantly more often than the group who heard Type 2 test sentences first (Group 2) (87.50% vs. 12.50%,  $Z = 2.77$ ,  $p = .01$ ), though both of the two groups rejected Type 1 test sentences 100% of the time. Figure 10

displays the proportion of ‘yes’ responses to the two types of test sentences by the two groups of children.

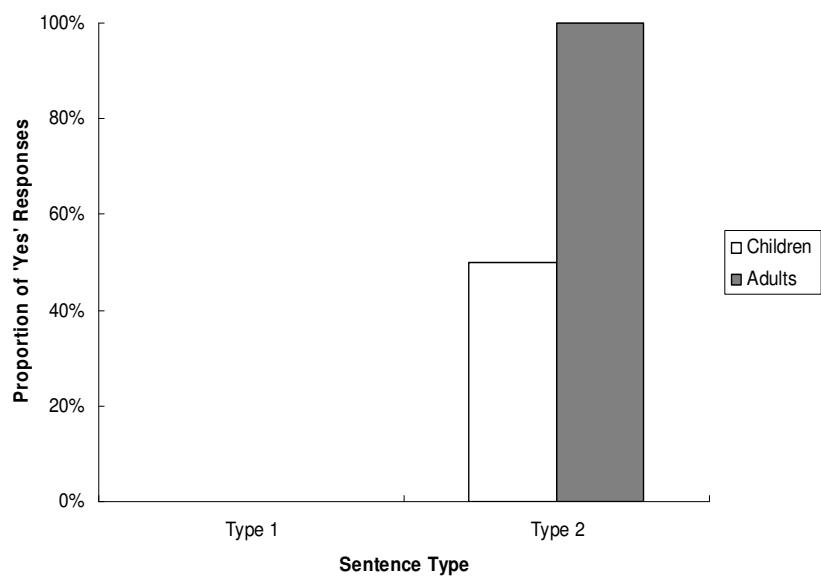


Fig.9. Proportion of ‘yes’ responses to the two types of test sentences by children and adults, Experiment 4

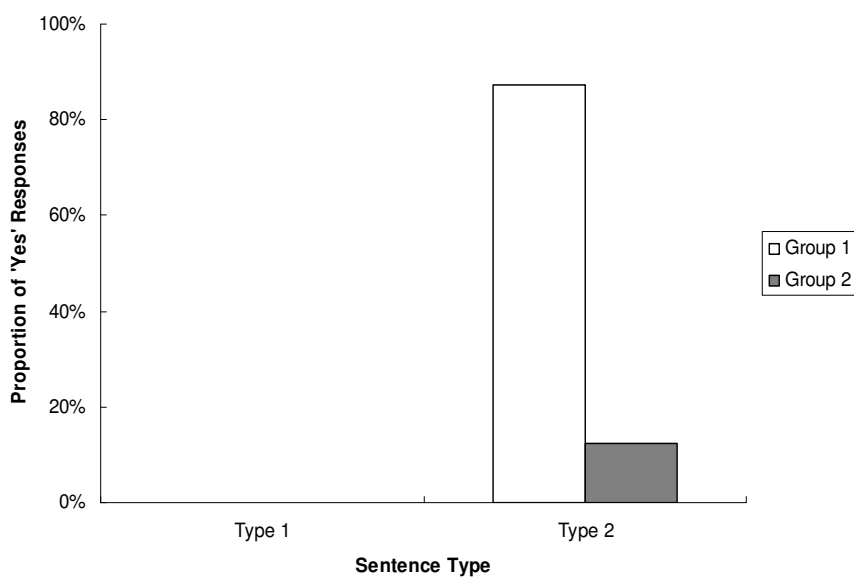


Fig.10. Proportion of ‘yes’ responses to the two types of test sentences by group 1 and group 2, Experiment 4



The results indicate that the addition of negation does block the association between the focus particle and the VP. The presence of negation assists children in accessing an adult-like interpretation, i.e., associating the focus particle with the subject NP. The findings support our analysis that Mandarin-speaking children treat contrastive focus particles like *zhiyou* as adverbials. And once children learn that presubject *zhiyou* can associate with the subject NP, based on the evidence from *zhiyou*-constructions with preverbal negation, they more freely associate it with the subject NP in simple *zhiyou*-constructions, as shown by the effect of the order of presentation. This is also evidence that children can use syntactic information to access the adult-like interpretation.

However, there is one more step children must make to reach the adult grammar. We turn to this in the concluding discussion.

### **General discussion and conclusion**

We began the present study by investigating how Mandarin-speaking children and adults understand contrastive focus constructions like *Zhiyou Yuehan chi-le pingguo* ‘Only John ate an apple’ and *Shi Yuehan chi-de pingguo* ‘It is John who ate an apple’. It was found that children tended to associate the focus particles *zhiyou* and *shi* with the VP, whereas adults uniquely associate them with the subject NP (Experiment 1 and Experiment 2). The findings indicate that children have no difficulty computing the meaning components of focus particles, i.e., the presupposition and the assertion. Children and adults differ only in identifying the element in focus. This supports Crain et al.’s (1994) proposal about the source of children’s non-adult interpretation. However, previous research does not tell us the whole story. One thing that has remained unspecified is a detailed account of why children are VP-oriented. Another missing piece is an account of children’s transition to the adult grammar.

As for the source of children's VP-orientation, we propose that children initially treat focus particles as adverbials. When a focus particle appears in a presubject position, it is treated as a sentential adverbial, thus ending up associating with the VP. In order to assess our proposal, two experiments were conducted. Experiment 3 investigated whether children can use contextual information to access the adult-like interpretation, using contexts in which focus on the subject NP was emphasized. It was found that children behaved more like adults in these contexts, i.e., associating the focus particle with the subject NP. This finding indicates that strong subject-oriented contexts assisted children in accessing the adult-like interpretation. However, some children continued to associate the focus particle with the VP even in these very strong subject-biased contexts, which suggests that the syntactic property of the focus particles in child language makes their association with the VP as a default value. Experiment 4 attempted to provide further empirical support for our analysis of the focus particles in child Mandarin. It looked at whether children can use syntactic information to access the adult-like interpretation, using *zhiyou*-constructions with negation positioned between the focus particle *zhiyou* and the VP, like *Zhiyou Yuehan meiyou chi pingguo* 'Only John didn't eat an apple.' The basic idea is that if children analyse the focus particle as a sentential adverbial in this situation, the negation should block its association with the VP, according to the Relativized Minimality Condition proposed by Rizzi (1990, 2001). We hypothesized, therefore, that the presence of negation could guide children to an adult-like interpretation, i.e., associating the focus particle with the subject NP, since the only element left in its c-command domain and which it can be associated with is the subject NP. This is exactly what we found in Experiment 4. Just like adults, children consistently associated the focus particle *zhiyou* with the subject NP. Perhaps the most interesting finding in this experiment was the effect of the order of presentation on children's interpretation. The group of children, who were presented with *zhiyou*-constructions with negation in preverbal position

like *Zhiyou Yuehan meiyou chi pingguo* ‘Only John didn’t eat an apple’, followed by simple *zhiyou*-constructions like *Zhiyou Yuehan chi-le pingguo* ‘Only John ate an apple’, interpreted simple *zhiyou*-constructions in the same way as adults did, consistently associating the focus particle *zhiyou* with the subject NP. By contrast, the other group of children who were presented with the test sentences in reverse order still associated the focus particle with the VP in simple *zhiyou*-constructions. These findings indicate that the presence of an intervening negation could guide children to associate the presubject focus particle with the subject NP and, once this kind of association was established, children continued to associate the focus particle with the subject NP, even in simple positive sentences. In other words, the presence of negation could assist children in reaching the adult grammar, by revealing that there is an alternative to the VP which can be associated with the focus particle like *zhiyou*. Nevertheless, children’s grammar cannot become equivalent to that of the adults based on this observation alone. Sentence (40a) is used to illustrate, repeated here as (46a). Though the presence of negation assists children in accessing an adult-like interpretation, i.e., associating the focus particle with the subject NP, the focus particle could still remain in the position of a sentential adverb, as represented in (46b), which is different from that of adults, as indicated in (46c), where the focus particle *zhiyou* and the subject NP *Yuehan* form a constituent *zhiyou Yuehan* ‘only John’.

Therefore, to converge on the adult grammar, children require further primary linguistic data revealing that a presubject focus particle *zhiyou* forms a constituent with the subject NP, since sentence structures like (46a) do not reveal this constituent relation between them. We contend that one such kind of primary linguistic data are readily available to children in the form of fragment answers to *wh*-questions, as discussed in (35) and (36), repeated here as (47) and (48). This, in combination with a ‘uniqueness’ constraint on form/meaning

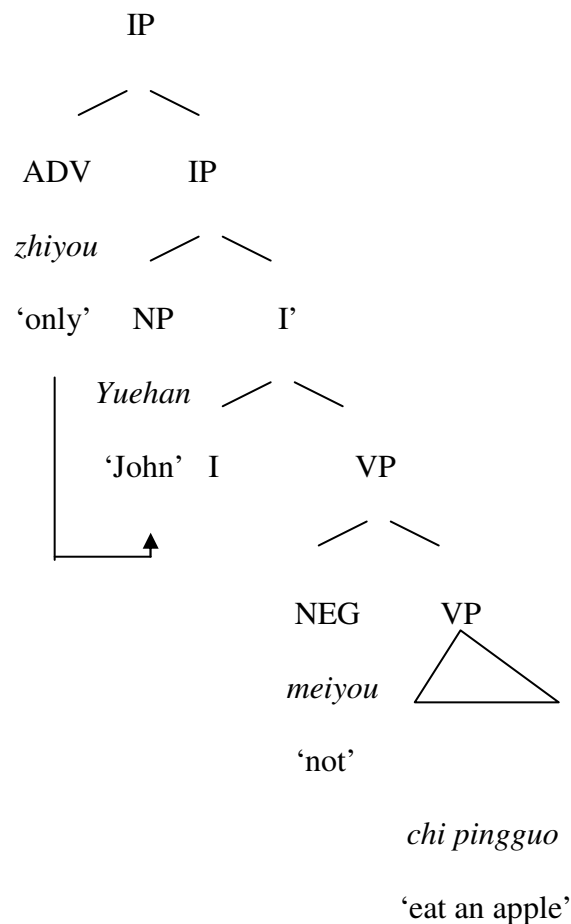
correspondence<sup>11</sup>, informs children that the presubject focus particle is uniquely associated with the subject NP. This completes our account of children's convergence on a grammar that is equivalent to that of the adults in the same linguistic community.

(46) a. Zhiyou Yuehan meiyou chi pingguo.

only John not eat apple

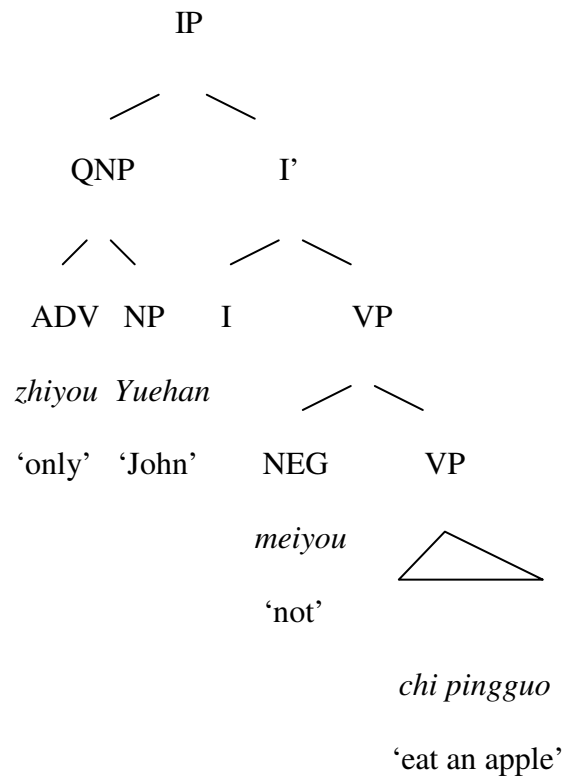
‘Only John didn’t eat an apple.’

b.



<sup>11</sup> This uniqueness constraint is known as the Uniqueness Principle (Pinker, 1984; Wexler, 1979), which is considered to be part of the Language Acquisition Device (LAD). Pinker (1984:113) characterized its function in the following way: “The child knows that when he or she is faced with a set of alternative structures fulfilling the same function, only one of the structures is correct unless there is direct evidence that more than one is necessary”.

c.



(47) a. Zhiyou shei chi-le pingguo?

only who eat-ASP apple

'Only who ate an apple?'

b. Zhiyou Yuehan.

only John

'Only John.'

(48) a. Shei chi-le pingguo?

who eat-ASP apple

'Who ate an apple?'

b. Zhiyou Yuehan.

Only John

'Only John.'

One question remains to be answered, however. If fragment answers to *wh*-questions inform children that the presubject focus particle can be associated with the subject NP, then children apparently have ample evidence to converge on the adult grammar. Why, then, does it take so long for children to attain the target grammar?

We have two responses to this question. First, fragment answers should suffice to inform Mandarin-speaking children that presubject focus particle can associate with the subject NP, but they do not suffice to eliminate the alternative VP-association from children's grammars. To jettison the non-adult association, children could conceivably appeal to a 'uniqueness' constraint on form/meaning correspondence, as we have just discussed. In the present case, however, the 'uniqueness' constraint does not clearly apply, since sometimes the preverbal focus particle is homophonous with the presubject one, i.e., both in the phonological form of *zhiyou*. Conflicting cues like this may prolong children's convergence on the target grammar. We wish to note also that similar delays are widely attested. Children take months, even years, to recover from other mistaken generalizations. For example, young English-speaking children initially hypothesize that reflexive pronouns (e.g., *herself*, *myself*, *yourself*) are formed by combining the bound morpheme *-self* with a possessive pronoun (e.g., *her*, *my*, *your*). This generalization is incorrect, as attested by the counter-examples *himself* and *themselves*. Despite never encountering the incorrect forms, children produce the non-adult forms *hisself* and *theirsself* until they are 4- or 5-years old. Similarly, children continue to produce erroneous past participles, such as *flied* (instead of *flown*) and *rided* (instead of *ridden*) for an extended period, lasting years, despite the absence of these forms in the parental input. Apparently, once a generalization is formed, children are loath to abandon it despite the absence of supporting evidence. Perhaps, the same reluctance to abandon a generalization is at work in the case of focus particles.

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## Appendix A

### Test Stimuli for Experiment 1

#### Test stories

##### Story 1

Plot: This is a story about Piglet and Donald Duck. They are going to compete in a weight-lifting contest to see who is the stronger. They have to try and lift a banana and a car. Mr Elephant is the winner of last year's competition, so this year he gets to be the judge. Now Piglet and Donald Duck are ready to try and lift the two things. Donald Duck comes to compete first. He thinks he is strong, so he starts with the heavier, the car. He goes to the car, stretches his wings and tries to lift the car. But he fails. Too bad. He must have slept too much this year. Then he tries the banana. This time he succeeds. Now it is Piglet's turn. He stretches all his muscles and comes directly to the car. Heave ho, heave ho. He makes a big effort to pick up the car. Oh, great job. He is now holding the car in the air. He made it. Then he goes to the banana and lifts it with one hand. Mr Elephant declares that the winner is Piglet.

Test sentence: Zhiyou Piglet juqi-le xiaoqiche.

only Piglet lift-ASP car

‘Only Piglet lifted the car.’

##### Story 2

Plot: This is a story about Mr Turtle and Mr Goat. They are going to have a swimming competition. At the far end of the pool there are three shells – two purples and one blue. They look so shiny. But only the one who swims faster can get these shells. Now Mr Turtle and Mr Goat are lined up at the start. Ready go! Mr Turtle slips easily into the pool. Mr Goat jumps into the pool too. Mr Turtle is swimming really fast. Mr Goat is not bad. He is right behind

Mr Turtle. But Mr Turtle is really a good swimmer and now he is very close to the end of the pool. Mr Turtle is so excited that he starts to sing (I am going to get all these shells...). But bad luck. When he is about to get to the finish line, he has a cramp. So he has to slow down. Just at this moment, Mr Goat catches up to him and wins the game. Mr Turtle is so sad. But Mr Goat is really a good guy. He takes a blue shell and a purple shell, and leaves the other purple shell to Mr Turtle. Mr Turtle is now moved into tears.

Test sentence: Zhiyou shanyang xiansheng nadao-le lanse beike.

only goat sir get-ASP blue shell

‘Only Mr Goat got a blue shell.’

### Story 3

Plot: This is a story about Mr Horse and Mr Pig. They are going to have a running race. At the far end of the track, there are three coins – two golds and one silver. They look so shiny. But only the one who runs faster can get these coins. Ready go! Mr Horse and Mr Pig start running. Mr Horse is really a fast runner. He leaves Mr Pig far behind him. But Mr Pig is running really hard (Mr Pig ate too much this morning and now he is too fat). Mr Horse almost gets to the finish line. Now he feels kind of hungry and he thinks that Mr Pig moves like a turtle, so he will have plenty of time. He goes to buy a cake without finishing the race. After eating a cake, Mr Horse eats a banana. Now the food makes him sleepy and he decides to take a nap. When he wakes up, Mr Pig has finished the race. Mr Horse feels so sad that he can’t help crying. But Mr Pig is always a nice guy. He takes a gold coin and a silver coin, and leaves the other gold coin to Mr Horse. Now a happy smile is on Mr Horse’s face.

Test sentence: Zhiyou zhu xiansheng nadao-le yinse yingbi.

only    pig    sir            get-ASP   silver coin

‘Only Mr Pig got a silver coin.’

#### Story 4

Plot: This is a story about Mr Monkey and Mr Dog. Look. There are two oranges and one pear on the tree. They are now ripe and look tasty. Mr Monkey and Mr Dog are now under the tree. They are going to climb up the tree to pick these fruits. They start climbing. Mr Monkey swings easily into the tree. He is really going fast. When he touches the top of the tree, Mr Dog is still under the tree. He is having trouble getting into the branches. He has too many legs to think about. Every time he lifts his front paws up, his back paws slide off the branches. Mr Monkey has already got a pear and an orange. When he is reaching for the other orange with his right foot, Mr Dog suddenly has an idea. He is now shaking the tree very hard. Not before long, the last orange drops off the tree and right into Mr Dog’s front paws. He has now got something to eat too.

Test sentence: Zhiyou houzi    xiansheng nadao-le   juzi.

only    monkey   sir            get-ASP   orange

‘Only Mr Monkey got the orange.’

#### Story 5

Plot: This is a story about Tigger and Winnie the Pooh. They are going to have a jumping game to see who is the better. They have to jump over two things, a fence and a house. Winnie the Pooh comes to compete first. He thinks that the fence would be too easy for him. So he starts with the house. He is now running towards the house. But as he gets closer, he realizes that it is much too high for him. He gives up. Then he tries the fence. It is easy. He

clears the fence. Now comes Tigger. He starts with the house too. He is doing some warm-ups. Ready go! He is getting closer. Wow, what a great jump! He made it. The fence is easy for him. He jumps over it without any effort. Tigger is a better jumper.

Test sentence: Zhiyou tiaotiaohu tiao-guo-le liba.

only Tigger jump-over-ASP fence

‘Only Tigger jumped over the fence.’

### Story 6

Plot: This is a story about Mr Cat and Mr Rabbit. It is lunch time now. Mr Cat and Mr Rabbit come to Mr Owl’s restaurant. Only two kinds of food are served here, fish and carrot. They are now ready to order. Mr Cat wants a fish and Mr Rabbit wants a carrot.

These food are their favourites. They soon eat them up. But Mr Rabbit feels like having one more carrot. So he orders another one. When he is about to eat, he smells a fish-flavour from the carrot. He hates fish and he always thinks that fish will taste yucky. So he gives it to Mr Cat. Mr Cat likes this fish-flavoured carrot. He soon finishes it. It is the most delicious carrot he has even eaten. This meal is awesome for him. Poor Mr Rabbit. He is still hungry.

Test sentence: Zhiyou mao xiansheng chi-le huluobo.

only cat sir eat-ASP carrot

‘Only Mr Cat ate a carrot.’

**(NOTE: Test sentences in stories 1, 2 and 3 are true on the adult reading; test sentences in stories 4, 5 and 6 are false on the adult reading.)**

## Filler stories

### Story 1

Plot: This is a story about two rats (a white rat and a black rat). They both are very good at car racing. Today they are going to have a car racing game. Look. There is a big carrot on the way to the finish line. If someone hits the carrot, then he is out. Only the one who avoids the carrot and reaches the finish line will win the game. Now they are ready. Go! Their cars start running. The white rat is so excited that he doesn't see the carrot is right in front of him and his car bumps into the carrot directly. He is out. Too bad. He should have been more careful. The black cat is really good at this game. His car doesn't hit the big carrot. In a few minutes, he reaches the finish line. Good job. He is the winner.

Filler sentence: Bai laoshu zhuangdao-le huluobo, hei laoshu meiyou zhuangdao.

white rat hit-ASP carrot black rat not hit

‘The white rat hit the carrot, but the black rat didn't hit the carrot.’

### Story 2

Plot: This is a story about Tigger and his two friends, the rabbit and the pig. They are going to play hide and seek. Tigger is very good at this game. He is always a good seeker. So this time he gets to be the seeker. Game starts. Tigger covers his eyes and starts counting a hundred while the rabbit and the pig go hide. The rabbit hides himself under the tree. The pig tries to climb up the tree. But he is too fat. He has to give up. Then he tries to get into the house, but the door is too small for him. He sticks himself in the door. Now Tigger starts seeking. He first inspects the small tree, but he finds no one. Then he sees a tail in the door. It is the Pig. He found him. Now Tigger tries to find the rabbit. He examines the big tree, top of it, behind it, but he fails to find the rabbit. The rabbit is really well hidden. Tigger has to give up.

Filler sentence: Tiaotiaohu zhaodao-le zhu, danshi meiyou zhaodao tuizi.

Tigger find-ASP pig but not find rabbit

‘Tigger found the pig, but he didn’t find the rabbit.’

### Story 3

Plot: This is a story about three girls (G1, G1 and G3). They live in a small village. This morning their mother needs to work. When she leaves the house, she tells her three girls to remember to feed the dog and the cat. After G1 got up, she feeds the cat a fish. When he is about to feed the dog, she feels hungry, so she goes to eat a cake, and then forgets to feed the dog. G2 feeds the cat after eating a cake, and when she is ready to feed the dog, her friend comes and they go out to play, and of course she forgets to feed the dog. G3 also feeds the cat a fish, and then she feels so sleepy that she forgets to feed the dog and goes to bed. Poor doggie. He is now hungry and needs a bone. So he walks into G3’s bed and tries to make some noises. It works. G3 wakes up and sees the poor doggie. She then feeds the dog a bone. The dog is now enjoying his meal.

Filler sentence: San-ge nühai dou wei-le mao, danshi dou wang-le wei gou.

three-CL girl all feed-ASP cat but all forget-ASP feed dog

‘The three girls fed the cat, but they forgot to feed the dog.’

### Story 4

Plot: This is a story about a boy and a girl. They want to go shopping. But the shopping centre is far away from their home. So they decide to ride an animal to go there. They have two animals, a horse and a turtle. They want to ride the horse, because it runs much faster than the

turtle. They try to get on the horse's back, but the horse is too tall. They try for several times, but all fail. Now they decide to ride the turtle. This time it is much easier. They get on the turtle's back with no effort. The turtle starts moving towards the shopping centre slowly.

Filler sentence: Nanhai he nühai qizhe ma qu mai dongxi le.

boy and girl ride horse go buy thing ASP

'The boy and the girl rode a horse to go shopping.'

**(NOTE: Filler sentences are obviously true in stories 1 and 2, and obviously false in stories 3 and 4.)**

## **Appendix B**

### **Test Stimuli for Experiment 2**

**The test stories used in Experiment 2 are the same as those in Experiment 1. The test sentences are as follows.**

Test sentence for story 1: Shi Piglet juqi-de xiaoqiche.

be Piglet lift-DE car

'It is Piglet who lifted the car.'

Test sentence for story 2: Shi shanyang xiansheng nadao-de lanse beike.

be goat sir get-DE blue shell

'It is Mr Goat who got a blue shell.'



Test sentence for story 3: Shi zhu xiansheng nadao-de yinse yingbi.

be pig sir get-DE silver coin

‘It is Mr Pig who got a silver coin.’

Test sentence for story 4: Shi houzi xiansheng nadao-de juzi.

be monkey sir get-DE orange

‘It is Mr Monkey who got an orange.’

Test sentence for story 5: Shi tiaotiaohu tiao-guo-de liba.

be Tigger jump-over-DE fence

‘It is Tigger who jumped over the fence.’

Test sentence for story 6: Shi mao xiansheng chi-de huluobo.

be cat sir eat-DE carrot

‘It is Mr Cat who ate a carrot.’

**The filler stories and sentences used in Experiment 2 are the same as those in Experiment 1**

## **Appendix C**

### **Test Stimuli for Experiment 4**

#### **Test stories**

##### **Story 1**

Plot: This is a story about three dogs (a white dog, a black dog and a brown dog). They are all very good at tree climbing. Today they are going to compete in a tree climbing contest to see who is the best. They need to climb a big tree and a small tree. They start with the small tree. They all made it to the top easily. Now they come to the big tree. It is much taller than the small tree. The black dog is really a good climber. He touches the top of the tree easily. But the white dog and the brown dog are having trouble getting into the branches. They have too many legs to think about. Each time they lift their front paws, their back paws slide off the branches. No luck, they didn't climb to the top. The white dog is the best climber.

Positive lead-in: San-zhi    gou dou    pa-shang-le    xiao shu.

three-CL dog all climb-up-ASP small tree

'All the three dogs climbed up the small tree.'

Test sentence 1: Zhiyou    bai    gou    meiyou    pa-shang    da    shu.

only    white dog not    climb-up big tree

'Only the white dog didn't climb up the big tree.'

Test sentence 2: Zhiyou    hei    gou    pa-shang-le    da shu.

only    black    dog    climb-up-ASP big tree

'Only the black dog climbed up the big tree.'

## Story 2

Plot: This is a story about three horses (a white horse, a red horse and a black horse). They are all very good at jumping. This time they are going to have a jumping game to see who is the best. They need to jump over two things, a fence and a house. They start with the fence. It is

easy. They all clear the fence. Now they are going to try the difficult one, the house. They start galloping towards the house, but as they get closer, they realize that it is much taller than they expected. So the white horse and the black horse gave up. The red horse still wants to give it a try. He is now doing some warm-ups. Ready, go! Wow, what a great jump. He made it. The red horse is the best jumper.

Positive lead-in: San-pi    ma    dou   tiao-guo-le        liba.

three-CL horse all    jump-over-ASP fence

‘All the three horses jumped over the fence.’

Test sentence 1: Zhiyou   bai    ma    meiyou   tiao-guo    fangzi.

only    white horse    not    jump-over house

‘Only the white dog didn’t jump over the house.’

Test sentence 2: Zhiyou   hong    ma    tiao-guo-le        fangzi.

only    red    horse jump-over-ASP house

‘Only the red horse jumped over the house.’

### Story 3

Plot: This is a story about three pigs (a white pig, a black pig and a yellow pig). They are all very strong. This time they are going to compete in a weigh-lifting contest to see who is the strongest. They need to try and lift a banana and a car. They start with the banana. It is easy for them. They all made it. Now they come to the heavier, the car. The white pig stretches his arms, and tries to lift it, but he fails. Then comes the black pig. He also stretches his arms and tries to pick up the car. But no luck, he fails too. Our last competitor is the yellow pig. He

stretches all his muscles and makes a big effort to pick up the car. Heave ho, heave ho. Oh, great job. He made it. The yellow pig is the strongest.

Positive lead-in: San-zhi zhu dou ju-qi-le xiangjiao.

three-CL pig all lift-up-ASP banana

‘All the three pigs lifted the banana.’

Test sentence 1: Zhiyou hei zhu meiyou ju-qi qiche.

only black pig not lift-up car

‘Only the black pig didn’t lift the car.’

Test sentence 2: Zhiyou huang zhu ju-qi-le qiche.

only yellow pig lift-up-ASP car

‘Only the yellow pig lifted the car.’

#### Story 4

Plot: This is a story about three dwarfs (D1, D2 and D3). They are going to have a treasure-hunting game. They are all very good at this game. But this time they want to see who is the best treasure hunter. They need to find two things, a shell and a coin. Only the one who finds both a shell and a coin can be the winner. Now they start hunting treasures. D1 found a shell under the tree. D2 found a shell in the box. D3 found a shell behind the door. But they all have trouble finding a coin. The coins are really well hidden. D1 and D2 finally gave up. But D3 is still searching. Suddenly it occurred to D3 that there is a place no one has searched yet, the yard behind the house. So he walks into the yard. He is a lucky guy. He found two coins there. D3 is the winner.

Positive lead-in: San-ge xiaairen dou zhaodao-le beike.

three-CL dwarf all find-ASP shell

‘All the three dwarfs found the shell.’

Test sentence 1: Zhiyou diyi-ge xiaairen meiyou zhaodao yingbi.

only first-CL dwarf not find coin

‘Only the first dwarf didn’t find the coin.’

Test sentence 2: Zhiyou disan-ge xiaairen zhaodao-le yingbi.

only third-CL dwarf find-ASP coin

‘Only the third dwarf found the coin.’

### **Control stories**

#### **Story 5**

Plot: This story is about three cats (a white cat, a yellow cat and a black cat). They are going to buy some fish and some biscuits for lunch. They first come to a fish shop. Only three fish are left. The white cat picks a big fresh one. The yellow cat chooses a small fresh one. So the black cat has to take the last one, but just at that moment he found that the fish has a big bruise. He decides not to buy it. Then they come to a biscuit shop. The black cat bought some fish-flavoured biscuits. The yellow cat bought some shrimp-flavoured biscuits. And the white cat bought some lobster-flavoured biscuits. Now they all have something to eat.

Positive lead-in: San-zhi mao dou mai-le binggan.

three-CL cat all buy-ASP biscuit

‘All the three cats bought biscuits.’

Control sentence: Hei mao meiyou mai yu. (True)

black cat not buy fish

‘The black cat didn’t buy fish.’

Or

Bai mao meiyou mai yu. (False)

white cat not buy fish

‘The white cat didn’t buy fish.’

## Story 6

Plot: This story is about three boys (B1, B2 and B3). They always want to go to the zoo to pet the animals there. Today they are going to pet two animals, a koala and a tiger. B1 comes to pet these two animals first. He approaches the koala and pets it. The koala is so cute. He then walks to the tiger to try to pet it. But the tiger starts growling at B1 and he cannot even get close to it. Then comes B2. After petting the koala, he gets close to the tiger. The tiger starts growling again. But he is brave. He still pets it. Now it is time for B3. He pets the Koala first. Then he approaches the tiger. This time the tiger is very quite. He just enjoys the petting of B3.

Positive lead-in: San-ge nanhai dou mo-le kaola.

three-CL boy all pet-ASP Koala

‘All the three boys petted the Koala.’

Control sentence: Diyi-ge nanhai meiyou mo laohu. (True)

first-CL boy not pet tiger

‘The first boy didn’t pet the tiger.’

Or

Dier-ge nanhai meiyou mo laohu. (False)

second-CL boy not pet tiger

‘The second boy didn’t pet the tiger.’

### Story 7

Plot: This is a story about three girls (G1, G2 and G3). They are having a bad cold. Their mother asks them to take some pills. After leaving the pills on the table, she goes to work. Now it is time for pills. These three girls walk to the table. But when they see the pills, they don’t want to eat them because they think the pills will taste bad. So they decide to eat an ice cream first. Now they all had an ice cream. It should be the time for pills. But G2 still doesn’t want to eat them. So she goes to bed instead. G1 and G3 manage to take the pills, because they want to get better.

Positive lead-in: San-ge nühai dou chi-le bingjiling.

three-CL girl all eat-ASP ice cream

‘All the three girls ate an ice cream.’

Control sentence: Diyi-ge nühai meiyou chi yao. (True)

first-CL girl not eat pill

‘The first girl didn’t take pills.’

Or

Dier-ge    nühai meiyou chi yao. (False)

second-CL girl    not    eat pill

‘The second girl didn’t take pills.’





# **The role of prosody in children's ambiguity resolution**

**This paper is based on the following paper which has been submitted for publication in  
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Zhou, P., & Su. Y., Crain, S., Gao, L.Q., & Zhan, L.K. (submitted). Children's use of  
phonological information in ambiguity resolution: A view from Mandarin Chinese.



## Abstract

How do children develop the mapping between prosody and other levels of linguistic knowledge? This question has received considerable attention in child language research. Much previous research has assessed children's use of prosodic information in ambiguity resolution. But these researches have yielded mixed results. The present study offers two further assessments of children's sensitivity to prosody in ambiguity resolution. Two experiments were conducted to investigate the role of prosody in Mandarin-speaking children's ambiguity resolution. Experiment 1 used eye-tracking to assess children's use of pitch accent in resolving structural ambiguities. Experiment 2 takes advantage of the special properties of Mandarin, where the same sequence of words can be used to perform different speech acts. As far as we know, no previous studies have looked at the role of prosody in children's resolution of ambiguities involving speech acts. So Experiment 2 investigated whether children can use intonational cues to resolve such ambiguities. The results of Experiment 1 showed that children are sensitive to pitch accent in sentence comprehension, but they are not as proficient as adults in using this information to resolve structural ambiguities. The results of Experiment 2 showed that children are as good as adults in using intonational cues to resolve speech act ambiguities. Taken together, we found that children's use of prosodic information in ambiguity resolution can vary according to the type of ambiguity involved. Children can use prosodic information more effectively to resolve speech act ambiguities, than to resolve syntactic ambiguities. This finding suggests that the mapping between prosody and semantics/pragmatics might be better established than the mapping between prosody and syntax in young children.

*Key words:* Child Mandarin; Phonological information; Structural ambiguity; Speech act;

Interface

## **The role of prosody in children's ambiguity resolution**

### **Introduction**

One of the main goals of research in child language is to understand how children develop the mapping between phonology and other levels of linguistic knowledge (e.g., syntax, semantics and pragmatics). Understanding children's mastery of the interfaces between phonology and other parts of the language apparatus is crucial for modelling the human language processing system, for example in stating the role prosody plays in sentence production and comprehension. There have been a handful of production studies of children's use of prosodic information, and the conclusion seems to be that children are as proficient as adults in their use of prosody in production. Much previous research has also assessed children's use of prosodic information in sentence comprehension. But these researches have yielded mixed results at best. Most studies conclude that children fail to use prosodic information in comprehension at the sentence level. Young children have been found to differ from older children and adults in three areas of research: (a) in establishing phrasal groupings (Choi & Mazuka, 2003; Halbert, Crain, Shankweiler, & Woodams, 1995), (b) in resolving ambiguities of phrasal attachment (Snedeker & Trueswell, 2001; Snedeker & Yuan, 2008), and (c) in associating focus particles with appropriate expressions (Gualmini, Maciukaite, & Crain, 2002; Halbert et al., 1995; Höhle, Berger, Müller, Schmitz, & Weissenborn, 2009; Hüttner, Drenhaus, van de Vijver, & Weissenborn, 2004; Szendrői, 2004). Taken together, the findings of previous research invite the conclusion that, although young children process prosodic information, and use prosodic information correctly in their productions, they are able to use such information much less effectively than older children and adults in deciding on the intended interpretation of sentences spoken to them.

The present study offers two further assessments of children's sensitivity to prosody in comprehension. Two experiments are reported investigating the role of prosody for Mandarin-speaking children. Mandarin is worth investigating for several reasons, as we will make clear in later sections. The first experiment is an eye-tracking experiment designed to make an on-line assessment of children's use of pitch accent<sup>1</sup> in resolving structural ambiguities involving the focus particle *zhiyou* (roughly English *only*). In order to maximize prosodic effects in children, the experiment adopted a between-subject design. The experiment used an online measure, eye-movement recordings, to gain an accurate picture of children's use of pitch accent in deciding on a speaker's intended interpretation of sequence of words presented with different prosodic contours.

The second experiment takes advantage of special properties of Mandarin to investigate another use of phonological information by children, namely the speech act that is being performed by a speaker. In Mandarin, the same sequence of words can be used to perform different speech acts. As far as we know, no studies have looked at the role of phonological cues in children's resolution of such ambiguities. More specifically, the experiment assesses Mandarin-speaking children's decisions about the illocutionary force of sentences with *wh*-words where, depending on intonation alone, a *wh*-word can be interpreted as a question-marker, or as part of an indefinite noun phrase, which is a constituent of a statement.

As far as we know, these two experiments comprise the first investigations of Mandarin-speaking children's use of prosodic information in sentence comprehension. The paper is structured as follows. First we review the previous literature. Then we introduce the role of pitch accent in ambiguity resolution in Mandarin Chinese. This is followed by Experiment 1. In section 5, we introduce the role of intonation in disambiguating between

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<sup>1</sup> Pitch accent refers to the relative prominence of a particular syllable, word, or phrase in a certain prosodic structure.

speech acts in Mandarin. This is followed by Experiment 2. Finally, conclusions are presented in section 7.

### **Previous research**

This section reviews several studies whose findings have led to the conclusion that prosody has no or little influence on children's interpretations at the sentence level, until age 5 or 6. We refer the reader to Speer & Ito (2009) for an extended review of the use of prosody in first language acquisition.

The conclusion that children perform poorly in comprehension is surprising, because studies of children's productions have revealed early awareness of the interface conditions that relate phonological and syntactic structures. For example a study of 4-year-old children's productions revealed adult-like use of stress in describing sequences of pictures (Hornby & Hass, 1970). Further confirmation is summarized in Cutler & Swinney (1987). In contrast to the findings of production studies, however, children's knowledge of how prosody functions at the sentence level has proven to be weaker in sentence comprehension. For example Maratsos (1973) found poor performance by 3- and 4-year-old children in understanding the role of stress in fixing the reference of stressed pronouns, and Solan (1980) found that even older children experienced difficulties in fixing the reference of stressed pronouns. This asymmetry in production versus comprehension is paradoxical. In most other aspects of language acquisition, comprehension far outstrips production. The finding that production outstrips comprehension is like finding that children are better at recalling faces than recognizing them.

Cutler & Swinney (1987) suggested that the paradox would be resolved if sensitive on-line measures were used in studies of children's knowledge of the interface relations between phonology and syntax in comprehension. This prediction was only partially

confirmed, however. On-line studies (such as eye-movement recording) have revealed children's sensitivity to phonological cues in language comprehension, as compared to off-line measures (e.g., Snedeker & Yuan, 2008; Höhle et al., 2009). But even studies using on-line measures have not consistently found that children are able to utilize these cues in making decisions about which interpretations to keep, and which to discard, for a majority of linguistic constructions. Let us review some of the relevant literature.

As noted, negative conclusions about children's use of prosody in comprehension have been obtained in experimental investigations of children's use of pitch accent to identify the linguistic expressions that speakers associate with focus particles. The earliest study of this was by Halbert et al. (1995), who investigated 3- to 6-year-old English-speaking children's sensitivity to prosodic cues in understanding ambiguous sentences with the focus particle *only*. Consider sentence (1), for example.

(1) Bill only gave a banana to Sue.

In this sentence, the focus particle *only* can either be associated with the direct object *a banana* or with the indirect object *Sue*. These different associations yield different truth conditions. Prosodic cues can mark the speaker's intended association. For example, with a pitch accent on *a banana*, as in *Bill only gave A BANANA<sup>2</sup> to Sue*, the sentence conveys the meaning that Bill gave a banana, but nothing else, to Sue. On the other hand, with a pitch accent on *to Sue*, as in *Bill only gave a banana TO SUE*, the sentence conveys the meaning that Bill gave Sue, but no one else, a banana.

In the Halbert et al. study, a group of adults were interviewed, and the adults were found to be extremely proficient in using pitch accent to identify the intended interpretations

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<sup>2</sup> Throughout the paper, pitch accent is indicated by capital letters.



of sentences like (1). However, only 13 of the thirty-one 3- to 6-year-old child subjects performed at the same level as adults. The other 18 children tested were apparently unable to use pitch accent at all. The children who ignored the pitch accent in determining the interpretations they assigned to sentences consistently interpreted all of the test sentences using a default strategy in which the focus particle *only* was consistently associated with either the direct object or the indirect object. Similar results for 4- to 5-year-old English-speaking children were obtained by Gualmini et al. (2002), and these findings have been replicated for German-speaking children, using the focus particle *auch* (Hüttner et al., 2004), and for Dutch-speaking children, using the focus particle *alleen* (Szendrői, 2004). A study of European Portuguese by Costa & Szendrői (2006) found that pitch accent did not suffice for correct comprehension by 3- to 5-year-olds, whereas syntactic cues (i.e., scrambling) led to adult-like performance in resolving ambiguities involving focus particles.

However, a recent study by Höhle et al. (2009) yielded a more positive result. These researchers used an on-line technique, eye-tracking, to investigate how German-speaking children interpret sentences with accented and unaccented focus particle *auch*, and found that children exhibited adult-like comprehension, in contrast to previous studies like Hüttner, et al. (2004).

Another sentence-level phenomenon involving prosody is the construction of constituents. Consider the examples in (2).

- (2) a. Bill gave/threw her cat food.  
b. Bill gave/threw her cat FOOD.  
c. Bill gave/threw her CAT food.

As (2) illustrates, sequences of words with verbs like *give* and *throw* are sometimes ambiguous between a double object construction where the cat was given food, or a compound noun construction where some woman or girl was given cat food. In English, pitch accent is used to disambiguate, so (2b) is analysed as a double object construction, and (2c) as a compound noun construction. Halbert et al. (1995) conducted an experiment with 18 children between the ages of 3;0 and 5;3 to see if they used pitch accent as the basis for deciding on how sequences of words were grouped together. Children's success in using pitch accent was verb-specific. Most children used pitch accent as a cue to assign the appropriate phrasal structure with the verb *throw*, but less than half were successful with the verb *give*. A subsequent study by Choi & Mazuka (2003) also found that young Korean-speaking children were unable to use prosody to resolve structural ambiguities (what they call phrasal grouping ambiguities). It is worth noting that children in the Choi & Mazuka study were able to use prosody to resolve ambiguities at the word level, i.e., in word-segmentation ambiguities.

Another sentence-level ambiguity can often be resolved using prosodic information, namely the attachment of prepositional phrases. Snedeker & Trueswell (2001) investigated whether 4- to 5-year-old English-speaking children can use prosodic cues to disambiguate sentences like (3).

(3) Tap the frog with the flower.

There are two possible attachments of the preposition phrase *with the flower* in (3). It can either be associated with the verb *tap* or with the noun phrase *the frog*. When it is associated with the verb *tap*, the sentence conveys the instruction to “tap the frog using the flower”. This is called the instrument reading. When it is associated with the noun phrase *the frog*, the sentence conveys the instruction to “tap the frog that has the flower.” This is called the

modifier reading. Prosodic cues can be used to distinguish between these two interpretations. A prosodic boundary between *frog* and *with*, as in [tap the frog] [with the flower], encourages the instrument reading. By contrast, a prosodic boundary between *tap* and *the*, as in [tap] [the frog with the flower], encourages the modifier reading. In the Snedeker & Trueswell study, children were presented auditorily with either of these two prosodic versions of the test sentences and they were asked to act upon objects in the experimental workspace, based on their interpretations of the sentences. It turned out that children didn't respond differently to the two versions of the test sentences.

A recent study by Snedeker & Yuan (2008) yielded a more positive result, using eye-movement recordings. These researchers suspected that children's failure to use prosodic cues to resolve ambiguities might have been masked, at least in part, by features of the experimental design. In the Snedeker & Trueswell study for example, prosody was manipulated within subjects, so each child listened to both versions of the test sentences in the same experimental session. Snedeker & Yuan (2008) reasoned that this design may have introduced 'carry-over' effects, which could have obscured children's competence in using phonological information. To investigate this possibility, the Snedeker & Yuan study used blocked experimental design in which half of the subjects heard the instrument version of the sentences (i.e., with a prosodic boundary between *frog* and *with*, like [You can feel the frog] [with the feather]) in the first session of the experiment, and then heard the modifier version (i.e., with a prosodic boundary between *feel* and *the*, as in [You can feel] [the frog with the feather]) in the second session. For the other half of the children, the sentences were presented in reverse order. As in the Snedeker & Trueswell study, the task was to act upon objects based on the spoken sentences. The finding was that children were able to use the prosodic boundary as a cue in selecting the intended interpretation.

Another linguistic phenomenon in which prosody plays a role is in contrastive meanings. For example, when adults hear the adjective + noun expression “red butterfly” with a pitch accent on the adjective, as in *RED butterfly*, they infer the existence of at least one non-red butterfly in the context. By contrast, when the pitch accent is on the noun, as in *red BUTTERFLY*, adults infer that the context contains at least one other red entity, in addition to at least one red butterfly. An eye-tracking study by Sekerina and Trueswell (in press) revealed that Russian-speaking children used the prosodic cues of pitch accent on the adjective (as in *RED butterfly*) to facilitate identification of the intended referent, but only when the adjective and noun were adjacent. If a verb intervened between the adjective and the noun, an early contrastive pitch accent didn’t facilitate the identification of the intended referent. A contrastive meaning was nevertheless inferred, and this led to facilitation, but the facilitation effect was solely due to the ‘split’ structure, i.e., where the adjective and the noun were not adjacent.

As in the Costa & Szendrői (2006) study, the findings of the Sekerina and Trueswell study suggest that syntactic structure is a more reliable cue for children in figuring out a speaker’s intended interpretation, whereas children’s use of prosodic cues is more circumscribed, and leads to adult-like performance by children only in certain linguistic structures and in experiments with particular design features, such as a blocked design, as in Snedeker & Yuan (2008). This design feature is not a silver bullet, however, for investigating children’s knowledge of the interface between prosody and syntax. It should be noted that Gualmini et al. (2002) also adopted a blocked design, but found that children were not sensitive to pitch accent in resolving ambiguities involving sentences with the focus particle *only*.

At this point, let us state the interim conclusions, based on the previous literature. However circumscribed, children’s knowledge of the role of prosody in sentence

comprehension is more likely to be revealed in on-line studies, as compared to off-line studies. Therefore, the first experiment in the present study uses an eye-tracking methodology to investigate the extent to which 4- to 5-year-old Mandarin-speaking children use pitch accent to resolve ambiguities related to focus particles. As far as we know, there are no previous studies of Mandarin-speaking children's use of prosody in ambiguity resolution, so it makes sense to use this on-line task to maximize the chances of detecting children's sensitivity to pitch accent in resolving structural ambiguities. Before we turn to the experiment, let us say more about the kind of ambiguity we will be investigating in Experiment 1.

### **How pitch accent is used to resolve syntactic ambiguities in Mandarin**

This section discusses the role of pitch accent<sup>3</sup> in resolving syntactic ambiguities involving the focus particle *zhiyou* for Mandarin-speakers (*zhiyou* roughly corresponds to English *only*). One characteristic of focus particles is that they associate with a unique expression in a sentence. This expression is called the focus element. Syntactically, the focus particle *zhiyou* 'only' can only associate with elements in its c-command domain<sup>4</sup> (e.g., Jackendoff, 1972; Reinhart, 2004, 2006). Semantically, the interpretation of a focus expression invokes a set of alternatives to the element in focus. These alternatives are presupposed, in the sense that they should have already been introduced in the discourse context (Horn, 1969; Kiss, 1998; Krifka, 1991; Rooth, 1985, 1992). Consider sentence (4), for example.

(4) Zhiyou Yuehan de<sup>5</sup> pingguo shi hongde.

only John DE apple is red

<sup>3</sup> In Mandarin Chinese, the acoustic correlates of pitch accent are mainly the duration and the high point of the pitch contour of the critical words. It is realized by expanding the pitch range and duration of the accented words (Garding, 1987; Jin, 1996; Wang, Lü, & Yang, 2002; Xu, 1999; Zhong, Wang, & Yang, 2001).

<sup>4</sup> Two definitions of c-command relation are generally accepted. One is Reinhart's (1976), that is, node A c-commands node B if neither A nor B dominates the other and the first branching node which dominates A dominates B; and the other is Aoun and Sportiche's (1983), namely, A c-commands B, iff every maximal projection dominating A dominates B, and A does not dominate B.

<sup>5</sup> The particle *de* here is a possessive marker.

‘Only John’s apple is red.’

a. Only [John’s apple]<sub>F</sub> is red.

b. Only [John]<sub>F</sub>’s apple is red.

In this sentence, the focus particle *zhiyou* ‘only’ can either associate with the entire subject noun phrase (NP) *Yuehan de pingguo* ‘John’s apple’, as in (4a), or with an element inside the subject NP, i.e., the modifier of the subject NP *Yuehan* ‘John’, as in (4b). There are two possible focus elements because both phrases are in the c-command domain of the focus particle. As a consequence, the sentence is ambiguous, in the absence of additional information about which expression is the intended focus element. If *zhiyou* ‘only’ is associated with the entire subject NP *Yuehan de pingguo* ‘John’s apple’, the sentence conveys the meaning that John’s apple is red and nothing else is red, as in (5). If *zhiyou* ‘only’ is associated with the modifier *Yuehan* ‘John’, the sentence conveys the meaning that John’s apple is red and no one else’s apple is red, as represented in (6)<sup>7</sup>. As noted earlier, the contrast sets are presupposed. They should already have been established in the discourse context.

(5) John’s apple is red, and nothing else (in the discourse context) is red.

(6) John’s apple is red, and no one else’s apple (in the discourse context) is red.

For our purposes, the point is that prosody provides the necessary information to disambiguate between the two interpretations. Specifically, a pitch accent on the head noun

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<sup>6</sup> Throughout the paper, the focus element is indicated by F-brackets.

<sup>7</sup> Another reading is possible in English, though not in Mandarin Chinese. On this reading the only thing that belongs to John and is red is his apple. Adult speakers of Mandarin Chinese do not assign this reading to the sentence.

*pingguo* ‘apple’, as in (7), encourages the interpretation in (5); and a pitch accent on the modifier *Yuehan* ‘John’, as in (8), encourages the interpretation in (6).

(7) Zhiyou Yuehan de PINGGUO shi hongde.

only John DE apple is red

‘Only John’s APPLE is red.’

(8) Zhiyou YUEHAN de pingguo shi hongde.

only John DE apple is red

‘Only JOHN’s apple is red.’

The first experiment was designed to see whether Mandarin-speaking children use pitch accent to distinguish between these two interpretations.

## **Experiment 1**

In this experiment, we investigated whether Mandarin-speaking children can use pitch accent to resolve syntactic ambiguities related to the focus particle *zhiyou* ‘only’.

### **Method**

#### *Participants*

We tested 44 monolingual Mandarin-speaking children between the ages of 4;1 and 4;10 (mean = 4;5). The child subjects were recruited from the kindergarten at Beijing Language and Culture University. They had no reported history of speech, hearing, or language disorders. In addition, 38 Mandarin-speaking adults were tested as controls. All of the adult

controls were students at Beijing Language and Culture University. They had no self-reported speech or hearing disorders. They ranged in age from 23 to 27, with a mean age of 25.

### *Procedures and materials*

Both children and adults were tested using the visual world paradigm (Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). Two versions of this paradigm have to date been successfully used with children, one in which participants were asked to act upon objects based on spoken instructions (e.g., Trueswell, Sekerina, Hill, & Logrip, 1999; Snedeker & Trueswell, 2004; Snedeker & Yuan, 2008) and the other in which participants were asked to decide whether a spoken sentence accurately described a visually co-present picture (e.g., Arnold, Brown-Schmidt, & Trueswell, 2007). In this study we adopted the second version. Participants' eye movements were recorded using an EyeLink 1000 eye tracker (by SR Research Ltd., Mississauga, Ontario, Canada) interfaced with a PC computer. The EyeLink 1000 allows remote eye tracking, without a head support. The sampling rate was 500 Hz. The picture stimuli were displayed on the monitor. Spoken test sentences were presented to the participants through the PC computer connected to two external speakers. Though the eye tracker doesn't require head stabilization, the child participants were still held by an adult experimenter, and they leaned slightly back in a chair in front of the monitor. This manoeuvre was taken to reduce back and forth movements by the child participants.

The picture stimuli were always about two characters, Xiaoming and Xiaohong, who are familiar to most children of this age. Xiaoming is a stereotypical boy's name and Xiaohong is a stereotypical girl's name in Chinese. The two characters also had stereotypical boy and girl appearances, for example, the girl character Xiaohong wears her hair in two braids, as in Figure 1.



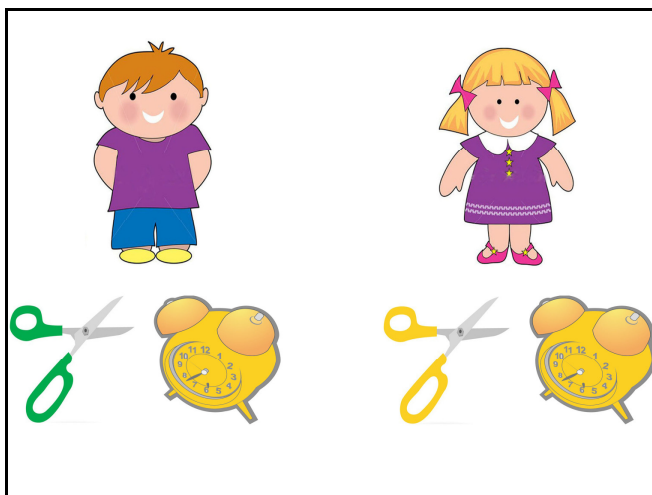


Fig.1. Example of picture stimuli presented to participants (boy character on the left)

In the pictures, both characters had two objects. One character had two objects that neither shared the form nor the colour (target character), and the other character had the same objects as the target character, but the two objects matched in colour (contrastive character). In Figure 1, for example, both Xiaoming (left) and Xiaohong (right) had scissors and a clock. Xiaoming's scissors and clock were different in colour (i.e., green scissors and yellow clock), but Xiaohong's scissors and clock had the same colour (i.e., yellow). So in the example, Xiaoming is the target character and Xiaohong is the contrastive character.

The test sentences were always about the target character. In the test sentences, the referent of the subject phrase was the object that the target character had that matched in colour with the two objects that the contrastive character had (e.g., the yellow clock of Xiaoming)<sup>8</sup>. For example, the corresponding sentence to the example picture stimulus is (9).

(9) Zhiyou Xiaoming de naozhong shi huangsede.

only Xiaoming DE clock is yellow

'Only Xiaoming's clock is yellow.'

<sup>8</sup> All the object phrases used in the test stimuli are disyllabic in Mandarin Chinese.

- (a) Xiaoming's clock is yellow; nothing else (in the discourse context) is yellow.
- (b) Xiaoming's clock is yellow; no one else's clock (in the discourse context) is yellow.

As discussed above, sentences of this type are ambiguous. In sentence (9), for example, the focus particle *zhiyou* 'only' can either be associated with the subject NP (i.e., *Xiaoming de naozhong* 'Xiaoming's clock') or the modifier of the subject NP (i.e., *Xiaoming* 'Xiaoming'), thereby yielding two interpretations as in (9a) and (9b). Prosodic cues can be used to distinguish between the two readings. To be specific, a pitch accent on the head noun (i.e., *naozhong* 'clock'), as in *Zhiyou Xiaoming de NAOZHONG shi huangsede* 'Only Xiaoming's CLOCK is yellow' encourages the interpretation in (9a), and a pitch accent on the modifier (i.e., *Xiaoming* 'Xiaoming'), as in *Zhiyou XIAOMING de naozhong shi huangsede* 'Only XIAOMING's clock is yellow', encourages the interpretation in (9b). Each test sentence was recorded in two prosodic versions, one with a pitch accent on the head noun and the other with a pitch accent on the modifier noun. We will refer to the two types of sentences as Accent-H condition and Accent-M condition respectively. In order to make the test sentences sound more natural, each test sentence was preceded by a short context. For example, sentence (9) was preceded by a context, as in (10).

- (10) Xiaoming he Xiaohong chuqu mai dongxi. Tamen dou mai-le jiandao he  
 Xiaoming and Xiaohong go buy thing they all buy-ASP scissors and  
 naozhong. Wo kankan, zhiyou Xiaoming de naozhong shi huangsede.  
 clock I look only Xiaoming DE clock is yellow  
 'Xiaoming and Xiaohong went to buy something. They both bought scissors and

a clock. Let me have a look, only Xiaoming's clock is yellow.'

The test sentences were produced by a female native speaker of Beijing Mandarin. She was asked to produce the test sentences in a child-directed manner. The recording was conducted in a sound treated booth at Beijing Language and Culture University.

In order to control for potential preferences for looking at particular displayed objects, the gender and the position of the target character were counterbalanced across trials. On half of the trials, the boy character (i.e., Xiaoming) served as the target character (e.g., Figure 1) and on the other half, the girl character (i.e., Xiaohong) served as the target character (e.g., Figure 2).

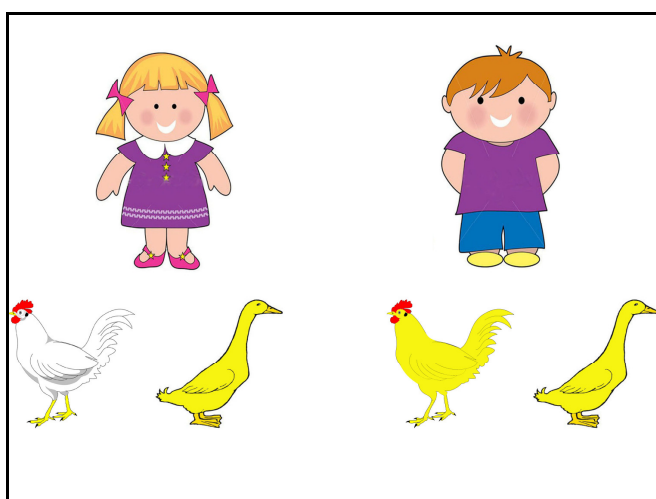


Fig.2. Example of picture stimuli presented to participants (girl character on the left)

In addition, on half of the trials, the target character appeared on the left of the picture and on the other half, the target character appeared on the right of the picture.

There were eight test trials. On each trial, participants viewed a picture like those in Figure 1 and listened to a spoken sentence like those in (9) (either with a pitch accent on the head noun or on the modifier). Their task was to verify whether the spoken sentence was a

true description of the picture. And whenever they judged the spoken sentence to be wrong, they were asked to justify their rejections. The spoken sentence started 2000 ms after the appearance of the picture stimulus. Participants' eye movements were recorded for 6 seconds from the onset of the focus particle *zhiyou* 'only'. The mean length of the spoken sentences was 3315 ms. The mean length of each word of the two types of sentences was illustrated in Table 1 and Figure 3.

Table.1. Duration analyses for the spoken sentences

Sentence segment	Mean for Accent-H condition	Mean for Accent-M condition
Focus particle (e.g., <i>zhiyou</i> 'only')	695 ms	653 ms
Modifier noun (e.g., <i>Xiaoming</i> 'Xiaoming')	505 ms	747 ms
Possessive marker DE	165 ms	151 ms
Head noun (e.g., <i>naozhong</i> 'clock')	835 ms	649 ms
BE (e.g., <i>shi</i> 'is')	195 ms	201 ms
Adjective (e.g., <i>huangse</i> 'yellow')	926 ms	909 ms

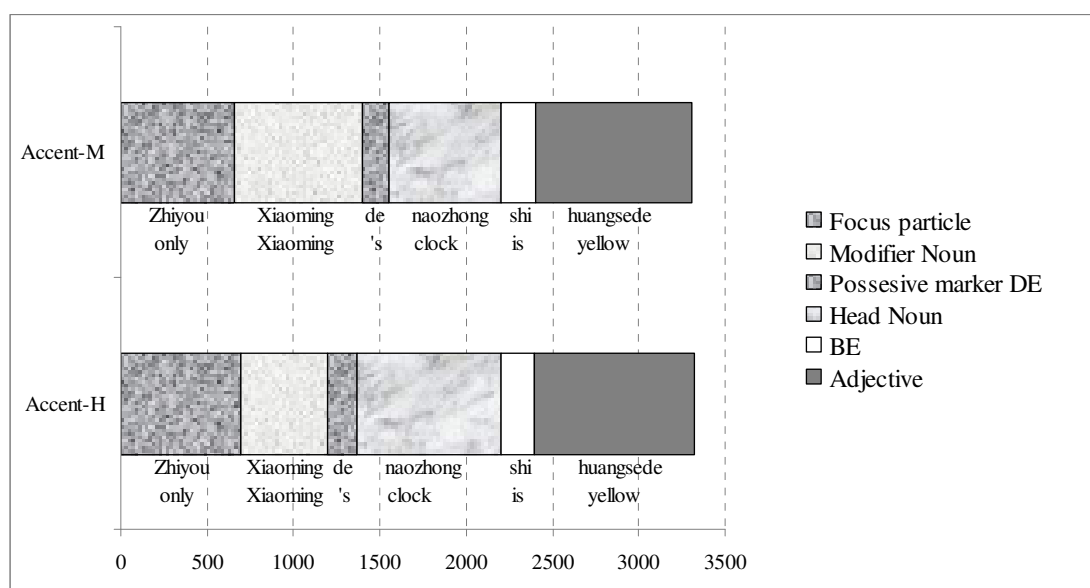


Fig.3. Time course for the spoken sentences

Before each trial, a picture of a little star was presented at the centre of the monitor, which anchored the beginning of each trial, and served to capture the participants' attention. This picture gave way to the trial as soon as the participant focused on the centre of the monitor.

Note that the test sentences, with either a pitch accent on the head noun or the modifier, were always false descriptions of the corresponding pictures. It is known that children tend to accept a test sentence to be true if they don't understand it or are unsure of the answer (Crain & Thornton, 1998). So if the correct answer corresponded to a "yes" response, then children's responses might be taken as evidence for the experimental hypothesis when in fact children simply failed to understand the test sentences. To avoid this possibility, we made all the test sentences false descriptions of the corresponding pictures. In addition, participants were asked to justify their rejections, whenever they judged the test sentences to be wrong. This was used to verify that participants reject the test sentences for the right reasons. This introduced a potential problem, i.e., participants might develop an expectation that all the sentences with the focus particle *zhiyou* 'only' are false. As a consequence, participants might judge all the test sentences to be false without fully attending to the test sentences. To prevent

this problem, eight filler trials were included. The picture stimuli on the filler trials were similar to those on the test trials (i.e., the gender and the position of the target character were counterbalanced across trials), and the spoken sentences on the filler trials had the same structures as the test sentences, but they were always true descriptions of the corresponding pictures. The following example is used to illustrate.

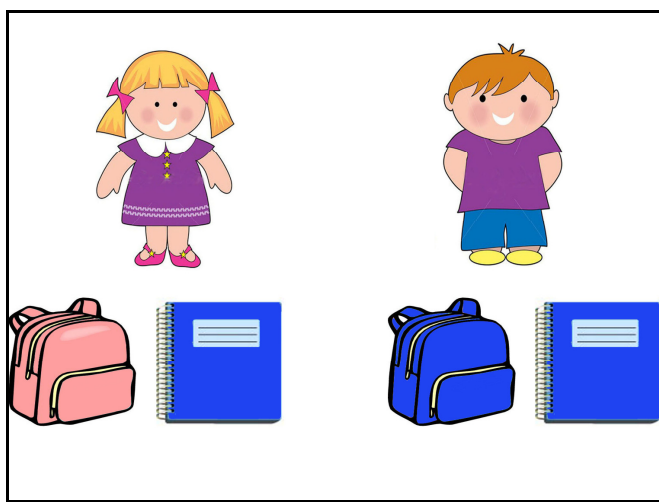


Fig.4. Example of filler pictures presented to participants (girl character on the left)

(11) Zhiyou Xiaohong de shubao shi fensedu.

only Xiaohong DE backpack is pink

‘Only Xiaohong’s backpack is pink.’

The corresponding sentence to Figure 4 is (11). Like the test sentences, each filler sentence had two prosodic versions, one with a pitch accent on the head noun and the other with a pitch accent on the modifier. But irrespective of where the pitch accent was placed, the filler sentence always matched the corresponding picture. Consider sentence (11), for example. With a pitch accent on the head noun *shubao* ‘backpack’, the sentence expresses the meaning that Xiaohong’s backpack is pink and nothing else is pink, whereas with a pitch accent on the

modifier *Xiaohong* ‘Xiaohong’, the sentence expresses the meaning that Xiaohong’s back pack is pink and no one else’s backpack is pink. Both interpretations are true descriptions of Figure 4.

We used a between-subject design. Participants were divided into two groups. One group (22 children and 19 adults) heard the sentences with a pitch accent on the head noun, and the other group (22 children and 19 adults) heard the same sentences with a pitch accent on the modifier. There were eight test trials and eight filler trials for each group (see Appendix A). The test and filler trials were presented to the participants in a random order. In order to familiarize children with the task, two warm-up trials were included, one in which the spoken sentence was obviously true in the picture context and the other in which the spoken sentence was obviously false in the picture context.

Before the actual experiment, we had an introduction session, in which we introduced the two characters and the objects that were presented in the pictures. And since the test sentences involve colour words, we also tested children’s knowledge of colours in this session. Only those children who could tell apart different colours used in the pictures were included in the actual test.

## Results and discussion

One child could not clearly distinguish the different colours used in our experiment. So he didn’t proceed to the actual test session. Five additional children and three adults were excluded because we were unable to calibrate them on the eye tracker. The remaining 38 children (20 in the Accent-H condition and 18 in the Accent-M condition) and 35 adults (18 in the Accent-H condition and 17 in the Accent-M condition) were included in the final analysis.

There were two sets of data. The first set of data was the judgement data. In the experiment, participants were asked to indicate whether a spoken sentence was a true description of a given picture, and when they judged the sentence to be wrong, they were asked to justify their rejections. The second set of data was the eye movement data. Participants' eye movements were recorded while they were listening to the test sentences. Their fixations were coded in four categories: target object (the object that the target character had and that matched in colour with the two objects that the contrastive character had ), first contrastive object (the object that the contrastive character had and that matched in form and colour with the target object), second contrastive object (the object that the contrastive character had and that matched only in colour with the target object) and non-contrastive object (the object that the target character had and that neither shared the form nor the colour with the target object). For example, in Figure 1, the target object is Xiaoming's yellow clock, the first contrastive object is Xiaohong's yellow clock, the second contrastive object is Xiaohong's yellow scissors, and the non-contrastive object is Xiaoming's green scissors, as indicated in Figure 5. The proportion of fixations following the onset of the focus particle *zhìyou* 'only' for each category was computed in a time window of 4200ms.

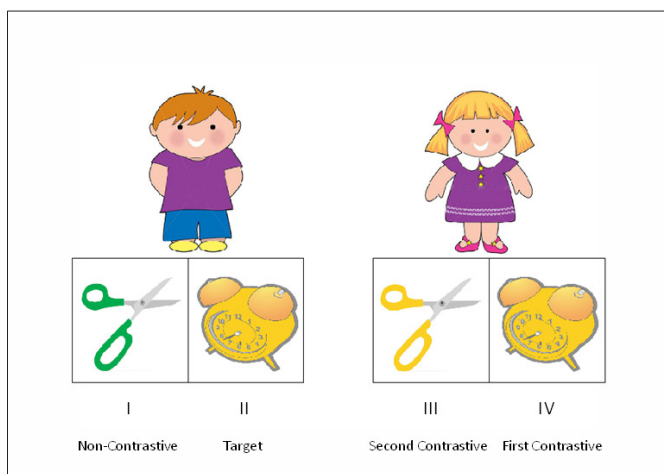


Fig.5. Example of interest areas (Xiaoming is the target character and Xiaohong is the contrastive character)



The critical fixation area is III (the second contrastive object). Our hypothesis is that if children are sensitive to pitch accent in resolving ambiguities involving the focus particle *zhiyou* ‘only’, then they should look more to the second contrastive object in the Accent-H condition than in the Accent-M condition, since with a pitch accent on the head noun, both the first contrastive object and the second contrastive object corresponding to the target object will be evoked, whereas with a pitch accent on the modifier, only the first contrastive object corresponding to the target object will be evoked. Using Figure 5 and sentence (9) (repeated here as (12)) as an example,

(12) *Zhiyou Xiaoming de naozhong shi huangsede.*

only Xiaoming DE clock is yellow

‘Only Xiaoming’s clock is yellow.’

(a) Xiaoming’s clock is yellow; nothing else (in the discourse context) is yellow.

(b) Xiaoming’s clock is yellow; no one else’s clock (in the discourse context) is yellow.

we would expect that children will look more to Xiaohong’s scissors (III) in the Accent-H condition than in the Accent-M condition, because a pitch accent on the head noun *Naozhong* ‘clock’ will evoke both contrastive objects: Xiaohong’s scissors (III) and Xiaohong’s clock (IV), but a pitch accent on the modifier *Xiaoming* ‘Xiaoming’ will only evoke the first contrastive object: Xiaohong’s clock (IV). To be more specific, a pitch accent on the head noun *Naozhong* ‘clock’ encourages the interpretation as in (12a), so in order to see whether this interpretation is a true description of Figure 5, children need to check whether everything else in the picture is not yellow, and it turns out that both contrastive objects are yellow: the

scissors (III) and the clock (IV). A pitch accent on the modifier *Xiaoming* ‘Xiaoming’ encourages the interpretation as in (12b), thus in order to verify whether this interpretation accurately describes Figure 5, children only need to check whether the contrastive character Xiaohong’ clock (IV) is yellow and it turns out that it is yellow. This interpretational difference will lead to more fixations on the second contrastive object (III) in the Accent-H condition than in the Accent-M condition.

### *Judgement data*

Thirty-eight children (20 in the Accent-H condition and 18 in the Accent-M condition) and 35 adults (18 in the Accent-H condition and 17 in the Accent-M condition) were included in the final analysis. All these participants responded correctly to the filler trials, i.e., they all judged the spoken sentences to be true descriptions of the corresponding pictures.

On the test trials, the test sentences, irrespective of where the pitch accent falls, were false descriptions of the corresponding pictures. So if children could use pitch accent to resolve the ambiguity related to the focus particle *zhiyou* ‘only’, then they were expected to reject the test sentences in both Accent-H and Accent-M conditions, but they were expected to give different justifications for their rejections. In the Accent-H condition where the pitch accent was placed on the head noun, children were expected to justify their rejections of the test sentences by making reference to the fact that the two things possessed by the contrastive character also had the property mentioned in the test sentences, whereas in the Accent-M condition where the pitch accent was placed on the modifier, they were expected to reject the test sentences on the grounds that the same thing possessed by the contrastive character also had the property mentioned in the test sentences. Sentence (9) is used to illustrate, repeated here as (13).

(13) Zhiyou Xiaoming de naozhong shi huangsede.

only Xiaoming DE clock is yellow

‘Only Xiaoming’s clock is yellow.’

(a) Xiaoming’s clock is yellow; nothing else (in the discourse context) is yellow.

(b) Xiaoming’s clock is yellow; no one else’s clock (in the discourse context) is yellow.

With a pitch accent on the head noun *naozhong* ‘clock’, sentence (13) means that Xiaoming’s clock is yellow and nothing else is yellow, as in (13a), whereas with a pitch accent on the modifier *Xiaoming* ‘Xiaoming’, the sentence means that Xiaoming’s clock is yellow and no one else’s clock is yellow, as in (13b). Both interpretations are false descriptions of the corresponding picture as in Figure 5. So if children can use pitch accent to distinguish between the two interpretations, they should be expected to reject the test sentence in both conditions but for different reasons. In the Accent-H condition, they should reject the test sentence by pointing out that Xiaohong’s scissors and clock are also yellow, and in the Accent-M condition, they should reject the test sentence by making reference to the fact that Xiaohong’s clock is also yellow. Here are the results.

In the Accent-H condition, adults rejected the test sentences 100% of the time (144/144 trials), and children rejected the test sentences 75% of the time (120/160 trials) and accepted them 25% of the time (40/160 trials)<sup>9</sup>. When examining their justifications for rejection, we found two types of rejections from adults and one type of rejection from children. Most of the adults justified their rejections by pointing out that the two things possessed by the contrastive character also had the property mentioned in the test sentences (136/144 trials (94.44%)), which we call “focus-on-head” rejection. Only one adult pointed

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<sup>9</sup> Five children consistently judged the test sentences to be true descriptions of the corresponding pictures (40/160 trials).

out that the same thing possessed by the contrastive character also had the property mentioned in the test sentences (8/144 trials (5.56%)), which we call “focus-on-modifier” rejection. However, all the children who rejected the test sentences justified their rejections by pointing out that the same thing possessed by the contrastive character also had the property mentioned in the test sentences (120/160 trials ( 75%)). In other words, children only gave “focus-on-modifier” rejections. On the example trial, 17/18 adults rejected sentence (13) by making reference to the fact that Xiaohong’s scissors and clock were also yellow, and one adult rejected the sentence on the grounds that Xiaohong’s clock was also yellow. However, all the children who rejected sentence (13) pointed out that Xiaohong’s clock was also yellow (15/20 children). A Mann-Whitney Test was used to compare the two types of rejections between children and adults, and significant differences were found between them. Children gave “focus-on-head” rejections 0% of the time, as compared to 94.44% by adults ( $Z = 5.77, p < .001$ ). Children gave “focus-on-modifier” rejections 75% of the time, as compared to 5.56% by adults ( $Z = 4.27, p < .001$ ).

In the Accent-M condition, adults rejected the test sentences 100% of the time (136/136 trials), and children rejected the test sentences 77.78% of the time (112/144 trials) and accepted them 22.22% of the time (32/144 trials)<sup>10</sup>. When examining their justifications for rejection, we found only one type of rejection. All the adults pointed out that the same thing possessed by the contrastive character also had the property mentioned in the test sentences (136/136 trials (100%)). Like adults, children who rejected the test sentences all pointed out that the same thing possessed by the contrastive character also had the property mentioned in the test sentences (112/144 trials (77.78%)). In other words, participants only gave “focus-on-modifier” rejections. On the example trial, 17/17 adults justified their rejections on the grounds that Xiaohong’s clock was also yellow, and children who rejected

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<sup>10</sup> Four children consistently judged the test sentences to be true descriptions of the corresponding pictures (32/144 trials).

the test sentence all pointed out that Xiaohong's clock was also yellow (14/18 children). A Mann-Whitney Test showed that there was no significant difference between children and adults in their justifications of rejections. Both children and adults gave "focus-on-modifier" rejections only (children: 77.78% vs. adults: 100%;  $Z = 2.04$ ,  $p = .10$ ).

Let us compare the responses of adults and children in the two conditions. We found that adults responded differently to the test sentences in the two conditions. In the Accent-H condition, adults gave "focus-on-head" rejections, i.e., they rejected the test sentences by making reference to the fact that the two things possessed by the contrastive character also had the property mentioned in the test sentences (e.g., "Xiaohong's scissors and clock were also yellow"), and in the Accent-M condition, adults gave "focus-on-modifier" rejections, i.e., they rejected the test sentences on the grounds that the same thing possessed by the contrastive character also had the property mentioned in the test sentences (e.g., "Xiaohong's clock was also yellow"). However, children responded similarly in the two conditions. In both Accent-H and Accent-M conditions, children gave "focus-on-modifier" rejections, i.e., they rejected the test sentences by pointing out that the same thing possessed by the contrastive character also had the property mentioned in the test sentences (e.g., "Xiaohong's clock was also yellow").

The judgement data show that when a pitch accent was placed on the head noun, adults associated the focus particle *zhīyou* 'only' with the head noun, and when a pitch accent was placed on the modifier, adults associated the focus particle with the modifier. However, children tended to associate the focus particle with the modifier irrespective of where the pitch accent was placed. These findings suggest that children can not use pitch accent to resolve ambiguities involving the focus particle *zhīyou* 'only', in contrast to adults. However, as we discussed in the introduction, off-line judgement tasks might not be sensitive enough to detect the subtle effect of pitch accent in children's sentence comprehension. It could be the

case that children are actually sensitive to pitch accent, but they could not carry this processing sensitivity to the desired judgment response. So we looked at the eye movement data.

### *Eye movement data*

The proportion of fixations following the onset of the focus particle *zhiyou* ‘only’ was computed in a time window of 4200ms for the four categories: the non-contrastive object (I), the target object (II), the second contrastive object (III) and the first contrastive object (IV). This 4200ms time window was then partitioned into 21 segments, each with a duration of 200ms. The mean length of the test sentences was 3315 ms. The data of thirty-eight children (20 in the Accent-H condition and 18 in the Accent-M condition) and 35 adults (18 in the Accent-H condition and 17 in the Accent-M condition) were included in the final analysis.

Before we report the data, let’s revisit the experimental hypothesis. We hypothesized that if children are sensitive to pitch accent in resolving ambiguities involving the focus particle *zhiyou* ‘only’, they should look more to the second contrastive object in the Accent-H condition than in the Accent-M condition, since with a pitch accent on the head noun, both the first contrastive object and the second contrastive object will be evoked, whereas with a pitch accent on the modifier, only the first contrastive object will be evoked. However, if children are not sensitive to pitch accent in resolving ambiguities involving the focus particle *zhiyou* ‘only’, then they should look to the second contrastive object equally often in the Accent-H condition and in the Accent-M condition, because irrespective of where the pitch accent was placed, they would always be associating the focus particle *zhiyou* ‘only’ with the modifier, as indicated by the judgement data.

### **Adult data**

Since the critical area is the second contrastive object, we compared the proportions of fixations in each of the 21 segments in this area in the two conditions. No significant differences were found in the two conditions before the time span between 1600-1800 ms. Adults started to launch more fixations to the second contrastive object in the Accent-H condition than in the Accent-M condition in the time span between 1600-1800 ms, when they heard the head noun of the test sentence. This difference reached significance in the time span between 2600-2800 ms ( $t(33) = 2.39, p < .05$ ) until the sentence was completed in the time span between 3200-3400 ms ( $t(33) = 3.08, p < .01$ ). Figure 6 indicated this difference.

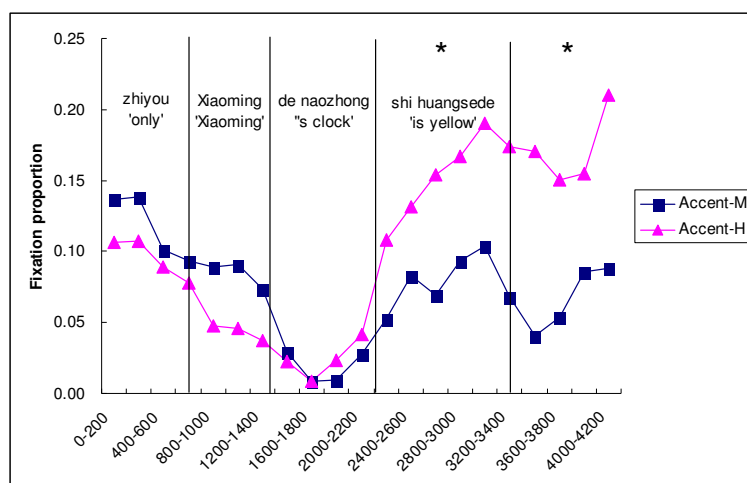


Fig.6. Average fixation proportions over time in III (the second contrastive object) in the two conditions, adults

## Child data

The proportions of fixations in each of the 21 segments on the second contrastive object were compared between the Accent-H condition and the Accent-M condition. No significant differences were found in the two conditions before the time span between 3200-3400 ms. Children started to look more to the second contrastive object in the Accent-H condition than in the Accent-M condition in the time span between 3200-3400 ms, after the test sentence was

completed. This difference reached significance in the time span between 3400-3600 ms ( $t(36) = 2.27, p < .05$ ). Figure 7 indicated this difference.

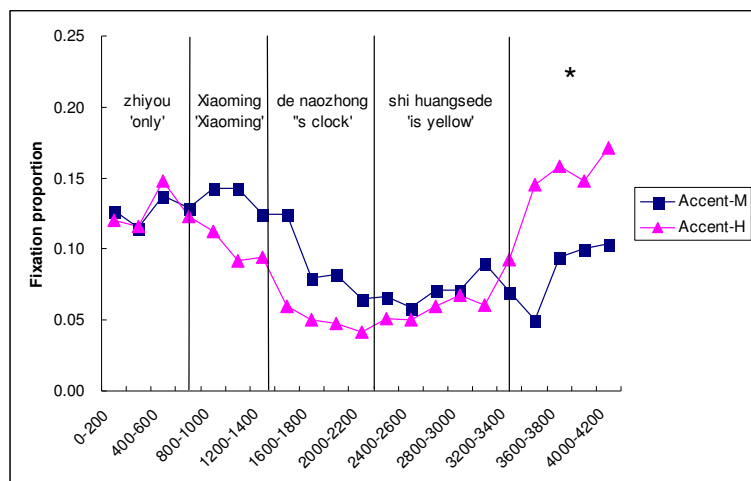


Fig.7. Average fixation proportions over time in III (the second contrastive object) in the two conditions, children

### A comparison between adult and child data

When children's fixation proportion pattern was compared with adults in this critical area in the two conditions, as indicated in Figures 6 and 7, we found that children and adults exhibited similar fixation patterns. Adults started to look to the second contrastive object more often in the Accent-H condition than in the Accent-M condition in the time span between 1600-1800 ms, when they heard the head noun of the test sentence. This effect reached significance between 2600-2800 ms ( $t(33) = 2.39, p < .05$ ) until the sentence was completed in the time span between 3200-3400 ms ( $t(33) = 3.08, p < .01$ ). A similar effect was found in children, but this effect was delayed. Children started to launch more fixations to the second contrastive object in the Accent-H condition as compared to the Accent-M condition in the time span between 3200-3400 ms, after the test sentence was completed. This effect reached significance in the time span between 3400-3600 ms ( $t(36) = 2.27, p < .05$ ).



Children and adults exhibited similar fixation patterns in the other three categories as well. Here we focus on their fixation patterns in area II (the target object). The fixation patterns in the other two categories (the non-contrastive object and the first contrastive object) are given in Appendix B. We looked in more detail at the fixation patterns in the target object area because the target object always corresponds to the head noun in the test sentences. So we expected a difference in the fixation proportions between the Accent-H condition and the Accent-M condition, if the participants are sensitive to pitch accent. Specifically, the participants should direct their attention to the target object more often in the Accent-H condition, than in the Accent-M condition after they hear the head noun, since the head noun received a pitch accent in the Accent-H condition and thus the target object corresponding to the head noun in the Accent-H condition will be more accessible, as compared to the Accent-M condition in which the head noun didn't receive a pitch accent. This is exactly what we found. Figures 8 and 9 illustrate the average fixation proportions over time in the target object area in the two conditions by adults and children.

Adults launched more fixations to the target object in the Accent-H condition than in the Accent-M condition in the time span between 1400-1600 ms, immediately after the head noun started ( $t(33) = 2.64, p < .05$ ). This effect was maintained in the following three time spans: 1600-1800 ms ( $t(33) = 4.19, p < .001$ ), 1800-2000 ms ( $t(33) = 5.65, p < .001$ ) and 2000-2200 ms ( $t(33) = 3.41, p < .01$ ). Similar effect was found in children, but with a 400 ms delay. Children fixated more on the target object in the Accent-H condition than in the Accent-M condition in the time span between 1800-2000 ms ( $t(36) = 2.91, p < .01$ ), after they heard the head noun. This effect was maintained in the following two time spans: 2000-2200 ms ( $t(36) = 4.63, p < .001$ ) and 2200-2400 ms ( $t(36) = 3.33, p < .01$ ).

The eye movement data show that children and adults exhibited similar fixation proportion patterns when processing the test sentences. Both adults and children fixated more

to the second contrastive object in the Accent-H condition than in the Accent-M condition. This finding suggests that children, like adults, are sensitive to pitch accent in resolving ambiguities related to the focus particle *zhiyou* ‘only’. However, the effect found in adults was delayed in children. Adults launched more fixations to the second contrastive object immediately after they heard the head noun, whereas children did so after the sentence was completed. The delayed effect suggests that though children were sensitive to pitch accent, they could not use it immediately in resolving ambiguities, in contrast to adults. Further evidence attesting to children’s sensitivity to pitch accent comes from the eye movement data in the target object area. Like adults, children looked more to the target object when they heard the head noun in the Accent-H condition, as compared to Accent-M condition.

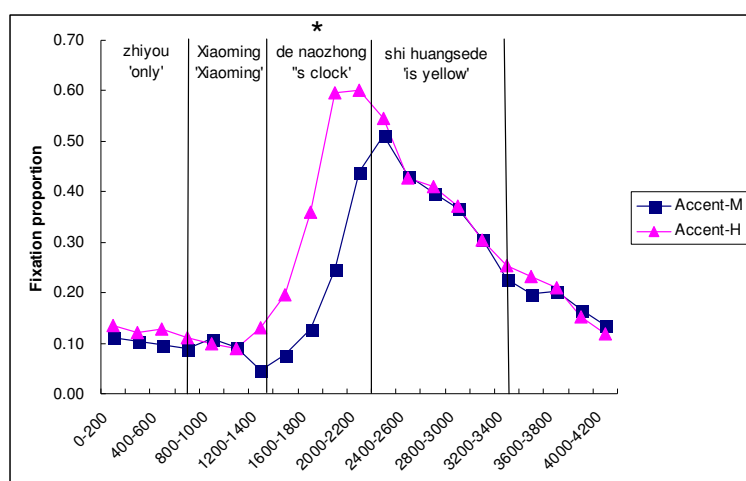


Fig.8. Average fixation proportions over time in II (the target object) in the two conditions, adults

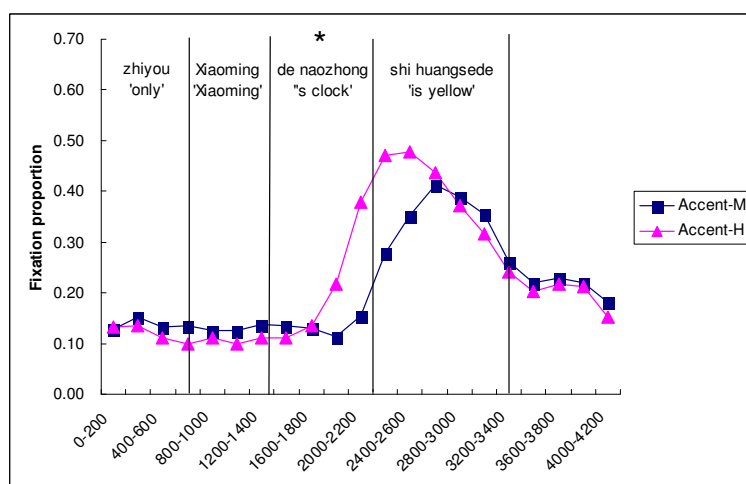


Fig.9. Average fixation proportions over time in II (the target object) in the two conditions, children

## *Discussion*

The judgement data show that adults associated the focus particle *zhiyou* ‘only’ with the head noun when a pitch accent was placed on the head noun, and they associated it with the modifier when a pitch accent was placed on the modifier, whereas children tended to associate the focus particle *zhiyou* ‘only’ with the modifier, irrespective of where the pitch accent was. Children seemed to have a default interpretation. This part of data are consistent with the findings of previous research (Gualmini et al., 2002; Halbert et al., 1995; Hüttner, et al., 2004; Szendrői, 2004), which seem to suggest that children are not sensitive to pitch accent in resolving ambiguities related to focus particles.

However, when we looked at the eye movement data, it was found that children, like adults, exhibited different fixation patterns when the pitch accent was placed on the head noun as compared to when the pitch accent was placed on the modifier. These data suggest that children are actually sensitive to pitch accent in resolving ambiguities. But the interesting difference is that the effect found in adults was always delayed in children. Adults could use pitch accent immediately in resolving ambiguities related to the focus particle *zhiyou* ‘only’. Children, however, were unable to use this information in time to resolve ambiguities, though they were sensitive to it. This delayed effect might explain why children could not use pitch accent to resolve ambiguities in the judgement task.

One question remains, however. Why were children unable to use pitch accent immediately in resolving ambiguities, though they were sensitive to it? We attribute this processing difficulty experienced by children to a delay in establishing the mapping between prosody and syntax. More specifically, we propose that the mapping between prosody and syntax in 4- to 5-year-old children is fragile and not yet automatic, and thus cannot be used immediately and effectively in resolving ambiguities. In the case of focus association,

children start out with a default association between the focus particle and the elements in its c-command domain, i.e., children initially associate the focus particle *zhiyou* ‘only’ with the modifier. As their sensitivity to the mapping between pitch accent and syntax develops, they come to appreciate that a pitch accent on the head noun encourages the association between the focus particle and the head noun, whereas a pitch accent on the modifier encourages the association between the focus particle and the modifier. However, this mapping between pitch accent and syntax is not firmly established in child language, so it cannot be used to execute a novel response.

### **The role of intonation in resolving ambiguities in speech acts**

In a second experiment, we look at another interface, i.e., between phonology and speech acts, to see whether children can use prosodic information in resolving ambiguities about the illocutionary force of spoken sentences. As noted in the introduction, Mandarin Chinese is ideally suited for evaluating children’s use of intonation in resolving speech act ambiguities, since minimal sentence/intonation pairs are readily available in Chinese, but rare at best in other languages, including English. Experiment 2 takes advantage of the special properties of Mandarin, where the same sequence of words can be used to perform different speech acts. As far as we know, there have been no previous studies, in any language, looking at the role played by prosody in children’s resolution of ambiguities involving speech acts.

Experiment 2 investigates Mandarin-speaking children’s decisions about the illocutionary force of sentences with *wh*-words. In Mandarin, a *wh*-word can be interpreted as a question-marker, or as part of an indefinite noun phrase, which is a constituent of a sentence that makes a statement. Which it is depends on intonation. Sentence (14) illustrates.

(14) Yuehan meiyou chi shenme shuiguo.

John not eat what fruit

- a. What kind of fruit didn't John eat?
- b. John didn't eat any fruit.

As (14) illustrates, negative sentences with a *wh*-word like (14) are ambiguous in Mandarin Chinese<sup>11</sup>. This sentence can be used to pose a question, as in (14a): “What kind of fruit didn't John eat?” Alternatively, the same sequence of words can make a statement, as in (14b): “John didn't eat any fruit”. Intonational cues are used to distinguish between these two speech acts. A rising intonation on the *wh*-phrase *shenme shuiguo* ‘what fruit’ indicates the question reading, whereas a level intonation (the absence of rising intonation) on the same *wh*-phrase signals the statement reading<sup>12</sup>. Both kinds of speech acts are used frequently in daily conversation. Experiment 2 was designed to investigate whether young Mandarin-speaking children are sensitive to intonational cues in resolving ambiguities involving different speech acts.

## Experiment 2

The goal of this experiment was to see whether children can use prosodic cues to resolve ambiguities involving different speech acts.

## Method

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<sup>11</sup> The ambiguity of this type of sentence is due to the properties of *wh*-words in Mandarin Chinese. *Wh*-words in Mandarin Chinese can either function as question words or as indefinite NPs (roughly like English *some*). In contrast to English, *wh*-words remain in situ in the word order of Mandarin Chinese. Interested readers are referred to the papers by Cheng (1991, 1994), Huang (1982), Li (1992) and Lin (1996, 1998). English has speech act ambiguities, but these are not as readily available as in Mandarin Chinese. For example, English has sentences like *Have the soldiers killed*, which can either be used to make a command *To kill the soldiers*, or to pose a question *Have the soldiers been killed?* But it is not clear whether prosody can be used to disambiguate between these two readings, and such ambiguities are not abundant in English.

<sup>12</sup> Mandarin Chinese is a tone language. In this case, the lexical tone of the *wh*-phrase *shenme shuiguo* ‘what fruit’ remains the same in the two readings. What has changed is the pitch of the *wh*-phrase, i.e., it has a higher pitch in the question reading than in the statement reading.

### *Participants*

Thirty-eight monolingual Mandarin-speaking children participated in this experiment (mean age 4;4, range 3;6 to 4;11). They were recruited from the kindergarten at Beijing Language and Culture University and had no reported history of speech, hearing, or language disorders. In addition, 20 Mandarin-speaking adults were tested as controls, all postgraduates at Beijing Language and Culture University (mean age 26, range 25 to 28). And they had no self-reported speech or hearing disorders.

### *Procedures and materials*

In order to evaluate the experimental hypothesis, we used a Question-Statement task. The experimenter acted out stories in front of the child participant using toy characters and props, and a puppet who appeared on a laptop computer screen watched the stories alongside the participant. After each story, the puppet attempted to explain to the participant what he thought had happened in the story, using a test sentence. The test sentences were pre-recorded and were presented to the participant through the laptop computer connected to an external speaker to make it appear that the puppet was talking. It was made clear to the participant that the puppet didn't always pay close attention to the story and thus was sometimes unsure about the outcome of the story. If that was the case, the puppet would make a guess about what happened in the story or ask the participant a question. On each trial, the participant's task was to decide whether the puppet made a statement about what happened in the story or asked a question about the story. If the participant judged the puppet to be making a statement, his task was to judge whether the statement was right or wrong. If the participant judged the puppet to be asking a question, his task was simply to answer the question.

The participants were introduced to the task individually and were tested individually. In order to familiarize them with the task, they were given two practice trials before the actual

test session. On one practice trial, the puppet made a statement informing the participant about what happened in the story, and on the other practice trial, the puppet asked the participant a question. Only those participants who correctly judged the puppet had made a statement on the first trial and had posed a question on the second trial were permitted to advance to the test session. Adult controls were tested on the same task.

There were four test stories. For each story, two versions of the test sentence were created, one with a rising intonation on the *wh*-phrase and the other with a level intonation on the *wh*-phrase. The following example is used to illustrate. In a typical story, three pandas went to buy something for their new house. They came to Minnie Mouse's shop. There were four things there: three types of furniture (i.e., wardrobes, mirrors and chairs) and flowers (as illustrated in Figure 10)<sup>13</sup>. They first came to the wardrobes, but the wardrobes were too big for their house, so they didn't buy them. Then they came to the flowers. The flowers were beautiful, so they all bought one. After that, they came to the mirrors. They wanted to buy mirrors. But when they looked into the mirrors, they found that they were not as good-looking as they expected. They thought the mirrors made them ugly. So they decided not to buy the mirrors. Finally they came to the chairs. The chairs were nice. So they all bought a chair. The last scene of the story is illustrated in Figure 11: the pandas bought the flowers and the chairs.

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<sup>13</sup> Before we started the story, we introduced every toys and props used in the story to make sure that children know that wardrobes, mirrors and chairs are furniture.



Fig.10. The pandas came to Minnie Mouse's shop



Fig.11. The last scene of the story

When the story concluded, sentence (15) was presented to the participants, either with a rising intonation on the *wh*-phrase *shenme jiaju* 'what furniture' or with a level intonation on the *wh*-phrase *shenme jiaju* 'what furniture'.

(15) Xiongmao meiyou mai shenme jiaju.

panda not buy what furniture

a. What type of furniture didn't the pandas buy?



b. The pandas didn't buy any furniture.

The intonation contours for the *wh*-phrase *shenme jiaju* 'what furniture' with a rising intonation and with a level intonation are illustrated in Figure 12.

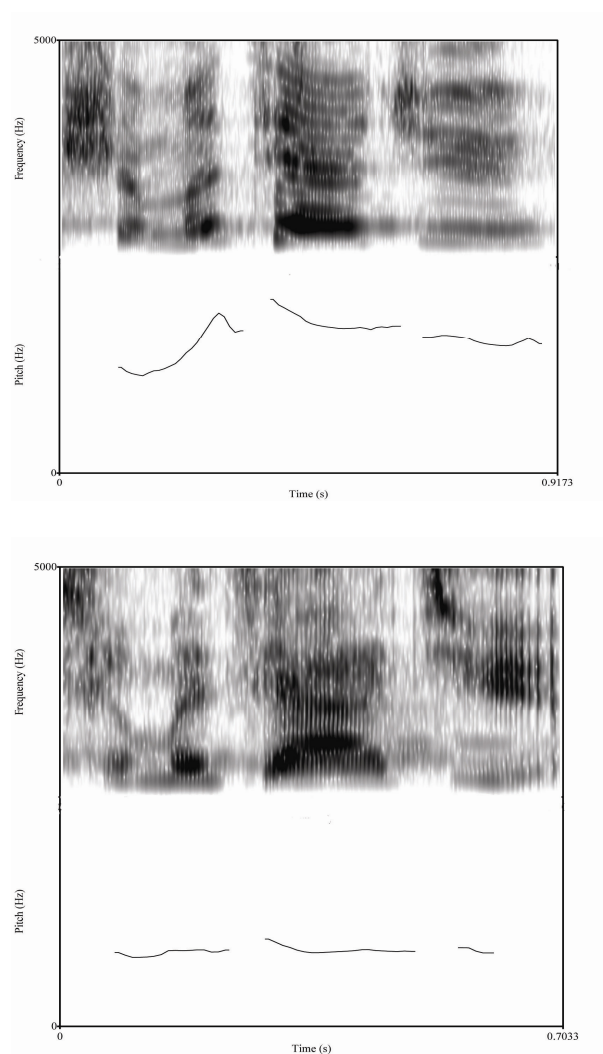


Fig.12. Intonation contours for the *wh*-phrase *shenme jiaju* 'what furniture' with a rising intonation (upper panel) and with a level intonation (lower panel)

We used between-subject design. Participants were divided into two groups. One group (19 children and 10 adults) heard the sentences with a rising intonation on the *wh*-phrase, and the other group (19 children and 10 adults) heard the same sentences with a level

intonation on the *wh*-phrase. The test sentences were produced by a female native speaker of Beijing Mandarin and she was asked to produce the test sentences in a child-directed manner. The recording was conducted in a sound-attenuated laboratory at Macquarie University.

In addition to the test trials, four filler trials were included for each group. The group of participants who heard the test sentences with a rising intonation on the *wh*-phrase were presented with four negative statement fillers like (16), and the statements were all false descriptions of the corresponding stories. And the group of participants who heard the test sentences with a level intonation on the *wh*-phrase were presented with four *wh*-question fillers like (17). These fillers were used to counterbalance the question and statement interpretations throughout the trials. The test and filler trials were presented in a pseudo-random order. All the test and filler sentences are given in Appendix C.

(16) Haidao meiyou nazou jinbi.

pirate not take gold-coin

‘The pirates didn’t take the gold coins.’

(17) Xiaoniao chi-le shenme shiwu?

bird eat-ASP what food

‘What kind of food did the bird eat?’

### *Predictions*

If children are sensitive to the intonational cues (i.e., rising intonation vs. level intonation) and can use the cues to resolve this speech act ambiguity (i.e., asking a question vs. making a statement), then they are expected to interpret sentences with a rising intonation on the *wh*-phrase as questions, and sentences with a level intonation on the *wh*-phrase as statements. On the example trial, they should respond to sentence (15) with a rising intonation by offering an

answer “wardrobes and mirrors”, and they should respond to sentence (15) with a level intonation on the *wh*-phrase by rejecting the sentence on the grounds that the pandas bought the chairs.

## Results and discussion

We recorded the responses of the participants to the two versions of the test sentences. All the participants responded correctly to the filler trials. So their data were all included in the final analysis.

Here are the main findings. In response to the test sentences with a rising intonation on the *wh*-phrase, children responded by providing an answer 97.37% of the time (74/76 trials)<sup>14</sup> and adults did so 100% of the time (40/40 trials). A Mann-Whitney Test showed that there was no significant difference in the response patterns between children and adults ( $Z = 1.05$ ,  $p = .53$ ). In the example story, children answered sentence (15) in one of two ways. One response, by 3 of the 19 child participants, was to point to the wardrobes and the mirrors. The remaining 16 children overtly mentioned that the pandas didn’t buy the wardrobes and the mirrors, saying “Meiyou mai yichu he jingzi” (“(They) didn’t buy the wardrobes and the mirrors”). All the adults provided an answer “Yichu he jingzi” (“The wardrobes and the mirrors”).

In response to the test sentences with a level intonation on the *wh*-phrase, children responded to the test sentences by rejecting them 86.84% of the time (66/76 trials) and adults rejected them 90% of the time (36/40 trials)<sup>15</sup>. A Mann-Whitney Test showed that there was no significant difference in the response patterns between children and adults ( $Z = .38$ ,  $p = 1$ ). In the example story, children and adults rejected sentence (15) by making reference to the

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<sup>14</sup> Two children responded to one of the test sentences by saying “yes” (2/76 trials (2.63%)).

<sup>15</sup> Two children consistently provided an answer to the test sentences and one children responded to two of the four test sentences by providing an answer (10/76 trials (13.16%)). One adult responded to the four test sentences by providing an answer (4/40 trials (10%)).

fact that the pandas bought the chairs. Children either explicitly mentioned the chairs ("No, they bought the chairs") or they pointed to the chairs. The responses of each child on this trial are provided in Appendix D. The results of this experiment are summarized in Table 2.

The results of this experiment clearly show that Mandarin-speaking children know that a rising intonation on the *wh*-phrase turns the sentences into questions, whereas a level intonation on the *wh*-phrase turns them into statements. This is compelling evidence that Mandarin-speaking children can reliably use intonational cues in resolving ambiguities involving different speech acts. When the nature of the speech act being performed depends on children's sensitivity to prosodic cues, Mandarin-speaking children are even sensitive to the fact that a level intonation indicates that the speaker is making a statement, rather than asking a question. These findings suggest that children are sensitive to intonational cues and can use them to resolve ambiguities of illocutionary force.

Table.2. Proportion of the two types of responses to the two types of test sentences by children and adults  
(Experiment 2)

Sentence Type	Response Type			
	Statement		Question	
	Children	Adults	Children	Adults
Rising intonation on the <i>wh</i> -phrase	0%	0%	97.37%	100%
Level intonation on the <i>wh</i> -phrase	86.84%	90%	13.16%	10%

## Discussion and conclusion

The present study investigated the role of prosody in children's ambiguity resolution. Two experiments were conducted. Experiment 1 looked at the role of pitch accent in children's resolution of syntactic ambiguities involving the focus particle *zhiyou* 'only', and Experiment 2 investigated the role of intonational cues in children's resolution of ambiguities involving different speech acts (i.e., asking a question vs. making a statement).

Using off-line tasks, previous research found that 4- to 5-year-old English-speaking children are not sensitive to prosodic cues in resolving ambiguities involving the focus particle *only* (Gualmini et al., 2002; Halbert et al., 1995). However, our study (Experiment 1), using an eye-tracking task, has shown that that 4- to 5-year old Mandarin-speaking children are sensitive to pitch accent in resolving such ambiguities, but this sensitivity cannot be used immediately and effectively in resolving ambiguities. We attributed children's processing difficulty to the fragile mapping between prosody and syntax. Our study also implies the importance of the tasks used in detecting children's knowledge of interfaces (e.g., the prosody-syntax interface). Since the mapping between prosody and syntax is fragile in child language, it requires more sophisticated and sensitive tasks than used in adult experiments, in order to observe and measure children's ability to use prosodic information in resolving syntactic ambiguities. And online techniques like eye-tracking have proved to be one of these sensitive measures (e.g., Höhle et al., 2009; Snedeker & Yuan, 2008).

In the second experiment, we looked at whether children are sensitive to prosodic cues in resolving ambiguities involving different speech acts. Mandarin Chinese is ideally suited for evaluating children's use of intonation in resolving speech act ambiguities, since minimal sentence/intonation pairs are readily available in Chinese, but rare at best in other languages, including English. Experiment 2 takes advantage of the special properties of Mandarin, where the same sequence of words can be used to perform different speech acts. As far as we know,

there have been no previous studies, in any language, looking at the role played by prosody in children's resolution of ambiguities involving speech acts. So Experiment 2 investigated whether Mandarin-speaking children can use intonational cues to resolve such kind of ambiguity. The results show that 4-year-old Mandarin-speaking children know that a rising intonation on the *wh*-phrase indicates a question reading, whereas a level intonation on the *wh*-phrase indicates a statement reading. Children are sensitive to intonational cues and can use them to resolve ambiguities involving basic communication skills (e.g., asking a question and making a statement).

Combining the data of the two experiments, we found that children's use of prosodic information in ambiguity resolution can vary according to the type of ambiguity involved. In our study, children can use prosodic information more effectively to resolve ambiguities of illocutionary force, than to resolve syntactic ambiguities. This finding suggests that the mapping between prosody and semantics/pragmatics might be better established than the mapping between prosody and syntax in young children. Of course, we can not simply generalize our results to other types of syntactic ambiguities and speech act ambiguities. Further investigations of different types of syntactic ambiguities and speech act ambiguities are required. We also want to point out that cross-linguistic studies are necessary, if we want to understand which aspects of prosodic information and what type of ambiguities are more easily processed in child language.

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## Appendix A Test sentences in Experiment 1

### Eight test sentences

(1) Zhiyou Xiaoming de naozhong shi huangsede.

only Xiaoming DE clock is yellow

‘Only Xiaoming’s clock is yellow.’

(2) Zhiyou Xiaohong de yazi shi huangsede.

only Xiaohong DE duck is yellow

‘Only Xiaohong’s duck is yellow.’

(3) Zhiyou Xiaoming de fanchuan shi huangsede.

only Xiaoming DE boat is yellow

‘Only Xiaoming’s boat is yellow.’

(4) Zhiyou Xiaohong de shoubiao shi zisede.

only Xiaohong DE watch is purple

‘Only Xiaohong’s watch is purple.’

(5) Zhiyou Xiaoming de pingguo shi hongse.

only Xiaoming DE apple is red

‘Only Xiaoming’s apple is red.’

(6) Zhiyou Xiaohong de maozi shi lansede.

only Xiaohong DE hat is blue

‘Only Xiaohong’s hat is blue.’

(7) Zhiyou Xiaoming de beizi shi lansede.

only Xiaoming DE cup is blue

‘Only Xiaoming’s cup is blue.’

(8) Zhiyou Xiaohong de piqu shi hongse.

only Xiaohong DE ball is red.

‘Only Xiaohong’s ball is red.’

Eight filler sentences

(9) Zhiyou Xiaohong de shubao shi fense.

only Xiaohong DE backpack is pink

‘Only Xiaohong’s backpack is pink.’

(10) Zhiyou Xiaoming de qianbi shi huangse.

only Xiaoming DE pencil is yellow

‘Only Xiaoming’s pencil is yellow.’

(11) Zhiyou Xiaohong de yusan shi lansede.

only Xiaohong DE umbrella is blue

‘Only Xiaohong’s umbrella is blue.’

(12) Zhiyou Xiaoming de qiqiu shi huangse.

only Xiaoming DE balloon is yellow

‘Only Xiaoming’s balloon is yellow.’

(13) Zhiyou Xiaohong de xiangpi shi fensedede.

only Xiaohong DE eraser is pink

‘Only Xiaohong’s eraser is pink.’

(14) Zhiyou Xiaoming de xiaoxiong shi huisede.

only Xiaoming DE teddy is brown

‘Only Xiaoming’s teddy is brown.’

(15) Zhiyou Xiaohong de dianhua shi hongse.

only Xiaohong DE telephone is red

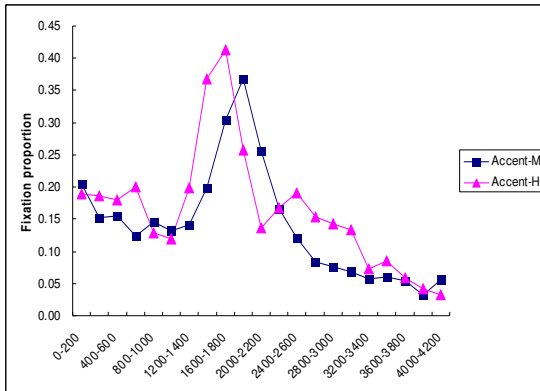
‘Only Xiaohong’s telephone is red.’

(16) Zhiyou Xiaoming de yali shi huangse.

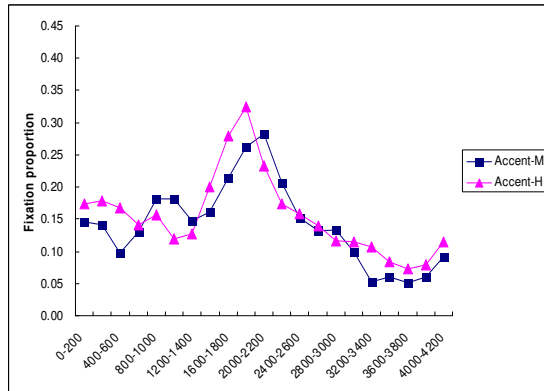
only Xiaoming DE pear is yellow

‘Only Xiaoming’s pear is yellow.’

## Appendix B Proportion of fixations in the other two categories

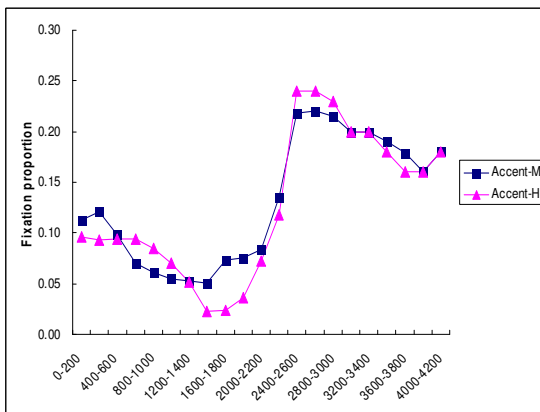


Adults

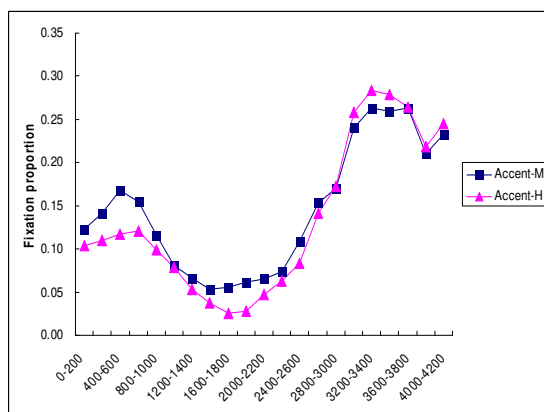


Children

Average fixation proportions over time in I (the non-contrastive object) in the two conditions by adults and children



Adults



Children

Average fixation proportions over time in IV (the first contrastive object) in the two conditions by adults and children

## Appendix C Test sentences in Experiment 2

Four test sentences

(1) Xiaoxiongmao meiyou mai shenme jiaju.

panda not buy what furniture

(2) Xiaojingling meiyou mai shenme shuiguo

smurf not buy what fruit

(3) Meirenyu meiyou mai shenme chongwu.

mermaid not buy what pet

(4) Jiqiren meiyou mai shenme chezi.

robot not buy what car

Filler sentences for Group A

(5) Xiaotuzi meiyou caidao xingxing.

bunny not step star

‘The bunny didn’t step on the star.’

(6) Haidao meiyou nazou jinbi.

pirate not take gold-coin

‘The pirates didn’t take the gold coins.’

(7) Xiannü meiyou dabai dahuolong.

fairy not beat dragon

‘The fairy didn’t beat the dragon.’

(8) Xiaofeima meiyou zhaodao hua.

pony not find flower

‘The pony didn’t find the flower.’

Filler sentences for Group B

(9) Xiaoniao chi-le shenme shiwu?

bird eat-ASP what food

‘What kind of food did the bird eat?’

(10) Xiaoma jian-le shenme baobei?

horse collect-ASP what treasure

‘What kind of treasure did the horse collect?’

(11) Shei dai-le xiaomao guo he?

who take-ASP cat cross river

‘Who helped the cat cross the river?’

(12) Shei dabai-le laowupo?

who beat-ASP witch

‘Who beat the witch?’



## Appendix D Children's responses on the example trial, Experiment 2

		A rising intonation on the <i>wh</i> -phrase
Group 1	Age	Responses
Girl	4;8	(They) didn't buy wardrobes and mirrors
Boy	4;8	Pointing to the wardrobes and the mirrors
Girl	4;8	(They) didn't buy wardrobes and mirrors
Girl	4;1	Wardrobes and mirrors
Girl	4;2	Wardrobes and mirrors
Boy	4;2	(They) didn't buy wardrobes and mirrors
Boy	4;2	Wardrobes and mirrors they didn't buy
Boy	3;11	Pointing to the wardrobes and the mirrors
Girl	4;4	Wardrobes and mirrors
Boy	4;5	They didn't buy wardrobes and mirrors
Girl	3;10	(They) didn't buy wardrobes and mirrors
Girl	3;6	Wardrobe and mirrors (they) didn't buy
Girl	4;1	(They) didn't buy wardrobes and mirrors
Girl	4;2	Pointing to the wardrobes and the mirrors
Boy	4;2	Wardrobes and mirrors (they) didn't buy
Girl	4;5	Wardrobes and mirrors
Girl	4;4	Wardrobes and mirrors
Girl	4;6	(They) didn't buy wardrobes and mirrors
Boy	4;7	Wardrobes and mirrors they didn't buy
		A level intonation on the <i>wh</i> -phrase
Group 2	Age	Responses
Girl	3;7	No, (they) bought chairs
Girl	3;10	You're wrong (pointing to the chairs)
Girl	4;5	No, (they) bought chairs

Girl	4;6	No, (they) bought chairs
Boy	3;11	Wardrobes and mirrors
Boy	3;11	You're wrong, they bought chairs
Girl	4;1	No, look at the chairs
Boy	4;3	You're wrong, look at the chairs
Girl	4;4	Pointing to the wardrobes and the mirrors
Girl	4;2	No (pointing to the chairs)
Boy	4;2	No, (pointing to the chairs)
Girl	4;8	No, (they) bought chairs
Girl	4;11	You're wrong, they bought chairs
Boy	4;5	No, they bought chairs
Boy	4;2	No, they have chairs
Boy	4;4	You're wrong, they have chairs
Girl	4;5	No, they have chairs
Girl	4;6	No, (they) bought chairs
Girl	4;6	You're wrong (pointing to the chairs)

**NOTE:** We have translated the corresponding sentences into English. The corresponding translations are as follows.

Bu dui.

not right

'No.'

Ni shuode bu dui.

you say not right

'You're wrong.'

Meiyou mai yichu he jingzi.

not buy wardrobes and mirrors

‘(They) didn’t buy wardrobes and mirrors.’

Mai-le yizi.

buy-ASP chair

‘(They) bought chairs.’

Kan, you yizi.

look, have chairs

‘Look at the chairs.’

Tamen you yizi.

they have chairs

‘They have chairs.’



## ***Wh*-quantification in child Mandarin**

**This chapter is based on the following two papers:**

Zhou, P., & Crain S. (in press). Children's knowledge of the quantifier *dou* in Mandarin Chinese. *Journal of Psycholinguistic Research*.

Su, Y., Zhou, P., & Crain, S. (submitted). Downward entailment in child Mandarin. *Journal of Child Language*.

The second paper “Downward entailment in child Mandarin” was co-authored by Yi Su, Stephen Crain, and only the second experiment reported in the paper was completed by myself and contributes to this thesis.



## Abstract

*Wh*-words in Mandarin Chinese exhibit quantificational variability. Aside from a typical interrogative reading, *wh*-words such as *shei* ‘who’ and *shenme* ‘what’ can also have an indefinite reading, or a universal reading. Which reading it is depends on the linguistic environments in which they occur. In the present study, three experiments were conducted to investigate whether young Mandarin-speaking children are sensitive to the linguistic environments which license the non-interrogative use of *wh*-words: the indefinite reading and the universal reading. The results show that 3- to 5-year-old Mandarin-speaking children exhibited adult-like sensitivity to the licensing environments for the non-interrogative use of *wh*-words. We then asked the question: how do Mandarin-speaking children establish the connection between the semantic interpretation of *wh*-words and the linguistic environments in which they occur? Given the difficulty that children may have in using distributional cues in the input to learn the interpretation of *wh*-words, and the early emergence of this knowledge in child Mandarin, we propose that the licensing mechanism for the non-interrogative use of *wh*-words is innate.

**Keywords:** *Wh*-words; Indefinite reading; Universal reading; Licensing mechanism;

Child Mandarin

## **Wh-quantification in child Mandarin**

### **Introduction**

*Wh*-words in Mandarin Chinese exhibit quantificational variability. In addition to the typical interrogative reading, as in (1a) and (1b), *wh*-words such as *shenme* ‘what’ and *shei* ‘who’ can also have an indefinite reading, as in (2a) and (2b), or a universal reading, as in (3a) and (3b) (Cheng, 1991, 1994, 2009; Huang, 1982b; Li, 1992; Lin, 1996; 1998).

(1) a. Yuehan chi-le shenme?

John eat-ASP what

‘What did John eat?’

b. Yuehan kandao-le shei?

John see-ASP who

‘Who did John see?’

(2) a. Ruguo ni xiang chi shenme, wo gei ni mai.

if you want eat what I give you buy

‘If you want to eat something, I’ll buy it for you’

b. Ruguo shei qifu ni, ni gaosu wo.

if who bully you you tell me

‘If someone bullies you, you let me know.’

(3) a. Yuehan shenme dou meiyou chi.

John what all not eat

‘John didn’t eat anything.’

b. Yuehan shei dou meiyou jian.

John who all not see

‘John didn’t see anyone.’



In sentences (1a) and (1b), the *wh*-words *shenme* ‘what’ and *shei* ‘who’ are interpreted as interrogative words. Note that in both examples *wh*-words stay in situ. This is probably one of the most important typological features of Mandarin *wh*-questions, that is, unlike many other languages (e.g., English) which form their *wh*-questions by moving a *wh*-phrase to a clause-initial position, Mandarin *wh*-questions are formed by leaving a *wh*-phrase in situ. So Mandarin Chinese is known as a *wh*-in-situ language (Huang, 1982a, 1982b; Huang, Li, & Li, 2009). In sentences (2a) and (2b), the *wh*-words *shenme* ‘what’ and *shei* ‘who’ appear in the antecedent clause of *if*-conditionals which is one of the licensing environments for existential *wh*-indefinites, and thus they are interpreted as existential indefinites *something* and *someone* respectively. And in sentences (3a) and (3b), the *wh*-words *shenme* ‘what’ and *shei* ‘who’ are bound by the universal quantifier *dou*, thereby rendering the combination of *shenme+dou* and *shei+dou* as universally quantified NPs *everything* and *everyone* respectively. With negation, the two sentences express negated universal statements, meaning “John didn’t eat anything” and “John didn’t see anyone”.

The above examples illustrate that the interpretation of *wh*-words in Mandarin Chinese is sensitive to the linguistic environments in which they occur. *Wh*-words in Mandarin Chinese are normally interpreted as interrogative words, but when they occur in certain linguistic contexts (e.g., in the antecedent clause of *if*-conditionals, in the scope of universal quantifiers etc.), they are interpreted non-interrogatively. The aim of the present studies was to find out whether or not young Mandarin-speaking children are sensitive to the licensing environments for the non-interrogative use of *wh*-words. Note that in learning the interpretation of *wh*-words, what children learn is that the same word functions as an interrogative word in certain linguistic contexts, but is interpreted as a non-interrogative indefinite in other linguistic contexts. It is not the distribution of the *wh*-word that is at issue

for young children, but its interpretive properties. The research question is: how do young children establish the connection between the semantic interpretation of *wh*-words and the linguistic contexts in which they occur? As far as we know, few studies have looked at children's knowledge of the licensing conditions for the non-interrogative use of *wh*-words in Mandarin Chinese. The present study consists of three experiments investigating Mandarin-speaking children's sensitivity to the two non-interrogative uses of *wh*-words: the indefinite reading and the universal reading.

The paper is structured as follows. First we introduce the indefinite reading of *wh*-words (Section 2). This is followed by Experiment 1, reported in Section 3. This experiment investigated whether Mandarin-speaking children are sensitive to linguistic environments that license the indefinite reading of *wh*-words. Section 4 introduces the universal reading of *wh*-words. This is followed by Experiments 2 and 3 (Sections 5 and 6), which explored Mandarin-speaking children's sensitivity to linguistic environments that license the universal reading of *wh*-words. In order to assess children's knowledge of the licensing mechanism of *wh*-indefinites, a new experimental task is introduced. Finally, the conclusions are presented in Section 7.

### **The indefinite reading of *wh*-words**

As we saw in example (2), the antecedent clause of *if*-conditionals licenses the existential indefinite reading of *wh*-words. There are some other linguistic environments which also license the indefinite reading of *wh*-words. For example, when *wh*-words appear in the scope of the epistemic adverb *keneng* 'possibly', as in (4), in yes-no questions, as in (5), in the predicate phrase of the negative quantificational expression *meiyouren* 'nobody', as in (6), and in A-not-A questions, as in (7), they are also interpreted as existential indefinites. Readers

are referred to Lin (1998) and Xie (2007) for detailed discussion about the contexts in which *wh*-words function as indefinites.

- (4) Keneng shei qifu Yuehan. (epistemic adverb)  
 possibly who bully John  
 ‘Possibly someone bullied John.’
- (5) Yuehan xiang chi shenme ma<sup>1</sup>? (yes-no question)  
 John want eat what Q  
 ‘Did John want to eat something?’
- (6) Meiyouren chi shenme shuiguo. (predicate phrase of *Nobody*)  
 not-have-person eat what fruit  
 ‘Nobody ate any fruit.’
- (7) You-mei-you shei xiang qu Beijing? (A-not-A question)  
 have-not-have who want go Beijing  
 ‘Does anyone want to go to Beijing or not?’

There has been a lot of discussion about the distribution of existential *wh*-indefinites and the properties of their licensing environments. Existential *wh*-indefinites are generally analysed as polarity items, therefore are subject to the licensing conditions for polarity items (Cheng, 1991, 1994; Huang, 1982b; Li, 1992; Lin, 1996, 1998). There is continuing controversy about the licensing conditions for polarity items. Some linguists use downward entailment to define the semantic properties of the licensing environments for polarity items (e.g., Ladusaw, 1979; von Stechow, 1999). However, some linguists use nonveridicality to define the licensing environments (e.g., Giannakidou, 1998, 2006, 2009). The precise formulation of the

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<sup>1</sup> The sentence-final *ma* is a yes-no question marker.

semantics of these licensing conditions is not our concern. Readers are referred to Xie (2007) for a comprehensive review of the two proposals. There is a general consensus, however, that the existential indefinite reading of *wh*-words in these licensing environments is derived by being bound by existential closure (Diesing, 1992; Heim, 1982). And we are interested in the fact that existential *wh*-indefinites, as polarity items, are licensed in some linguistic environments, but not others. For example, when the *wh*-phrase *shenme shuiguo* ‘what fruit’ appears in the predicate phrase of the negative quantificational expression *meiyouren* ‘nobody’, as in (6) (repeated here as (8a)), it is interpreted as a polarity item like English *any*. However, when the same *wh*-phrase *shenme shuiguo* ‘what fruit’ appears in the predicate phrase of the positive quantificational expression *meigeren* ‘everybody’, as in (8b), it cannot be interpreted as a polarity item like English *some*. Rather it is interpreted as an interrogative phrase, as indicated in (8c).

- (8) a. *Meiyouren*            *chi shenme shuiguo.*  
       not-have-person eat what fruit  
       ‘Nobody ate any fruit.’
- b. *Meigeren*            *dou chi-le shenme shuiguo.*  
       every-CL-person all eat-ASP what fruit  
       \*‘Everybody ate some fruit.’
- c. *Meigeren*            *dou chi-le shenme shuiguo?*  
       every-CL-person all eat-ASP what fruit  
       ‘What kind of fruit did everybody eat?’

Notice that *wh*-words serve dual semantic functions here. In the predicate phrase of *meigeren* ‘everybody’, they serve as interrogative words and turn the sequence of words into a question

(e.g., (8c)). By contrast, when they appear in the predicate phrase of *meiyouren* ‘nobody’, *wh*-words function as polarity items (e.g., (8a)). This means that the sequence of words becomes a statement, rather than a question. This interpretational difference is schematically represented in (9).

(9) a. *Meiyouren* PRED [.....*wh*-word.....] = Statement

b. *Meigeren* PRED [.....*wh*-word.....] = Question

As shown by the schema, a minimal pair arises in the interpretation of sentences with the negative quantificational expression *meiyouren* ‘nobody’ (i.e., (9a)) vs. the positive quantificational expression *meigeren* ‘everybody’ (i.e., (9b)). This type of minimal pairs provides a good testing ground for investigating children’s knowledge of the licensing mechanism of *wh*-indefinites, and therefore forms the basis of the experiments we conducted with Mandarin-speaking children. The basic idea is that if children are sensitive to the licensing environments for the existential indefinite reading of *wh*-words, then they would be expected to interpret sentences like (9a) as statements, as compared to sentences like (9b), which they should interpret as questions.

## Experiment 1

In this experiment, we investigated whether Mandarin-speaking children are sensitive to the linguistic environments that license the indefinite reading of *wh*-words, using minimal pairs as in (9).

## Method

### *Participants*

We tested 28 monolingual Mandarin-speaking children between the ages of 3; 5 and 4; 9 (mean age 4; 2). The child subjects were recruited from the kindergarten at Beijing Language and Culture University. In addition, 20 Mandarin-speaking adults were tested as controls, all postgraduates at Beijing Language and Culture University.

### *Procedures*

In order to evaluate the experimental hypotheses, we designed a new experimental technique, which we call the Question-Statement task. The Question-Statement task involved two experimenters. One acted out stories in front of the child subject using toy characters and props, and the other played the role of a puppet who watched the stories alongside the child subject. After each story, the puppet attempted to explain to the child subject what he thought had happened in the story, using one of the test sentences. It was made clear to the subjects that the puppet didn't always pay close attention to the story and thus was sometimes unsure about the outcome of the story. If that was the case, the puppet would make a guess about what happened in the story or ask the subject a question. On each trial, the subject's task was to decide whether the puppet made a statement about what happened in the story or asked a question about the story. If the subject judged the puppet to be making a statement, his task was to judge whether the statement was right or wrong. If the subject judged the puppet to be asking a question, his task was simply to answer the question.

The subjects were introduced to the task individually and were tested individually. In order to familiarize the subjects with the task, they were given two practice trials before the actual test session. On one practice trial, the puppet made a statement informing the subject about what had happened in the story, and on the other practice trial, the puppet asked the subject a question. Only those subjects who correctly judged that the puppet had made a

statement on the first practice trial and had posed a question on the second trial were permitted to advance to the main session. Adult controls were tested on the same task.

### *Materials*

There were 6 test stories. For each, two types of test sentences were created. One contained the *wh*-word *shenme* ‘what’ in the predicate phrase of the negative quantificational expression *meiyouren* ‘nobody’, as in (10), and one contained the *wh*-word *shenme* ‘what’ in the predicate phrase of the positive quantificational expression *meigeren* ‘everybody’, as in (11). A typical story is used to illustrate.

This story is about three pandas that went to have breakfast. They had four choices, including three types of fruit (lemons, pears, and strawberries) and eggs. They came to the lemons first. None of them picked one, because they were too sour. Then they came to the eggs and each of them took one. Then they came to the pears. Two of them didn’t like pears but the third panda chose one big pear. Finally, they came to the strawberries. They all liked strawberries, so each panda took one.

When the story concluded, the puppet either produced test sentence (10) or test sentence (11).

(10) Meiyou xiongmao chi shenme shuiguo.

not-have panda eat what fruit

‘No panda ate any fruit.’

(11) Mei-zhi xiongmao dou chi-le shenme shuiguo?

every-CL panda all eat-ASP what fruit

‘What kind of fruit did every panda eat?’

For the presentation of the test sentences, the subjects were divided into two groups. One group (14 child subjects and 10 adult subjects) heard test sentence (10). The other group (14 child subjects and 10 adult subjects) heard test sentence (11). Altogether, there were six test trials. Each group was presented with only one type of test sentence for each story, and the two types of test sentences were counterbalanced, so that each group was presented with three each, of the two sentence types. In order to control for the effect of the intonation on subjects' judgements, the experimenter who played the role of the puppet was asked to produce the test sentences with the same intonation pattern, i.e., with level intonation. Moreover, this experimenter was not informed about the purpose of the experiment, or about the experimental hypothesis, so that the experimenter playing the role of the puppet should not have been inadvertently biased to support either of the possible interpretations using prosodic cues.

In addition to the test trials, each subject witnessed four control trials. On two of these control trials, the puppet produced the questions in (12) and (13). These trials were included to see whether subjects understand simple *wh*-questions. On the other two control trials, the puppet produced the simple statements with the universal quantifier *mei* 'every' in (14) and (15). These control trials were included to verify that subjects could understand the universal quantifier *mei* 'every'. The control trials were also used to counterbalance the "yes" and "no" responses throughout the trials. The statements in the test trials were all false in the relevant stories, so the statements (14) and (15) were true depictions of the stories. The test and control trials were presented in a pseudo-random order.

(12) Shei cong qiao-shang diaoxiaqu-le?

who from bridge-top fall-ASP



‘Who fell off the bridge?’

(13) Shei tou-le xiaairen de yu?

who steal-ASP dwarf DE fish

‘Who stole the dwarf’s fish?’

(14) Mei-zhi xiongmao dou chi-le caomei.

every-CL panda all eat-ASP strawberry

‘Every panda ate a strawberry.’

(15) Mei-zhi kaola dou mai-le yumao.

every-CL koala all buy-ASP feather

‘Every koala bought a feather.’

Before we report the results, let us look at the experimental hypotheses. If children are sensitive to the licensing environments for the existential indefinite reading of *wh*-words (e.g., they know that the predicate phrase of the negative quantificational expression *meiyouren* ‘nobody’ licenses the existential indefinite reading of *wh*-words, but the predicate phrase of the positive quantificational expression *meigeren* ‘everybody’ does not), then they would be expected to interpret sentences like (10) as statements, as compared to sentences like (11), which they should interpret as questions. If, on the other hand, children are not sensitive to the licensing environments for *wh*-indefinites, then they would be expected to interpret both types of sentences as questions. In the story under consideration, if children know that the *wh*-word *shenme* ‘what’ is licensed as a polarity item like English *any*, when it appears in the predicate phrase of the negative quantificational expression *meiyouren* ‘nobody’, whereas the same *wh*-phrase is interpreted as an interrogative phrase when it occurs in the predicate phrase of the positive quantificational expression *meigeren* ‘everybody’, then they were expected to reject the puppet’s statement in (10), and to justify their rejections by pointing out the fact that every

panda ate some fruit. By contrast, they should respond to the puppet's question in (11) by providing an answer "strawberry", because every panda ate a strawberry. On the other hand, if children don't know that the predicate phrase of *meiyouren* 'nobody' licenses the *wh*-word *shenme* 'what' as a polarity item, then they would be expected to interpret *shenme* 'what' in the predicate phrase of *meiyouren* 'nobody' as marking a *wh*-question. In short, children would be expected to respond to both (10) and (11) in the same way, by offering an answer "strawberry".

## Results and discussion

We recorded the responses of the subjects to the two types of test sentences. All the subjects responded correctly to the control trials. The main findings were, first, that both children and adults responded to test sentences with the *wh*-word in the predicate phrase of *meiyouren* 'nobody' by rejecting the puppet's statements 100% of the time. In the example story, both children and adults said "no" to the puppet's statement in (10) and they justified their rejections by making reference to the fact that every panda ate some fruit. By contrast, both children and adults responded by providing an answer to test sentences with the *wh*-word in the predicate phrase of *meigeren* 'everybody' 100% of the time, though children's answers were different from adults. For example, in the given story, adults produced the answer "strawberry", whereas children pointed out the fruit that was eaten by each individual panda, i.e., the first panda ate a pear and a strawberry, the second panda ate a strawberry, and the third panda ate a strawberry. The reasons for children's non-adult answers are not our concern. We are interested in the fact that children interpreted the *wh*-word as an interrogative word when it appears in the predicate phrase of *meigeren* 'everybody', whereas they interpreted the same *wh*-word as a polarity item when it occurs in the predicate phrase of *meiyouren*

‘nobody’. This is compelling evidence that 3- to 5-year-old Mandarin-speaking children are aware that the predicate phrase of the negative quantificational expression *meiyouren* ‘nobody’ licenses the indefinite reading of *wh*-words. Young Mandarin-speaking children are sensitive to the licensing environments for *wh*-indefinites.

In the following sessions, we turn to the other non-interrogative use of *wh*-words, the universal reading, to see if young Mandarin-speaking children are sensitive to the linguistic environments that license the universal reading of *wh*-words.

### **The universal reading of *wh*-words**

Example (3) illustrates that *wh*-words *shenme* ‘what’ and *shei* ‘who’ are bound by the universal quantifier *dou*, thereby rendering the combination of *shenme+dou* and *shei+dou* as universally quantified NPs *everything* and *everyone* respectively. In this section, we’ll talk more about the quantifier *dou* and *wh*-words.

#### *Dou is a universal quantifier and a Q-adverb*

Despite continuing controversy about the syntax and semantics of the quantificational expression *dou*, there are some generally acknowledged characteristics of *dou*. The first observation is that *dou* is a distributive universal quantifier that quantifies over expressions that precede it (Cheng, 1995; Lee, 1986; Pan, 2006). Consider the sentences in (16) and (17). Without *dou*, as in (16), the sentence means that the entire group of individuals denoted by *tamen* ‘they’ collectively bought a car. The sentence could be true, moreover, even if it turned out that one or two of the individuals in the group denoted by *tamen* ‘they’ did not contribute to the purchase. In (17), by contrast, *dou* quantifies over the entire set of individuals, thereby giving the sentence a distributive reading. Thus (17) means, roughly, that each of the relevant

individuals bought their own car<sup>2</sup>. The sentence is false, moreover, if even a single individual failed to purchase a car. These two examples illustrate that *dou* is interpreted as a distributive universal quantifier, quantifying over plural noun phrases that precede it.

(16) Tamen mai-le yi-liang che.

they buy-ASP one-CL car

‘They bought a car.’

(17) Tamen dou mai-le yi-liang che.

they all buy-ASP one-CL car

‘They all bought a car.’

A second property of *dou* is that it can quantify over events/situations, as well as quantifying over individuals, as in the previous example (Cheng, 1995; Lee, 1986; Pan, 2006). Example (18) illustrates that *dou* can quantify over events/situations.

(18) Ta shengqi de<sup>3</sup> shihou, wo dou gei ta jiang xiaohua.

he get-angry DE time I all give he tell joke

‘Whenever he gets angry, I tell him a joke.’

In (18), *dou* quantifies over all of the events in which a particular male individual denoted by *ta* ‘he’ became angry. The use of *dou* renders the sentence with a universal reading according to which, in each event in which the relevant individual becomes angry, there is a subsequent event in which the speaker tells a joke to that individual. As in (17), *dou* quantifies over the

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<sup>2</sup> There are important differences between *dou* and English *each*, but such differences are not critical to the experiments we report. For a useful discussion of the differences between *dou* and *each*, see Xiang (2008).

<sup>3</sup> The particle *de* here is a relative clause marker. So the subordinate clause of (3), *ta shengqi de shihou*, literally means ‘the time when he gets angry’.

elements to its left in (18). Notice also that the events under consideration in (18) are mentioned in the subordinate clause, whereas *dou* appears in the main clause. This illustrates a second property of *dou*. It is a Q-adverb, able to bind expressions outside the clause that contains it (Lewis, 1975).

#### *Dou and wh-words*

As discussed, *wh*-words in Mandarin Chinese can be quantified by *dou*. When this happens, they are no longer interpreted as interrogative words. Instead, they are interpreted as having a universal reading (Cheng, 1991, 1994; Huang, 1982b; Li 1992; Lin, 1996, 1998). The examples in (19) and (20) illustrate. In both examples, *dou* binds a *wh*-word to its left, *shei* ‘who’ in (19), and *shenme* ‘what’ in (20). The combination of *dou* and the *wh*-word yields a universally quantified NP, corresponding to English *everyone* in (19), and *everything* in (20). Note that in (19) and (20), *dou* and the *wh*-word it binds appear in the same clause.

(19) Shei dou xihuan ta.

who all like he

‘Everyone likes him.’

(20) Yuehan shenme dou chi.

John what all eat

‘John eats everything.’

As we saw in example (18), the quantifier *dou* and the element it binds need not reside in the same clause. Examples are given in (21) and (22). These sentences are known as *dou*-conditionals. In this construction, *dou* and the *wh*-word it binds appear in separate clauses, but a variable-binding relation still holds.

(21) Ni jiao shei jinlai, wo dou jian.

you ask who enter I all see

‘Whoever you ask to come in, I’ll see him.’

(22) Ni xiang chi shenme, wo dou gei ni mai.

you want eat what I all give you buy

‘Whatever you want to eat, I’ll buy it for you.’

There is continuing controversy about the proper analysis of *dou*-conditionals. But this is not our concern, readers are referred to Cheng and Huang (1996), and Pan and Jiang (1997), for discussions about the semantics of *dou*-conditionals. We are interested in the fact that, although *dou* appears in the consequent clause of *dou*-conditionals, it is able to quantify over a *wh*-word that appears in the antecedent clause. This is attributed to the status of *dou* as a Q-adverb.

The two experiments that follow were designed to find out whether or not Mandarin-speaking children know that *wh*-words can be quantified by *dou* both when they occur in the same clause (Experiment 2) and when they occur in separate clauses, i.e., *dou*-conditionals (Experiment 3).

## Experiment 2

In this experiment, we investigated whether Mandarin-speaking children know that *wh*-words can be bound by *dou* when they appear in the same clause. The experiment contrasted minimal pairs of sentences, namely sentences with *dou* and ones without *dou*. A typical minimal pair of test sentences is illustrated in (23) and (24).

(23) *Shei dou meiyou pa-shang dashu.*

who all not climb-up big tree

‘Everyone didn’t climb up the big tree.’

(24) *Shei meiyou pa-shang dashu?*

who not climb-up big tree

‘Who didn’t climb up the big tree?’

In (23), *dou* quantifies over the *wh*-word *shei* ‘who’, thereby rendering the combination *shei* + *dou* as the universally quantified NP *everyone*. Thus (23) is a negated universal statement, meaning ‘nobody climbed up the big tree’. Without *dou*, the *wh*-word *shei* in (24) marks the sentence as a question, asking ‘who didn’t climb up the big tree?’ So the experimental hypothesis is that if children know that the universal quantifier *dou* binds the *wh*-words to its left, then they were expected to interpret sentences like (23) as statements, but they should interpret sentences like (24) as questions. On the other hand, if children do not know that *dou* binds the *wh*-words to its left, then they were expected to interpret sentences like (23) as questions, just like sentences such as (24).

## Method

### *Participants*

We tested 30 Mandarin-speaking children between the ages of 3;5 and 4;9 (mean age 4;2). The child subjects were recruited from the kindergarten at Beijing Language and Culture University. In addition, 30 Mandarin-speaking adults were tested as controls, all postgraduate students at Beijing Language and Culture University. None of the subjects had participated in Experiment 1.

### *Procedures*

In order to evaluate the experimental hypotheses, we used the Question-Statement task, as in the first experiment. The subjects were introduced to the task individually and were tested individually. In order to familiarize children with the task, they were given two practice trials before the actual test session. On one practice trial, the puppet made a statement informing the subject about what had happened in the story, and on the other practice trial, the puppet asked the subject a question. Only those subjects who correctly judged that the puppet had made a statement on the first practice trial and had posed a question on the second trial were permitted to advance to the main session. Adult controls were tested on the same task.

### *Materials*

There were 6 test stories. For each, two types of test sentences were created. One contained the *wh*-word + *dou*, as in (23), and one contained the *wh*-word alone, as in (24). An example of a typical story is as follows.

A black dog, a white dog and a brown dog are going to see who is best at tree climbing. They are all very good. Today, they will try to climb a big tree and a small tree. They start with the small tree. They all made it to the top easily (as illustrated in Figure 1). Now they come to the big tree. It is much taller than the small tree. The black dog is really a good climber. He reaches the top of the tree easily. But the white dog and the brown dog have trouble, and get caught in the branches. Each time they lift up their front paws, their back paws slide off the branches. No luck, they didn't reach the top (Figure 2 illustrates the scene at the conclusion of the story).





Fig.1. The first half of the story, Experiment 2



Fig.2. The second half of the story, Experiment 2

Since the test sentences involved negation, it was important for us to ensure that our test stories satisfied the felicity conditions associated with the use of negation. For this purpose, we adopted the research strategy advocated by Crain et al. (1996) who refer to the felicity conditions associated with negation as the Condition of Plausible Dissent. They credit Russell (1948) with the basic insight about these felicity conditions, which is essentially that a negative judgement is appropriate only when the corresponding positive judgement is under consideration in the discourse context. Because subjects in Experiment 2 were asked to indicate whether the puppet's statements about what happened in the story were possibly false,

it was critical to satisfy the Condition of Plausible Dissent. Following Russell's observation, it would be appropriate to ask subjects for a negative (false) judgement of the puppet's assertion only if the corresponding positive judgement was under consideration at some point in the story. To meet this condition, it was made clear, in the first half of the story, that all of the dogs were good climbers, and that one possible outcome was that all of the dogs would climb both trees. The puppet reinforced this possible outcome by producing a positive lead-in before the test sentence, which corresponded to the first half of the story. In the story under consideration, the positive lead-in was *San-zhi gou dou pa-shang-le xiaoshu* 'All the three dogs climbed up the small tree.' Following the positive lead-in, the puppet either produced the test sentence (23) or the question (24). The examples (23) and (24) are repeated here as (25) and (26).

(25) *Shei dou meiyou pa-shang dashu.*

who all not climb-up big tree

'Everyone didn't climb up the big tree.'

(26) *Shei meiyou pa-shang dashu?*

who not climb-up big tree

'Who didn't climb up the big tree?'

For the presentation of the test sentences, the subjects were divided into two groups. One group (15 child subjects and 15 adult subjects) heard test sentence (25). The other group (15 child subjects and 15 adult subjects) heard test sentence (26). Altogether, there were six test trials. Each group was presented with only one type of test sentence for each story, and the two types of test sentences were counterbalanced, so that each group was presented with three each, of the two sentence types. In order to control for the effect of the intonation on

subjects' judgements, the experimenter who played the role of the puppet was asked to produce the test sentences with the same intonation pattern, i.e., with level intonation. Moreover, this experimenter was not informed about the purpose of the experiment, or about the experimental hypothesis, so that the experimenter playing the role of the puppet should not have been inadvertently biased to support either of the possible interpretations using prosodic cues.

In addition to the test trials, each subject witnessed four control trials. On two of these control trials, the puppet produced the questions in (27) and (28). These trials were included to see whether subjects understand simple *wh*-questions without *dou*. On the other two control trials, the puppet produced the simple statements with *dou* in (29) and (30). These control trials were included to verify that subjects could understand simple statements with *dou*. The control trials were also used to counterbalance the “yes” and “no” responses throughout the trials. The statements in the test trials were all false in the relevant stories, so the statements (29) and (30) were true depictions of the stories. The test and control trials were presented in a pseudo-random order.

(27) Shei zhuangdao-le huluobo?

who hit-ASP carrot

‘Who hit the carrot?’

(28) Shei nadao-le beike?

who get-ASP shell

‘Who got the shell?’

(29) Xiaomao he xiaotuzi dou chi-le yu.

cat and bunny all eat-ASP fish

‘The cat and the bunny both ate a fish.’

(30) Xiaonanhai he xiaonühai dou qi-le changjinglu.

boy and girl all ride-ASP giraffe

‘The boy and the girl both rode a giraffe.’

Before we report the results, let us revisit the experimental hypotheses. If children know that the universal quantifier *dou* binds the *wh*-words to its left, then they would be expected to interpret sentences with a *wh*-word + *dou* as a statement. By contrast, they should interpret sentences with a *wh*-word alone, without *dou*, as a question. In the story under discussion, children who know that the *wh*-word *shei* ‘who’ is bound by *dou* should reject the puppet’s statement in (25), and should justify this response by pointing out that the black dog climbed up the big tree. In addition, children should provide an answer to the puppet’s question in (26), offering as an answer that the white dog and the brown dog didn’t climb up the big tree. On the other hand, if children do not know that *dou* binds the *wh*-words to its left, then they would be expected to interpret sentences with a *wh*-word + *dou* as having the same meaning as the counterparts to these sentences with a *wh*-word alone. In the story, children would be expected to respond in the same way, by offering answers to both (25) and (26), i.e., pointing out that the white dog and the brown dog didn’t climb up the big tree.

## Results and discussion

We recorded the responses of the subjects to the two types of test sentences. All the subjects responded correctly to the control trials. The main findings were, first, that children responded to test sentences with a *wh*-word + *dou* by rejecting the puppet’s statements 96% of the time<sup>4</sup>.

Adults rejected them 100% of the time. A Mann-Whitney Test showed that there was no

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<sup>4</sup> The other 4% of the time children said “Yes” to the puppet’s statements. But none of the child subjects responded to this type of test sentences by providing an answer, as they did for the test sentences with a *wh*-word alone.

significant difference between children and adults ( $Z = 1.86, p = .1$ ). In addition to overtly rejecting the test sentences, by saying “Bu dui” (“No”) or “Ni shuode bu dui” (“You’re wrong”), both children and adults pointed out that one of the characters did perform the action mentioned in the test sentence. In the example story, children and adults rejected the puppet’s statement in (25) by making reference to the fact that the black dog climbed up the big tree. Children either explicitly mentioned the black dog (“No, the black dog did.”) or they pointed to the black dog.

The second main finding concerns the responses of children and adults to the test sentences with a *wh*-word alone. Both children and adults consistently responded by providing an answer to the puppet’s question, i.e., they responded with an answer that mentioned the fact that the other two characters didn’t perform the action mentioned in the test sentences (children: 95%<sup>5</sup> vs. adults: 100%;  $Z = 1.86, p = .1$ ). In the example story, they answered the puppet’s question (26) in one of two ways. One response, by 3 of the 15 child subjects, was to point to both the white dog and the brown dog. The remaining 12 children overtly mentioned the two dogs that failed to climb up the big tree, saying “Bai gou he huang gou” (“The white dog and the brown dog”). The responses of each child on this trial are provided in Appendix A. The results of this experiment are summarized in Table 1.

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<sup>5</sup> The other 5% of the time children gave a wrong answer to the test sentences. We believe these non-adult responses were due to the fact that children were simply distracted during the telling of the story. The interpretation of children’s responses is supported by the fact that none of the child subjects responded to these test sentences in the same way as they had done for test sentences with the a *wh*-word + *dou*.

Table.1. Proportion of the two types of responses to the two types of test sentences by children and adults  
(Experiment 2)

Sentence Type	Response Type			
	Statement		Question	
	Children	Adults	Children	Adults
Sentences with a <i>wh</i> -word + <i>dou</i>	96%	100%	0	0
Sentences with a <i>wh</i> -word alone	0	0	95%	100%

The results of this experiment clearly show that children know that the quantifier *dou* turns sentences like (25) into statements. This stands in contrast to their counterparts without *dou*, such as (26), which children correctly interpreted as questions. This is compelling evidence that 3- to 5-year-old Mandarin-speaking children know that *wh*-words can be quantified by *dou* when they occur in the same clause. In the next experiment, the aim was to see if Mandarin-speaking children know that *dou* licenses the universal reading of *wh*-words even when they occur in separate clauses, such as *dou*-conditionals.

### Experiment 3

Experiment 3 was devised to see whether Mandarin-speaking children know that *dou* licenses the universal reading of *wh*-words when *dou* and the *wh*-word reside in different clauses, as in *dou*-conditionals like (21), repeated here as (31).

(31) Ni    jiao    shei jinlai, wo    dou jian.

you ask who enter I all see

‘Whoever you ask to come in, I’ll see him.’

As discussed earlier, *dou* is a Q-adverb that is able to bind the expressions outside the clause that contains it (Lewis, 1975). So if children analyse *dou* as a Q-adverb, then they should permit *dou* to bind a *wh*-word in the antecedent clause of *dou*-conditionals, thereby giving the sentence a universal reading.

## Method

### *Participants*

We tested 30 Mandarin-speaking children ranging in age from 3;5 to 5;0, with a mean age of 4;3. The child subjects were recruited from the kindergarten at Beijing Language and Culture University. In addition, 20 Mandarin-speaking adults were tested as controls, all postgraduate students at Beijing Language and Culture University. None of the subjects had participated in either Experiment 1 or Experiment 2.

### *Procedures*

As in the first two experiments, Experiment 3 used the Question-Statement task. The subjects were introduced to the task individually and were tested individually. There were two practice trials before the test session began. On one practice trial, the puppet informed the subject about what happened in the story and, on the other practice trial, the puppet posed a question to the subject. Only child subjects who correctly distinguished between a statement versus a question about these stories were permitted to proceed to the main test session. Adult controls were tested on the same task.

## Materials

There were 4 test stories. For each story, two types of test sentences were created<sup>6</sup>. The following sentences are used to illustrate a typical trial. Each sentence was presented following the same story, but to different subjects.

(32) Eyu      qu yao shei, maotouying cunzhang dou zhao-le zhizhuxia bangmang.  
crocodile go bite who owl village-head all find-ASP Spiderman help  
‘Whoever Mr. Crocodile went to bite, Mr. Owl asked Spiderman for help.’

(33) Eyu      qu yao shei, maotouying cunzhang zhao-le zhizhuxia bangmang?  
crocodile go bite who owl village-head find-ASP Spiderman help  
‘Who did Mr. Owl ask Spiderman to help when Mr. Crocodile went to bite?’

Sentence (32) is a *dou*-conditional, in which *dou* quantifies over the *wh*-word in the antecedent clause, thus the sentence expresses a statement, meaning ‘whoever Mr Crocodile went to bite, Mr Owl asked Spiderman for help.’ The *dou*-conditionals like (32) were contrasted with sentences like (33). Example (33) differs from (32) in that it lacks *dou* in the consequent clause. Therefore, (33) is used to pose a question, asking ‘who did Mr Owl ask Spiderman to help when Mr Crocodile went to bite?’ For the ease of exposition, we will refer to the two types of sentences as Type 1 and Type 2 respectively.

The experimental hypotheses were as follows. If children know that the quantifier *dou*, as a Q-adverb, binds the *wh*-word in the antecedent clause, then they were expected to interpret Type 1 sentences (e.g., sentence (32)) as statements. This contrasts with Type 2 sentences (e.g., sentence (33)), which were expected to be interpreted as questions. The

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<sup>6</sup> In the actual experiment, there were three types of test sentences, but the third type is not directly relevant to this paper, so we will not discuss it here.



following example illustrates a typical context, which was followed by sentences of both types, albeit for different subjects.

This story is about a small village. There are four guys living in this village. One is the village head, Mr Owl, and there are 3 villagers: Mr Rabbit, Mr Pig and Mr Cat. The villagers lived a happy life until last week, when a bad guy started coming to the village. His name is Mr Crocodile. Mr Crocodile always came at night to try to bite the villagers. When the village head, Mr Owl, found out about this, he came up with an idea. He asked two of his super friends, Mr Spiderman and Mr Batman, to protect his villagers. The next night Mr Crocodile came to Mr Pig's house (Figure 3). Mr Owl found out, and called Mr Spiderman. Just when Mr Crocodile was about to bite Mr Pig, Mr Spiderman came down from the roof and ran Mr Crocodile out of the house (Figure 4). As a reward, Mr Owl gave Mr Spiderman a purple shell. The next night Mr Crocodile came to Mr Pig's house again. He wanted revenge. Mr Owl found out, and called Mr Spiderman again. When Mr Crocodile jumped towards Mr Pig, Mr Spiderman came out from behind the door and ran Mr Crocodile out of the house. Mr Owl rewarded Mr Spiderman with another purple shell. The following night, Mr Crocodile decided not to try to bite Mr Pig, because Mr Spiderman always came to help. So he went to Mr Rabbit's house (Figure 5). Mr Owl found out again and, this time, he called Mr Batman. When Mr Crocodile broke into the house, he found Mr Batman standing right in front of him (Figure 6). Again Mr Crocodile was run out of the house. Mr Owl gave Mr Batman a white shell as a reward. After that, Mr Crocodile left the village and never came back.



Fig.3. Scene 1, Experiment 3



Fig.4. Scene 2, Experiment 3



Fig.5. Scene 3, Experiment 3



Fig.6. Scene 4, Experiment 3

To remind subjects of the events that had taken place in the story, the last scene of the story is as illustrated in Figure 7. Following the story, Mr Spiderman has two purple shells, because he had helped Mr Pig twice and Mr Batman has one white shell, because he had helped Mr Rabbit once.



Fig.7. Scene 5, Experiment 3

For the presentation of the test sentences, the child and adult subjects were divided into two groups, with 15 children and 10 adults in each group. When the story concluded, one group of

children heard the puppet produce the test sentence in (32), the other group heard the test sentence in (33). There were four test stories altogether. Each group was presented with only one type of test sentence for each story, and the two types of test sentences were counterbalanced, so that each group was presented with two each, of the two sentence types.

As in the first two experiments, the effect of the intonation on subjects' judgement was controlled for, as far as possible, by instructing the experimenter who played the role of the puppet to produce the target sentences using the same intonation pattern, i.e., with level intonation. In addition to the test trials, the subjects were presented with four control trials. On two of the control trials, the puppet produced the statements in (34) and (35). In both sentences, *dou* is used as a Q-adverb that quantifies over the events denoted by the subordinate clauses. Therefore (34) means 'in every situation in which the dwarfs were asleep, the witch would go to steal their fish', and (35) means 'in every situation in which the little monkey got hungry, his dad would feed him an ice cream.' In the relevant stories, both (34) and (35) were true. These two trials were used to counterbalance the "yes" and "no" answers throughout the trials, because all the statements in the test trials were made false in the relevant stories. On the other two control trials, the puppet produced the questions in (36) and (37). These two trials were used to verify that subjects could understand simple questions. The test and control trials were presented in a pseudo-random order.

(34) Xiaairen shuijiao de shihou, laowupo dou hui qu tou yu.

dwarf sleep DE time witch all will go steal fish

'Whenever the dwarfs were asleep, the witch would go to steal their fish.'

(35) Xiaohouzi e de shihou, houzi baba dou hui wei ta bingjiling.

little monkey hungry DE time monkey dad all will feed him ice cream

'Whenever the little monkey got hungry, his dad would feed him an ice cream.'

(36) Shei cong qiao-shang diaoxiaqu-le?

who from bridge-top fall-ASP

‘Who fell off the bridge?’

(37) Xiaoxiongmao gei-le xiaowugui shenme?

panda give-ASP turtle what

‘What did the panda give to the turtle?’

Before we report the results, let’s revisit the experimental hypotheses. We hypothesized that, if children know that the quantifier *dou*, as a Q-adverb, binds the *wh*-word in the antecedent clause, then they were expected to interpret Type 1 sentences as statements, as compared to Type 2 sentences, which children should interpret as questions. In the example story, children were expected to reject the test sentence in (32), and to justify their rejections on the grounds that Mr Owl asked Mr Batman for help when Mr Crocodile tried to bite Mr Rabbit. By contrast, children were expected to provide an answer (i.e., “Mr Pig”) to the test sentence in (33).

## Results and discussion

We recorded the responses of the subjects to the two types of test sentences. Two children were eliminated from the experiment, because they didn’t respond correctly to the practice trials. The remaining 28 children and 20 adults proceeded to the main session.

Here are the main findings. In response to Type 1 sentences, 24 out of the 28 children consistently interpreted the Type 1 sentences as statements, and correctly rejected them. However, the remaining four children provided an answer to the puppet’s Type 1 sentences. Similar response patterns were obtained from adults. For adults, 18 out of 20 adults

interpreted the Type 1 sentences as statements, and rejected them. However, two adults interpreted them as questions, and provided an answer to the puppet's Type 1 sentences. In the example story, the children and adults who interpreted sentence (32) as a statement said “Bu dui” (“No”) or “Ni shuode bu dui” (“You’re wrong”), and justified their negative judgment by explicitly referring to the fact that Mr Batman also came to help (“Bianfuxia xiansheng ye lai bangmang-le”), or by pointing to Mr Batman. The children and adults who interpreted sentence (32) as a question offered the answer “Mr Pig”. A Mann-Whitney Test showed that there were no significant differences between children and adults in their pattern of responses ( $Z = .25, p = 1$ ). Children rejected the Type 1 sentences 86% of the time, as compared to 90% rejection by adults.

In response to Type 2 sentences, 24 out of 28 children consistently interpreted the Type 2 sentences as questions, and provided the correct answers. The remaining four children interpreted the sentences as statements, and rejected them. All of the adults interpreted the puppet's Type 2 sentences as questions, and provided the correct answers. In the sample story, the children and adults who interpreted sentence (33) as a question answered “Mr Pig”. The children who interpreted sentence (33) as a statement rejected it and pointed out that Mr Batman also came to help. No significant differences were found between children and adults in response patterns. Children responded to it by providing an answer 86% of the time, and adults did so 100% of the time ( $Z = 1.95, p = .07$ ). Detailed responses of each individual child on this trial are given in Appendix B. The results of this experiment are summarized in Table 2.

Table.2. Proportion of the two types of responses to the two types of test sentences by children and adults  
(Experiment 3)

Sentence Type	Response Type			
	Statement		Question	
	Children	Adults	Children	Adults
Type 1 sentences	86%	90%	14%	10%
Type 2 sentences	14%	0	86%	100%

The results show that Mandarin-speaking children, and adults, overwhelmingly interpreted Type 1 sentences as statements, and Type 2 sentences as questions. This is compelling evidence that Mandarin-speaking children know that *dou*, as a Q-adverb, is able to bind a *wh*-word in the antecedent clause, thereby licensing its universal reading. Two questions remain, however. One question is why some children (four children) and some adults (two adults) interpreted Type 1 sentences (i.e., *dou*-conditionals) as questions. The second question is why four children, but none of the adults, interpreted Type 2 sentences as statements.

To address the first question, we offer the following proposal, invoking the human sentence processing mechanism, i.e., the on-line parser. The parser computes the interpretation of sentences on a word-by-word basis, as sentences unfold in real time (see e.g., Crain & Steedman, 1985; Frazier & Fodor, 1978). In *dou*-conditionals, the *wh*-word and *dou* appear in separate clauses. In Mandarin, the antecedent clause, with the *wh*-word, always precedes the consequent clause, which contains *dou*. Before the parser reaches the consequent

clause, then, the sentence is likely to be interpreted as a question, because the *wh*-word in the antecedent clause will initially be understood as a question marker; without evidence to the contrary, this will be the parser's initial hypothesis. However, when *dou* is encountered in the consequent clause, the parser needs to reanalyse, converting the analysis of the sentence from a question into a statement. So if subjects only attend to the first half of the *dou*-conditional structure, or cannot easily revise their initial interpretation of the antecedent clause, then they will be left with the question interpretation of the *wh*-word. These remarks are intended to shed light on why some subjects in the study interpreted Type 1 sentences as questions. In short, we propose that some subjects, due to limited processing resources, were unable to revise their initial analysis of the antecedent as a question, in order to convert the antecedent into a statement upon encountering the consequent clause, with *dou*. Thus, these subjects retained their initial question interpretation, and consequently provided an answer to the question.

This brings us to the outliers for the Type 2 sentences. We speculate that these children interpreted Type 2 sentences as statements, rather than questions, simply due to a carryover effect. Recall that the experiment used a within-subject design. In any within-subject design, there is a possibility that a subject's performance in one test condition might influence their performance in another test condition. In the present case, subjects were presented with two types of test sentences. So their judgements on one type of test sentences might have influenced their judgements on the other type of test sentences. More specifically, the judgments of some children on Type 2 test sentences might have been affected by their responses to the Type 1 sentences, because these two types of test sentences were quite similar. Notice that the only difference between the two is the presence or absence of *dou*. In other words, after having judged Type 1 sentences as statements, these children may have felt encouraged to provide a similar analysis of the Type 2 test sentences. To establish the



plausibility of this explanation, we examined the data of these four children, and found that the four children had been presented with the Type 1 sentences first, which they interpreted as statements. This observation vindicates the “carryover effect” account of why the four children interpreted Type 2 sentences as statements.

More generally, however, the results of Experiment 3 show that 3- to 5-year-old Mandarin-speaking children know that *dou*, as a Q-adverb, can bind a *wh*-word in different clauses, as long as this *wh*-word precedes *dou*.

Taken together, the findings from Experiment 2 and Experiment 3 provide evidence that 3- to 5-year-old Mandarin-speaking children are aware that the quantifier *dou* licences the universal reading of *wh*-words. Young Mandarin-speaking children are sensitive to the licensing environments for the universal reading of *wh*-words.

## **General discussion and conclusion**

The present study investigated whether Mandarin-speaking children are sensitive to linguistic environments which license the non-interrogative use of *wh*-words: the indefinite reading and the universal reading. We focused on two linguistic environments: the predicate phrase of the negative quantificational expression *meiyouren* ‘nobody’ and the universal quantifier *dou*, among which the former licenses the indefinite reading of *wh*-words and the latter licenses the universal reading of *wh*-words. Three experiments were conducted. Experiment 1 examined if children know that *wh*-words function as existential indefinites when they occur in the predicate phrase of *meiyouren* ‘nobody’. Experiments 2 and 3 explored whether children know that *wh*-words are interpreted as having a universal reading when they appear in the scope of the quantifier *dou*. It was found that 3- to 5-year-old Mandarin-speaking children are sensitive to these licensing environments for the non-interrogative use of *wh*-words. Our study established that children know that *wh*-words are

interpreted as existential indefinites in the predicate phrase of the negative quantificational expression *meiyouren* ‘nobody’, but as interrogative words in the predicate phrase of the positive quantificational expression *meigeren* ‘everybody’. And our study established that children know that *wh*-words are interpreted as having a universal reading in the scope of the quantifier *dou*, but not in the corresponding sentences without *dou*. These results attest to the early mastery of adult-like linguistic knowledge of *wh*-quantification in child Mandarin.

Now the question becomes: how do young children establish the connection between the semantic interpretation of *wh*-words and the linguistic contexts in which they occur? One possibility that people can think of is that children use distributional cues in the input to learn the semantic interpretation of *wh*-words. But can they? It might be possible to use distributional facts to account for how children acquire the licensing environments for the Mandarin negative polarity item *renhe* ‘any’. For example, if children are extremely good record keepers, they might keep track of the fact that *renhe* ‘any’ appears in the predicate phrase of the negative quantificational expression *meiyouren* ‘nobody’ (e.g., *Juhuishang meiyouren chi renhe shuiguo* ‘Nobody ate any fruit at the party’), but not in the predicate phrase of the positive quantificational expression *meigeren* ‘everybody’ (e.g., *Juhuishang meigeren dou chi \*renhe shuiguo* ‘Everybody ate\*any fruit at the party’). However, note that in learning the interpretation of *wh*-words, what children learn is that the same *wh*-word functions an interrogative word in certain linguistic contexts, but it is interpreted as a non-interrogative indefinite in some other linguistic contexts. It is not the distribution of the *wh*-word that is at issue for children, but its interpretive properties. So, children would be hard-pressed to use distributional cues to establish the connection between the semantic interpretation of *wh*-words and the linguistic contexts in which they occur. Given the difficulty that children may have in using distributional cues to learn the semantic interpretation of *wh*-words, and the early emergence of this knowledge in child Mandarin, we

propose that the licensing mechanism for the non-interrogative use of *wh*-words is innate in child Mandarin.

We propose the following learning scenario. *Wh*-words are treated as variables in child Mandarin, therefore, the interpretation of *wh*-words is governed by a variable-binding relation. When *wh*-words occur in linguistic environments like yes-no questions, the predicate phrase of the negative quantificational expression *meiyouren* ‘nobody’, and A-not-A questions, etc., they are licensed as polarity items and get the existential indefinite reading by being bound by existential closure. In this case, the binder is the existential operator introduced by existential closure. When they appear in the scope of the universal quantifier *dou*, they are bound by *dou*, and thus interpreted as having a universal reading. In this case, the universal quantifier *dou* is the binder. We propose that this variable-binding mechanism in child Mandarin is innate. So children don’t need to learn how these linguistic environments license the non-interrogative use of *wh*-words. In other words, they don’t need to learn whether an indefinite reading is licensed or a universal reading is licensed in certain linguistic contexts. The innate variable-binding mechanism will help children access the proper interpretation. What children need to learn are the semantic properties of these different linguistic environments, for instance, they need to learn what a yes-no question is, what negation is, what a A-not-A question is, and what the property of *dou* is. Once children acquire the semantic properties of these different linguistic environments, the innate variable-binding mechanism will help them get the semantic interpretation of *wh*-words automatically, i.e., whether an indefinite reading is licensed or a universal reading is licensed. In other words, once children know the semantic properties of these different linguistic environments, they can draw on the innate variable-binding mechanism to establish the interpretation of *wh*-words and the linguistic contexts in which they occur.

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## Appendix A: Children's responses on the example trial, Experiment 1

		The sentence with <i>dou</i>
Group 1	Age	Responses
Girl	4;9	No, the black dog did
Boy	4;8	No, he climbed up the big tree (pointing to the black dog)
Girl	4;8	No, the black dog climbed up the big tree
Girl	4;1	No, the black dog climbed up the big tree
Girl	4;2	You're wrong, the black dog climbed up the big tree
Boy	4;2	No, he did (pointing to the black dog)
Boy	4;2	Yes
Boy	3;11	You're wrong, he did (pointing to the black dog)
Girl	4;4	No, the black dog did
Boy	4;5	No, the black dog did
Girl	3;10	No, the black dog did
Girl	3;5	No, he climbed up the big tree (pointing to the black dog)
Girl	4;1	You're wrong, the black dog did
Girl	4;2	You're wrong, he did (pointing to the black dog)
Boy	4;2	No, the black dog did
		The sentence without <i>dou</i>
Group 2	Age	Responses
Girl	3;7	The white dog and the brown dog
Girl	3;10	Pointing to the white dog and the brown dog
Girl	4;5	The white dog and the brown dog
Girl	4;6	The white dog and the brown dog
Boy	3;11	Pointing to the white dog and the brown dog
Boy	3;11	The white dog and the brown dog

Girl	4;1	The white dog and the brown dog
Boy	4;3	Pointing to the white dog and the brown dog
Girl	4;4	The white dog and the brown dog
Girl	4;2	The white dog and the brown dog
Boy	4;2	The white dog and the brown dog
Girl	4;8	The white dog and the brown dog
Girl	4;8	The white dog and the brown dog
Boy	4;8	The white dog and the brown dog
Boy	4;2	The white dog and the brown dog

**NOTE:** We have translated the corresponding sentences into English. The corresponding translations are as follows.

Bu dui.

not right

‘No.’

Dui.

right

‘Yes.’

Ni shuode bu dui.

you say not right

‘You’re wrong.’

Hei gou



black dog

‘The black dog.’

Bai gou he huang gou.

white dog and brown dog

‘The white dog and the brown dog.’

## Appendix B: Children’s responses on the example trial, Experiment 2

		Type 1
Group 1	Age	Responses
Boy	4;5	No, Mr Batman also came to help
Girl	4;4	You’re wrong, Mr Batman also came to help
Boy	3;7	No, Mr Batman also came to help
Girl	4;2	No, Mr Batman also came to help
Boy	4;3	No, Mr Batman also came to help
Boy	4;1	No, Mr Batman also came to help
Girl	4;1	Mr Pig
Girl	4;2	You’re wrong, Mr Batman also came to help
Girl	4;5	No, he also came to help (pointing to Mr Batman)
Girl	4;4	You’re wrong, Mr Batman also came to help
Boy	3;5	No, Mr Batman also came to help
Boy	4;8	No, Mr Batman also came to help
Boy	4;3	No, he also came to help (pointing to Mr Batman)
Girl	4;1	No, Mr Batman also came to help
		Type 2
Group 2	Age	Responses
Boy	4;5	No, Mr Batman also came to help
Girl	4;2	Mr Pig

Girl	4;3	Mr Pig
Girl	4;4	Mr Pig
Girl	4;5	Pointed to Mr Pig
Boy	4;2	Mr Pig
Girl	4;7	Mr Pig
Girl	4;1	Mr Pig
Girl	4;2	You're wrong, Mr Batman also came to help
Girl	4;5	Mr Pig
Girl	4;4	Mr Pig
Boy	4;3	Pointed to Mr Pig
Boy	3;6	Mr Pig
Boy	3;7	Mr Pig
		<b>Type 3</b>
<b>Group 3</b>	<b>Age</b>	<b>Responses</b>
Boy	4;1	Mr Spiderman
Girl	4;1	Mr Spiderman
Girl	4;8	Mr Spiderman
Girl	3;6	Mr Spiderman
Girl	4;6	Pointed to Mr Spiderman
Girl	4;1	Mr Spiderman
Girl	4;2	Mr Spiderman
Girl	3;9	Mr Spiderman
Boy	5;0	Pointed to Mr Spiderman
Boy	4;8	Mr Spiderman
Boy	4;1	Mr Spiderman
Girl	4;2	Mr Spiderman
Girl	4;2	Mr Spiderman
Girl	4;2	Mr Spiderman

**NOTE:** We have translated the corresponding sentences into English. The corresponding

translations are as follows.

Bu dui.

not right

‘No.’

Ni shuode bu dui.

you say not right

‘You’re wrong.’

Bianfuxia xiansheng ye lai bangmang-le.

Batman sir also come help-ASP

‘Mr Batman also came to help.’

Zhu xiansheng

pig sir

‘Mr Pig.’

Zhizhuxia xiansheng

Spiderman sir

‘Mr Spiderman.’



# **Scope assignment in child language: Evidence from the acquisition of Chinese**

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## Abstract

In this paper, we investigated how Mandarin-speaking children and adults understand the scope relation between the universal quantifier and negation in sentences like *Mei-pi ma dou meiyou tiaoguo liba* ‘Every horse didn’t jump over the fence’ and *Bushi mei-pi ma dou tiaoguo-le liba* ‘Not every horse jumped over the fence’. We found that Mandarin-speaking children accepted these two types of sentences in both the surface scope and the inverse scope scenarios, whereas Mandarin-speaking adults only permitted them in the surface scope scenarios. The findings of this study, combined with previous research with English-speaking children, invite the conclusion that children start off with a flexible scope relation between the universal quantifier and negation. Children’s grammar allows flexibility in the mappings between syntax and semantics.

*Keywords:* Scope assignment; Surface scope; Inverse scope; Flexibility

## Scope assignment in child language: Evidence from the acquisition of Chinese

### Introduction

Consider the sentence *Every boy did not ride the elephant*. This sentence is ambiguous. It can mean either that (i) none of the boys rode the elephant, or (ii) not all of the boys rode the elephant. This difference in interpretation is referred to as a ‘scope phenomenon’. It is said that the ‘none’ meaning arises when *every* takes scope over *not* (EVERY > NOT), and the ‘not all’ meaning arises when *not* takes scope over *every* (NOT > EVERY). Scope phenomena such as this involve the interplay of different levels of linguistic representation: syntax, semantics and pragmatics. Therefore, children’s understanding of scope phenomena provides a good testing ground for investigating their knowledge of linguistic principles that operate at these different levels. In recent years, this area of inquiry has received considerable attention in the field of developmental psycholinguistics. Two main questions have been asked: (i) Do children and adults differ in scope assignments? And (ii) If children and adults do differ, what is the nature of children’s linguistic representation underlying their scope assignments? The answers to these two questions have been subject to vigorous debate, because it has been proven difficult to identify the factors that give rise to children’s non-adult interpretations, i.e., are they due to children’s syntactic, semantic or pragmatic knowledge?

In this paper, we focus on Mandarin-speaking children’s knowledge of the scope interaction between the universal quantifier and negation, in the hope of shedding new light on children’s developing knowledge of scope phenomena. The paper is organized as follows. First we introduce the relevant scope phenomena in English and in Mandarin Chinese. Then we review previous research on children’s understanding of sentences with the universal



quantifier and negation. Finally, we present two experiments investigating Mandarin-speaking children's interpretation of sentences involving the universal quantifier and negation.

### Scope Phenomena in English

We first look at English, which has been the focus of the majority of recent research on children's interpretation of scope phenomena. For English-speaking adults, English is somewhat flexible in permitting interpretations involving the universal quantifier and negation. Consider the sentences in (1) and (2).

(1) Every horse didn't jump over the fence.

(2) Not every horse jumped over the fence.

In (1), the universal quantifier *every* and negation *not* can each take scope over the other. Following standard parlance, we will use the term 'surface scope' to refer to the reading in which the syntactic and semantic representations are isomorphic: what you hear/read is what you get. The surface scope reading of (1) is the EVERY > NOT reading. This is typically analysed using the following logical form:  $\forall x [\text{horse}'(x) \rightarrow \neg \text{jumped over the fence}'(x)]^1$ . We will use the term 'inverse scope' to refer to the reading in which there is no isomorphism between the syntactic and semantic representations. This is the NOT > EVERY reading of (1), with the associated logical form:  $\neg \forall x [\text{horse}'(x) \rightarrow \text{jumped over the fence}'(x)]^2$ .

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<sup>1</sup> There is a noteworthy problem with using this conditional statement as the logical form, namely, it makes sentence (1) true in circumstances in which there are no horses. The problem arises because conditionals are true if the antecedent is false. One way around this problem is to suppose that quantificational expressions, including the universal quantifier *every*, presuppose the existence of some set of entities denoted by the subject phrase. For the purposes of this paper, we will adhere to this supposition.

<sup>2</sup> There is also a problem with this logical form, namely, it is entailed by the logical form associated with the surface scope reading of (1): if every horse didn't jump over the fence, then not every horse did. This means that if the surface scope reading of (1) is true, then so is the inverse scope reading. This calls into question whether sentences like (1) are properly described as ambiguous. This issue will be discussed as we proceed but, for now, we will refer to the situation as one of ambiguity.

In response to example (1), adult English-speakers can access both the surface scope reading (EVERY > NOT) and the inverse scope reading (NOT > EVERY). For example, a sign at one of the airlines at Logan airport in Boston reads: *Every airplane does not carry pets*. The intended interpretation is clearly that not all airplanes carry pets, just some of them do (cf. *All that glitters is not gold; All dishwashing detergents are not the same*).

Next, consider example (2). The logical forms associated with (2) are the same as those associated with (1), but in reverse order. The surface scope reading is the NOT > EVERY reading and the inverse scope reading is the EVERY > NOT reading. In contrast to example (1), most English speakers find it difficult to access the inverse scope reading of (2).

There are at least two possible accounts of the unavailability of the inverse scope reading of sentence (2). One possibility is that (2) is actually unambiguous, with only a surface scope reading NOT > EVERY. Since the (hypothetical) inverse scope reading entails the surface scope reading, one set of circumstances in which (2) will be true on the surface scope reading will be those in which none of the horses jumped over the fence. This makes it difficult to provide evidence that there is a separate, inverse scope reading, in addition to the interpretation on which negation has scope over the universal quantifier in sentences like (2).

Even if (2) were ambiguous, the (hypothetical) inverse scope reading would be difficult for language users to access, for pragmatic reasons. One of the main pragmatic principles is the Principle of Cooperation (Grice, 1989). According to the Principle of Cooperation, speakers are expected to convey as much relevant information as they can about a given topic. This has a profound effect on how certain sentences are interpreted. Its effect is particularly pronounced in the interpretation of linguistic expressions that form a natural scale with other expressions, on the basis of the information strength they convey<sup>3</sup>. Familiar scales of this kind include <*or, and*> and <*some, many, most, every*>, where terms on the left of the scale are

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<sup>3</sup> By definition, information strength is defined in terms of entailment relations: if interpretation A asymmetrically entails interpretation B, then A is 'stronger' (more informative) than B.

‘weaker’ than terms to their right. When a speaker uses a statement that contains a ‘weaker’ (less informative) term from one of these scales (e.g., *or*), this invites the hearer to infer that the speaker was not in a position to use a ‘stronger’ (more informative) term from these scales (e.g., *and*). In order to keep the hearer’s mental model of the conversation information-aligned with that of the speaker, the hearer attributes to the speaker the negation of the statement with the ‘stronger’ term, and the hearer augments his or her mental model of the discourse context accordingly.

This brings us back to example (2): *Not every horse jumped over the fence*. Again, the critical observation is that the (hypothetical) inverse scope reading (EVERY > NOT) asymmetrically entails the surface scope reading (NOT > EVERY). Therefore, the surface scope reading is ‘weaker’ than the inverse scope reading. Consequently, a hearer who accesses the surface scope interpretation of (2) will infer that the speaker did not feel entitled to assert the ‘stronger’ inverse scope reading (supposing, perhaps contrary to fact, that there is a separate EVERY > NOT reading). This inference is based on the hearer’s assumption that the speaker was being cooperative and produced the most informative statement that he or she was in a position to make. If the surface scope reading of (2) is the strongest statement the speaker felt entitled to make, then upon hearing (2), the hearer would augment his or her mental model of the discourse with the negation of the ‘stronger’ inverse scope reading, so the hearer would add to his or her mental model: *At least one horse jumped over the fence*<sup>4</sup>. This effectively eliminates the inverse scope reading of (2) from contention, even supposing that such a reading exists.

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<sup>4</sup> This is a logical consequence of negating the EVERY > NOT reading, i.e., if it not the case that none of the horses jumped over then fence, then at least one horse jumped over the fence.

Of course, conversational implicatures are ‘defeasible’, i.e., they can be overtly cancelled (Grice, 1989). Accordingly, the adult English-speakers we have interviewed find the assertion in (3) to be acceptable or, at least, not contradictory<sup>5</sup>.

(3) Not every horse jumped over the fence. In fact none of them did.

In contrast to English, adult speakers of Mandarin find the translation of the English sequence in (3) to be an overt contradiction. The offending assertion is (4).

(4) Bushi mei-pi ma dou tiaoguo-le liba; shijishang, meiyou  
not-be every-CL horse all jump-over-ASP fence; in fact, not-have  
  
ma tiaoguo liba.  
horse jump-over fence  
  
‘It wasn’t every horse that jumped over the fence; in fact none of them did.’

One might be tempted to explain the unacceptability of (4) for Mandarin-speakers by supposing that Mandarin uniquely licenses the surface scope reading of sentences corresponding to English (2), whereas English licenses both the surface scope and the inverse scope reading. The problem with this analysis of the situation is that, even if Mandarin uniquely allowed the surface scope reading, Mandarin-speakers should still accept the assertion in (4), i.e., *Bushi mei-pi ma dou tiaoguo-le liba* ‘Not every horse jumped over the fence’ in circumstances in which none of the horses jumped over the fence. As long as the

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<sup>5</sup> The line of reasoning we have been pursuing requires the corollary assumption that the most accessible reading of a scopally ambiguous sentence in English is the surface scope reading. This seems reasonable in English, because this reading is surface compositional, and does not require any ‘extra’ grammatical operations, such as quantifier raising.

surface scope reading (NOT > EVERY) in Mandarin is asymmetrically entailed by the (hypothetical) inverse scope reading (EVERY > NOT), then the surface scope reading will make Mandarin sentences true in the circumstances that correspond to the inverse scope reading (EVERY > NOT). And this, in turn, suggests that Mandarin-speakers should not find (4) to be contradictory to any greater extent than English-speakers find (3) contradictory. The fact that Mandarin-speakers do find (4) contradictory suggests that Mandarin imposes an additional restriction on the truth conditions of ‘not...every’ sentences, thereby breaking the asymmetric entailment relation with ‘every...not’ sentences. We will return to this issue shortly.

It should be noted that the pragmatic account of the preference for the surface scope interpretation of (2) does not extend to example (1). The surface compositional interpretation of (1) asymmetrically entails the inverse scope reading, so the inverse scope reading constitutes a ‘weaker’ statement. Presumably, the fact that language users can access the ‘weaker’ inverse scope reading of sentences like (1) is largely due to another pragmatic convention, the Principle of Charity (Davidson, 1984; Grice, 1975). According to this principle, when confronted with an ambiguous sentence that is true on one reading, and false on the other reading in the discourse context, hearers tend to access the interpretation that makes the sentence true. In the absence of context, if the ‘weaker’ reading of (1) (the NOT > EVERY reading) is judged to be more plausible, according to the hearers’ real-world knowledge, than the ‘stronger’ reading (the EVERY > NOT reading), then the Principle of Charity is engaged, and hearers will tend to access the ‘weaker’ reading. In this way, the Principle of Charity explains why English-speakers access the inverse scope interpretation of sentences like (1). By contrast, even supposing that sentences like (2) are ambiguous, the Principle of Charity would be in conflict with the Principle of Cooperation in sentences like

(2), so English-speakers would find it more difficult to access the (hypothetical) inverse scope reading of (2), as compared to (1), where the Principle of Cooperation is not operative.

### Scope Phenomena in Mandarin Chinese

In contrast to English, Mandarin Chinese has been argued to exhibit scope rigidity, in the sense that scope is determined exclusively by the surface structural relations between quantificational expressions (Aoun and Li, 1989; Huang, 1982; Lee, 1986). The Mandarin sentences corresponding to the English examples (1) and (2) are given in (5) and (6). In sentence (5), the universal quantifier *mei* ‘every’ c-commands the expression for negation *meiyou* ‘not’ in the overt syntax, so the only reading available for adult Mandarin-speakers is the EVERY > NOT reading, which can be paraphrased as ‘none of the horses jumped over the fence’. The associated logical form is indicated in (5a). The NOT > EVERY reading of (5) is represented in (5b). This interpretation is judged by many linguists to be unavailable for Mandarin-speaking adults, as indicated by the asterisk.

(5) Mei-pi     ma     dou meiyou tiaoguo     liba.

every-CL horse all not-have jump-over fence

‘Every horse didn’t jump over the fence.’

a.  $\forall x [\text{horse}'(x) \rightarrow \neg \text{jumped over the fence}'(x)]$

b.  $*\neg \forall x [\text{horse}'(x) \rightarrow \text{jumped over the fence}'(x)]$

Next, consider example (6). In this example, a different expression for negation *bu* ‘not’ c-commands the universal quantifier *mei* ‘every’. It is the contention of many linguists that the unique interpretation is one in which negation takes wider scope than the universal quantifier (NOT > EVERY). The EVERY > NOT reading, as represented in (6a), is judged by

many linguists to be unavailable for Mandarin-speaking adults, as indicated by the asterisk. According to these linguists, (6) can be paraphrased as ‘some, but not all of the horses jumped over the fence.’

(6) Bushi mei-pi ma dou tiaoguo-le liba.

not-be every-CL horse all jump-over-ASP fence

‘Not every horse jumped over the fence.’

a.  $*\forall x [\text{horse}'(x) \rightarrow \neg \text{jumped over the fence}'(x)]$

b.  $\neg \forall x [\text{horse}'(x) \rightarrow \text{jumped over the fence}'(x)]$

But what is the logical form for the unique NOT > EVERY interpretation, such that it prevents Mandarin-speakers from accepting (6) in circumstances in which none of the horses jumped over the fence? One candidate for the associated logical form of (6) is indicated in (6b):  $\neg \forall x [\text{horse}'(x) \rightarrow \text{jumped over the fence}'(x)]$ . As we have seen, there is a problem using this logical form to represent the surface scope interpretation of (6). The problem is that, on this rendering, the sentence will be true if none of the horses jumped over the fence. That is, if we stick to the traditional logical form for the NOT > EVERY reading of (6), then the truth conditions represented in (6a), in which none of the horses jumped over the fence, will not be ruled out. Again, the problem arises because the (hypothetical) inverse scope reading (EVERY > NOT) asymmetrically entails the traditional version of the surface scope reading. Because adult speakers of Mandarin do not judge sentence (6) to be true in circumstances that verify (5), in which none of the horses jumped over the fence, this means that (6b) cannot be the logical form underlying Mandarin-speakers’ interpretation of (6). In order to correctly represent Mandarin sentences like (6), an alternative logical form is needed.

We follow standard practice and attribute the limited availability of scope assignments in Mandarin to the use of the linguistic expression *dou* ‘all’ in (5), and to the appearance of *shi* ‘be’ in (6). In particular, we adopt the analysis by Lee (2005) and Pan (2006), according to which Mandarin *shi* and *dou* are focus-sensitive operators that induce cleft-like structures. The essential idea is that the Mandarin sentences (5) and (6) correspond to the English cleft constructions in (7) and (8), respectively. According to this analysis, the Mandarin sentences (5) and (6) can be decomposed into two conjoined propositions, which we will call the presupposition and the assertion, as described in Horn (1969)<sup>6</sup>.

- (7) It was every horse that didn’t jump over the fence.
  - a. Presupposition: some  $x$ ,  $x$  = horse,  $x$  didn’t jump over the fence
  - b. Assertion: every  $x$ ,  $x$  = horse,  $x$  didn’t jump over the fence
- (8) It wasn’t every horse that jumped over the fence.
  - a. Presupposition: some  $x$ ,  $x$  = horse,  $x$  jumped over the fence
  - b. Assertion: not every  $x$ ,  $x$  = horse,  $x$  jumped over the fence

In both (5) and (6), as in (7) and (8), the presuppositions claim that some horses have the property denoted by the predicate (i.e., at least one horse didn’t jump over the fence; at least one horse jumped over the fence). The assertion in (7b) makes the claim that the focus element, *every horse*, has the relevant property (i.e., didn’t jump over the fence), whereas the assertion in (8b) denies the claim that the focus element, *every horse*, has the relevant property (i.e., jumped over the fence). Based on these considerations, we propose to revise the glosses and the logical forms associated with the Mandarin examples (5) and (6). The revised representations are given in (9) and (10), respectively.

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<sup>6</sup> We adopt this terminology for convenience only, following common practice in the literature. We do not use ‘presupposition’ to indicate that this proposition can be flouted any more easily than the assertion can be.



(9) Mei-pi      ma    dou meiyou tiaoguo      liba.

every-CL horse all not-have jump-over fence

‘It was every horse that didn’t jump over the fence.’

Logical form:  $\exists x [\text{horse}'(x) \wedge \neg \text{jumped over the fence}'(x)] \wedge$

$\forall x [\text{horse}'(x) \rightarrow \neg \text{jumped over the fence}'(x)]$

(10) Bushi mei-pi      ma    dou tiaoguo-le      liba.

not-be every-CL horse all jump-over-ASP fence

‘It wasn’t every horse that jumped over the fence.’

Logical form:  $\exists x [\text{horse}'(x) \wedge \text{jumped over the fence}'(x)] \wedge$

$\neg \forall x [\text{horse}'(x) \rightarrow \text{jumped over the fence}'(x)]$

The problem that arose in using the traditional logical form in (6b) to represent the unique interpretation of the surface scope interpretation of ‘not...every’ sentences like (10) can now be dealt with. If the logical form indicated in (10) is used to represent the NOT > EVERY reading, then there is no longer an entailment relation between the Mandarin sentences in (9) and (10). Sentence (9) is true in circumstances in which none of the horses jumped over the fence, and (10) is true in circumstances in which at least one horse, but not all of the horses jumped over the fence. If none of the horses jumped over the fence, as (9) states, then it cannot be the case that some of the horses jumped over the fence, as (10) would now claim. In short, this linguistic analysis accounts for why Mandarin sentences like (9) and (10) have only surface scope readings and lack inverse scope readings. This is due to the focus-sensitive properties of *dou* in (9) and *shi* in (10).

The scope rigidity of Mandarin contrasts with other languages, including English.

Notice that the logical form in (10) is not a viable candidate to express the truth conditions

associated with the English sentence corresponding to (10): *Not every horse jumped over the fence*. The reason is that the truth conditions for this sentence include circumstances in which none of the horses jumped over the fence. As we saw, the English sentence *Not every horse jumped over the fence* implies that at least one horse jumped over the fence, but it does not assert this. This makes the use of *Not every horse jumped over the fence* infelicitous, but not truth-conditionally false, in circumstances in which none of the horses jumped over the fence. The infelicity is produced by a pragmatic implicature, which is ‘defeasible’ (Grice, 1989). To cancel the implicature, the speaker simply insists, overtly, that none of the horses jumped over the fence, by saying for example: *Not every horse jumped over the fence. In fact none of them did*. In contrast to English, we suggest that Mandarin imposes a presupposition of existence in the logical form associated with (10). If so, then adult Mandarin-speakers should not only reject (10) as an accurate description of circumstances in which none of the horses jumped over the fence, but they should continue to rule out this interpretation even in the face of an overt claim that none of the horses jumped over the fence. We test this prediction in the next section.

### **A comparison of English and Mandarin**

We sought concrete evidence that Mandarin-speakers impose a presupposition of existence in sentences like (10). Our analysis was put to the test by seeing whether or not adult Mandarin-speakers judge (11) to express a contradiction. As we have seen, the corresponding English sentence is not a contradiction for English-speaking adults, presumably because they do not impose such a condition.

- (11) Bushi   mei-pi   ma   dou   tiaoguo-le   liba; shijishang,   meiyou  
       not-be   every-CL horse   all   jump-over-ASP   fence; in fact,   not-have

ma    tiaoguo    liba.

horse jump-over fence

‘It wasn’t every horse that jumped over the fence; in fact none of them did.’

We conducted a survey of 15 Mandarin-speaking adults to see whether the lack of inverse scope interpretation of (10) *Bushi mei-pi ma dou tiaoguo-le liba* ‘It wasn’t every horse that jumped over the fence’ is due to a language-specific restriction on its truth conditions (presumably prompted by *shi*). In the interview, subjects were asked to indicate whether sentences like (11) were acceptable or not. The basic idea is that if the lack of inverse scope reading for sentences like (10) is due to an implicature, then the additional comment *shijishang, meiyou ma tiaoguo liba* ‘in fact, none of them did’ should cancel the implicature without contradiction. However, if adult Mandarin-speakers do not permit the truth conditions for (10) to include circumstances in which none of the horses jumped over the fence, then (11) should amount to a contradiction for them.

The finding was that 10 of the 15 adults we interviewed judged sentence (11) to be unacceptable, and five judged it to be acceptable. This difference reached statistical significance (67% vs. 33%,  $Z = 3.74$ ,  $p < .001$ ). All of those people who rejected the sentence volunteered that the additional comment *shijishang, meiyou ma tiaoguo liba* ‘in fact, none of them did’ contradicted the initial sentence *Bushi mei-pi ma dou tiaoguo-le liba* ‘It wasn’t every horse that jumped over the fence’. We interpret the findings of this interview as suggestive evidence that the lack of an inverse scope interpretation for sentences like (10) in Mandarin is not due to a pragmatic implicature, but, instead, is due to language-internal properties.

There are two candidates for the language-internal properties. One possibility is that the lack of an inverse scope reading for sentence (10) is caused by the focus-sensitive property of *shi*. Alternatively, it could be due to the presence of *dou*. To adjudicate between these alternatives, we conducted a second interview with another ten Mandarin-speaking adults. The sentence we presented was (12), which is exactly like (11), but with *dou* removed. This time we asked adult speakers, first, to say whether the first part of the sentence, without *dou*, was acceptable, i.e., *Bushi mei-pi ma tiaoguo-le liba*. Then we asked the subjects whether the entire sentence in (12) expressed a contradiction.

(12) *Bushi mei-pi ma tiaoguo-le liba; shijishang, meiyou ma*  
 not-be every-CL horse jump-over-ASP fence; in fact, not horse

*tiaoguo liba.*

jump-over fence

‘It wasn’t every horse that jumped over the fence, in fact none of them did.’

The main findings were as follows. All ten adults we interviewed judged the initial part of (12) to be acceptable, i.e., *Bushi mei-pi ma tiaoguo-le liba*, although five of them commented that it is not as natural as the same sentence with *dou* inserted, i.e., *Bushi mei-pi ma dou tiaoguo-le liba*. Moreover, all ten subjects indicated that the additional comment *shijishang, meiyou ma tiaoguo liba* ‘in fact, none of them did’ contradicts the initial sentence *Bushi mei-pi ma tiaoguo-le liba* ‘It wasn’t every horse that jumped over the fence’.

In short, the findings from interviews with native speakers of Mandarin reinforce the two-fold conclusions that, first, sentences like (10) are unambiguous in Mandarin and, second, that the lack of ambiguity is due to the occurrence of the focus expression *shi*. To sum up,

Mandarin and English differ in scope interpretation in that Mandarin exhibits scope rigidity, whereas English is more flexible in scope assignment. This difference is due to language-internal properties. We turn now to children's knowledge of scope interpretation in these languages, to see whether or not they have adult-like knowledge.

### **Child Language Research**

Previous studies on English-speaking children's knowledge of scope relations involving the universal quantifier and negation have resulted in two main proposals. One proposal, by Musolino (1998), is that English-speaking children differ from adults in that children initially assign only the surface scope reading to sentences like (1), repeated here as (13). This conclusion is sometimes referred to as the 'observation of isomorphism'. According to this observation, English-speaking children initially adopt the same scope rigidity exhibited in Mandarin. Presumably, English-speaking children add the additional inverse scope reading to sentences like (13) in response to positive evidence.

(13) Every horse didn't jump over the fence.

An alternative proposal has been advanced by Gualmini (e.g., 2004). According to Gualmini, children can access both readings for sentences like (13), but the pragmatic context needs to be carefully constructed to elicit the inverse scope reading from children. The prerequisite for children to access the inverse scope reading, according to Gualmini, involves the satisfaction of the felicity conditions associated with the use of negation. Negative statements are typically used to point out a discrepancy between what was expected to happen and what actually happened (see, e.g., De Villiers and Tager-Flusberg, 1975; Givon, 1978; Wason, 1965). In this regard, the inverse scope reading of (13) is felicitous in a context in

which every horse was expected to jump over the fence, but in the end, some horses ran into the fence instead of jumping over it, say, thus failing to meet the expectation. By contrast, sentence (14) sounds odd as a description of the same context, even though it is true, because the context didn't establish the expectation that every horse would run into the fence.

(14) Every horse didn't run into the fence.

According to Gualmini, studies in which children failed to access both readings of sentences like (13) did not satisfy the felicity conditions on the use of negation. In a series of experimental studies, Gualmini demonstrated that English-speaking children are able to assign the inverse scope reading of ambiguous sentences, such as (13), as long as these felicity conditions are satisfied (Gualmini et al., 2005; Gualmini, 2005/2006). The finding that English-speaking children have access to both readings of scopally ambiguous sentences was subsequently confirmed by Musolino and Lidz (2002, 2006), who showed that children's ability to access the inverse scope reading of (13) was greatly enhanced if negative sentences were preceded by a positive lead-in, as in (15).

(15) Every horse jumped over the rock, but every horse didn't jump over the fence.

In light of these findings, an emerging consensus is that English-speaking children have access to the alternative scope interpretations for sentences with the universal quantifier and negation. On this view, children and adults do not differ in linguistic competence, but differ in their pragmatic ability to access the inverse scope reading in certain contexts. Adults accommodate to the context, and can deal with unmet felicity conditions, whereas children access the inverse scope reading only when felicity conditions are met (Gualmini, 2005/2006).

Previous studies on Mandarin-speaking children's knowledge of scope interpretation mainly focused on their understanding of sentences with universal and existential quantifiers like *Mei-ge xiaohai dou zai chi yi-ge dangao* 'Every child is eating a cake'. It was found that young children do not exhibit the same scope rigidity as adults do in response to such sentences. In contrast to adults, young Mandarin-speaking children appear to have access to both scope interpretations for sentences with universal quantifiers and existential quantifiers, including the inverse scope reading (Chien and Wexler, 1989; Lee, 1991). This finding raises a learnability dilemma for Mandarin-speaking children, however, since the finding suggests that children allow a superset of the readings permitted by adult speakers. We anticipated that the same learnability dilemma might arise in children's understanding of sentences with the universal quantifier and negation, as we now discuss.

In the present study, we sought to investigate how Mandarin-speaking children understand the scope relations between the universal quantifier and negation in sentences like (9) and (10). Two main questions were addressed. The first question is whether or not Mandarin-speaking children have adult-like knowledge of the restrictions on the interpretation of sentences like (9) and (10), which are deemed to be unambiguous for adults. As discussed earlier, we attribute the unambiguity of sentences like (9) and (10) to the focus sensitivity of *dou* in (9) and *shi* in (10). Thus, for children to have completely adult-like knowledge, this would mean that they should treat *dou* and *shi* as focus-sensitive operators and compute the relevant presuppositions and assertions that are associated with such expressions. If so, then children should be expected to interpret these sentences as being unambiguous, i.e., children should access only the surface scope reading. This brings us to the second question. What if children do not have adult-like knowledge? On this scenario, children will not be sensitive to the focus-sensitive properties of *dou* and *shi*, then are therefore expected to interpret sentences

like (9) and (10) in the same way as English-speaking children interpret sentences like (1) and (2).

Although no studies have investigated English-speaking children's interpretation of the kind of 'not...every' sentences under consideration, such as (2)<sup>7</sup>, it has been found that English-speaking children younger than 5 or 6 years old typically lack sensitivity to conversational implicatures, at least in certain tasks (see, e.g., Chierchia et al., 2001; Noveck, 2001; Papafragou and Musolino, 2003). For example, Noveck (2001) found that English-speaking children treated sentences with a 'weaker' term *some* (e.g., *Some giraffes have long necks*) equally as sentences with a 'stronger' term *all* (e.g., *All giraffes have long necks*). Chierchia, et al. (2001) found that English-speaking children interpreted sentences with a 'weaker' term *or* (e.g., *John bought pizza or pasta to the party*) as having the same meaning as sentences with a 'stronger' term *and* (e.g., *John bought pizza and pasta to the party*). Based on the findings of these studies, we would expect English-speaking children to accept 'not...every' sentences like (2) in a scenario in which none of the horses jumped over the fence. And, if Mandarin-speaking children interpret Mandarin sentences like (9) and (10) in the same way as English-speaking children interpret (1) and (2), then Mandarin-speaking children should permit the use of 'not...every' sentences in the 'none' contexts. The experiments that follow were designed to assess these two possibilities.

## Experiment 1

In this experiment, we investigated how Mandarin-speaking children and adults interpret sentences like (9) and (10).

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<sup>7</sup> Musolino and Lidz (2006) tested English-speaking children using sentences with negation in the verb phrase, such as *Joe didn't buy every plane*. They found that children accepted the 'NP didn't V every N' sentences in the 'none' contexts. To our knowledge, no one has tested sentences of the kind under investigation here, with negation combining directly with the universal quantifier in the subject phrase.



### *Subjects*

We tested 20 Mandarin-speaking children between the ages of 3;4 and 5;11 (mean 4;3). In addition, 20 Mandarin-speaking adults served as controls.

### *Method and Procedures*

This study used Truth Value Judgment Task. This research technique is designed to investigate which meanings children can and cannot assign to sentences (Crain and Thornton, 1998). The task involves two experimenters – one acting out the stories with toy characters and props, and the other playing the role of a puppet who watches the stories alongside the child subject. At the end of the story, the puppet explains to the child subject what he thinks happened in the story. The child's task is to decide whether the puppet said the right thing or not. If the child informs the puppet that he was wrong, then he is asked to explain: "what really happened?"

The child subjects were introduced to the task individually and then tested individually. They were given two practice items before the actual test, one in which the puppet's statement was obviously true and one in which it was obviously false, so that children knew that the puppet could say something wrong. These practice items were also used to familiarize children with the task. Only those children who correctly rejected the puppet's statement were included in the actual test.

The 20 adult subjects were tested on the same stories but using a questionnaire. All the stories were written out and subjects were asked to indicate, for each story, whether the puppet was right or wrong; and if they judged the puppet to be wrong, they were also asked to justify their answers.

### *Materials*

Two kinds of scenarios were constructed, one corresponding to the EVERY > NOT reading and the other to the NOT > EVERY reading. We will refer to these scenarios as the ‘none’ and ‘some’ scenarios, respectively. Test sentences like (9) and (10) were presented following either of the scenarios. Thus subjects were tested in four conditions: (i) ‘every...not’ sentences like (9) in the ‘none’ scenario, (ii) ‘every...not’ sentences in the ‘some’ scenario, (iii) ‘not...every’ sentences like (10) in the ‘none’ scenario, and (iv) ‘not...every’ sentences in the ‘some’ scenario. There were two trials in each condition, yielding eight test trials. Conditions (i) and (iv) are used to illustrate.

On a typical trial in condition (i), three girls had a bad cold. They were going to take some pills. But when they saw the pills, they didn’t want to eat them, because they thought the pills would taste bad. So they decided to eat an ice cream first. After eating the ice cream, they still didn’t want to eat the pills. Finally they decided to take a nap instead of taking the pills. In order to satisfy the felicity conditions on the use of negation, an expectation about the main characters’ actions was explicitly established at the beginning of the story: the three girls were expected to take some pills, because they were ill. But what actually happened in the story did not conform to this expectation: the three girls didn’t take any pills. After the story, the puppet described what happened in the story, using the test sentence in (16).

(16) Mei-ge nühai dou chi-le bingjiling, danshi mei-ge nühai dou meiyou

every-CL girl all eat-ASP ice cream but every-CL girl all not

chi yao.

eat pill

‘Every girl ate an ice cream, but every girl didn’t take pills.’

As (16) illustrates, a positive lead-in *every girl ate an ice cream*, which corresponded to the first half of the story, was also included in the test sentence. This was to satisfy the Condition of Plausible Dissent proposed by Crain et al. (1996). This condition is based on Russell's (1948) observation that a negative judgment is appropriate only when the correlative positive judgment has already been made or considered. In Truth Value Judgment Task, children are asked to say whether sentences are true or false. Following Russell's observation, it is appropriate to ask children for a negative judgment of a sentence only if the corresponding positive judgment has been under consideration at some point of the story.

On a typical trial in condition (iv), three horses are having a jumping contest. In the contest, they try to jump over two things: a house and a fence. Since they are all very good jumpers, they are expected to jump over both things. It turned out, however, that all three horses cleared the fence, but only one horse jumped over the house. When the story concluded, the puppet produced the test sentence in (17).

(17) Mei-pi      ma      dou tiaoguo-le      liba, danshi bushi mei-pi  
           every-CL horse all jump-over-ASP fence, but not-be every-CL  
  
           ma      dou tiaoguo-le      fangzi.  
           horse all jump-over-ASP house  
           'Every horse jumped over the fence, but not every horse jumped over the house.'

Four control trials were included to investigate children's understanding of negation in simple sentences, and their understanding of universal quantification in simple sentences. These control trials were used to verify that children could answer both 'yes' and 'no' correctly and that they had no difficulty understanding negation when it appeared alone, and

universal quantification when it appeared alone. If the child always said ‘yes’ to the puppet’s statements on these control trials, this would be used as evidence that the child did not understand the task, and his or her data would be eliminated from the subsequent analysis. On two of these control trials, the puppet produced the negative statements in (18) and (19). In the relevant scenarios, the statement in (18) was true and (19) was false.

(18) Xiaotuzi zhuangdao-le juanxincai, danshi meiyou zhuangdao huluobo.

rabbit hit-ASP cabbage but not hit carrot

‘The rabbit hit the cabbage, but he didn’t hit the carrot.’

(19) Tiaotiaohu zhaodao-le xiaotuzi, danshi meiyou zhaodao xiaozhu.

Tigger find-ASP rabbit but not find pig

‘Tigger found the rabbit, but he didn’t find the pig.’

On the other two trials, the puppet presented sentences in (20) and (21) with the universal quantifier. In the relevant scenarios, (20) was true and (21) was false.

(20) Mei-ge ren dou nadao-le beike.

every-CL person all get-ASP shell

‘Everyone got shells.’

(21) Mei-zhi xiaomao dou mai-le binggan.

every-CL cat all buy-ASP biscuit

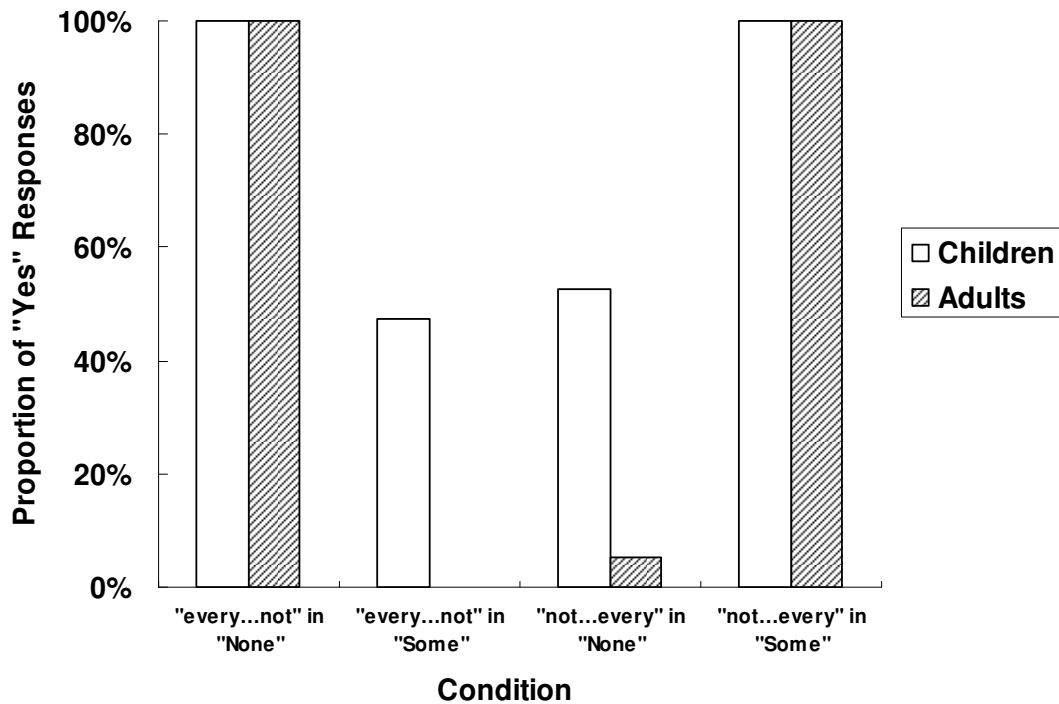
‘Every cat bought biscuits.’

## *Results and Discussion*

The dependent measure in the study was the proportion of ‘yes’ responses to the puppet’s statements in each condition. The data from one child was eliminated from the analysis because this child said ‘yes’ to the puppet’s statements in the two ‘no’ control trials (19) and (21). The remaining 19 children and all 20 adults gave correct responses on the control trials 100% of the time, i.e., they accepted the puppet’s statements (18) and (20), and correctly rejected the puppet’s statements (19) and (21).

A Mann-Whitney Test was used to compare the patterns of responses by children and adults in each condition. No significant differences were found between children and adults in conditions (i) and (iv). In condition (i), on the ‘none’ scenario, both the children and the adults accepted the ‘every...not’ sentences 100% of the time. Likewise, both the children and the adults accepted the ‘not...every’ sentences 100% of the time in condition (iv), on the ‘some’ scenario.

By contrast, significant differences between children and adults were observed in conditions (ii) and (iii). In condition (ii), on the ‘some’ scenario, children accepted the ‘every...not’ sentences significantly more often (47%) than adults did (0%) ( $Z = 3.68$ ,  $p < .001$ ). In condition (iii), on the ‘none’ scenario, children’s acceptance rate for the ‘not...every’ sentences was significantly higher than that of the adults (53% vs. 5%;  $Z = 3.38$ ,  $p < .001$ ). Figure 1 displays the proportion of ‘yes’ responses to the puppet’s statements for children and adults in each condition.



**FIGURE.1. Proportion of ‘Yes’ Responses to the Puppet’s Statements for Children and Adults in Each Condition, Experiment 1**

As noted earlier, children who rejected the puppets’ statements were asked why the puppet was wrong. They justified their answers in the same way as adults did. For example, in condition (ii), which corresponded to the inverse scope reading of the ‘every...not’ sentences, they justified their rejections of the test sentences by citing the fact that one of the characters performed the action mentioned in the test sentences. In condition (iii), corresponding to the inverse scope reading of the ‘not...every’ sentences, children justified their negative responses by pointing out that none of the characters performed the action mentioned in the test sentences.

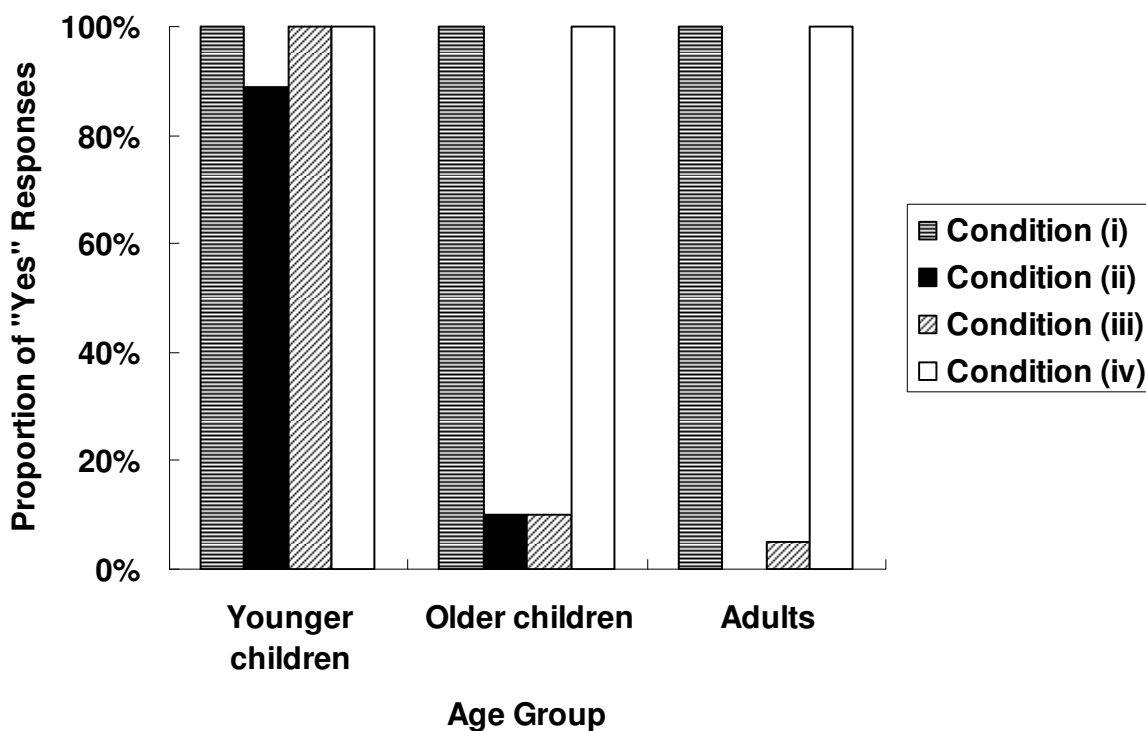
So far, the main finding is that both children and adults accepted test sentences like (9) and (10) in scenarios that match the surface scope reading. However, adults rejected these sentences in scenarios in which a ‘yes’ response indicated access to the inverse scope reading,

whereas children accepted them almost 50% of the time in the scenarios in which a ‘yes’ response is indicative of the inverse scope reading.

This figure of 50% could be misleading, however, because it glosses over any patterns of children’s responses that vary by age. The data for the 19 child subjects were therefore further divided by forming two age groups: the youngest nine children formed one group (ages 3;4-4;3) and the ten eldest children formed the other group (ages 4;5-5;11). These two groups of children were compared with adult controls. This analysis revealed distinct patterns of ‘yes’ responses according to age, in each condition. A K-W Test was used to assess the differences across age groups. It should be noted, first, that no significant differences were observed in conditions (i) and (iv). In condition (i), all three groups accepted the ‘every...not’ sentences 100% of the time, and in condition (iv), they all accepted the ‘not...every’ sentences 100% of the time. However, significant differences were found in conditions (ii) and (iii) across the three age groups: (ii) ( $\chi^2(2, N=39) = 32.47, p < .001$ ) and (iii) ( $\chi^2(2, N=39) = 29.48, p < .001$ ).

A post hoc Mann-Whitney Test was used to evaluate the two child groups against each other, and each child group against the adult controls. In condition (ii), it turned out that younger children accepted the ‘every...not’ sentences significantly more often than the older children (89% vs. 10%,  $Z = 3.56, p < .001$ ) and the younger children accepted the ‘every...not’ sentences significantly more often than adults (89% vs. 0%,  $Z = 5.23, p < .001$ ). The acceptance rates of the older children versus adults did not differ (10% vs. 0%,  $Z = 1.41, p = .33$ ). In condition (iii), the younger children accepted the ‘not...every’ sentences significantly more often than the older children (100% vs. 10%,  $Z = 4.06, p < .001$ ) and the younger children accepted the ‘not...every’ sentences significantly more often than adults (100% vs. 5%,  $Z = 4.96, p < .001$ ). Again, the acceptance rates of older children and adults did not differ (10% vs. 5%,  $Z = .75, p = .58$ ).

Within each group, a Wilcoxon Signed Ranks Test was used to compare the acceptance rates of test sentences in their surface scope scenarios as compared to their inverse scope scenarios in the two sentence conditions. It was found that younger children accepted the ‘every...not’ sentences in the surface scope scenarios to the same extent as they did in the inverse scope scenarios (100% vs. 89%,  $Z = 1.41$ ,  $p = .50$ ). Similarly, the younger children accepted the ‘not...every’ sentences in the surface scope scenarios and in the inverse scope scenarios equally often (100% vs. 100%,  $Z = 0$ ,  $p = 1$ ). Older children, by contrast, accepted both sentence types significantly more often in the surface scope scenarios than in the inverse scope scenarios (For ‘every...not’ sentences,  $Z = 3$ ,  $p < .01$ ; for ‘not...every’ sentences,  $Z = 2.97$ ,  $p < .01$ ). There was a similar finding for the adults (For ‘every...not’ sentences,  $Z = 4.47$ ,  $p < .001$ ; for ‘not...every’ sentences,  $Z = 4.30$ ,  $p < .001$ ). Figure 2 gives the proportion of ‘yes’ responses to the puppet’s statements for the three age groups in each condition.



**FIGURE.2. Proportion of ‘Yes’ Responses to the Puppet’s Statements for Younger Children, Older Children and Adults in Each Condition, Experiment 1**



The findings of Experiment 1 revealed that younger Mandarin-speaking children accepted sentences involving universal quantification and negation in both the surface scope and the inverse scope scenarios. Older children and adults, by contrast, accepted the same sentences only in the surface scope scenarios. These two patterns of responses were anticipated, based on the account we offered. Older children and adults are sensitive to the focus sensitivity of *dou* and *shi* in the relevant sentences, and thus analyze sentences with these focus expressions along the lines of cleft structures in English. In this respect, older children and adult-speakers of Mandarin differ from English-speaking adults in the interpretations they assign to sentences with the universal quantifier and negation. For English-speaking adults, the corresponding sentences contain ‘bare’ quantificational expressions ‘every’ and ‘not’, rather than focus expressions. Younger Mandarin-speaking children, by contrast, interpret the relevant sentences as similar in structure to the corresponding English sentences with ‘bare’ quantificational expressions, since these children are not aware of the focus sensitivity of *dou* and *shi*. Based on the findings of Experiment 1, then, we can answer the first question raised in section 5: Do Mandarin-speaking children have adult-like knowledge of scope phenomena? The answer is clearly negative.

This brings us to the second question put forward in section 5. We proposed there that, if Mandarin-speaking children do not have adult-like knowledge of the focus-sensitive properties of *dou* and *shi*, then they should interpret sentences like (9) and (10) in the same way as English-speaking children interpret sentences like (1) and (2). But the question is although both English-speaking and Mandarin-speaking children accepted ‘every...not’ sentences in the felicitous ‘some’ contexts, the acceptance rate of the Mandarin-speaking

children in our study was higher than that of the English-speaking children in Musolino and Lidz (2006) (100% vs. 60%)<sup>8</sup>. Then how can we interpret this difference?

We attribute this difference to pragmatic factors. To be specific, we believe that Mandarin-speaking children in our study accepted the inverse scope reading of the ‘every...not’ sentences more often than their English counterparts did in the study by Musolino and Lidz (2006) because the test stimuli in our study better satisfied the felicity conditions associated with the use of negation. In Musolino and Lidz (2006), children were presented with the test sentence preceded by a positive lead-in as in *Every horse jumped over the rock, but every horse didn’t jump over the fence*. By satisfying the felicity conditions for negation in this way, the inverse scope reading was accessed by children 60% of the time, compared to just 7.5% of the time in Musolino (1998). However, Gualmini et al. (2005) used the pragmatic context to satisfy the felicity conditions associated with negation, and found that children’s acceptance rate of the inverse scope reading increased to 81%. In the contexts used by Gualmini, a discrepancy was explicitly established between what was expected to happen and what actually happened. In the present study, both ways of satisfying the felicity conditions were implemented. That is, the test sentences were preceded by a positive lead-in and they were presented in a context that explicitly established a discrepancy between what was expected to happen and what actually happened. We suggest that this is why the Mandarin-speaking children in our study accepted the inverse scope reading of the ‘every...not’ sentences more often than their English counterparts did in previous studies.

Let us review our proposal briefly. First, we witnessed Mandarin-speaking children’s acceptance of ‘every...not’ sentences like (9) in the ‘none’ contexts, as did Mandarin-speaking adults. However, in contrast to adults, Mandarin-speaking children also accepted sentences like (9) in the ‘some’ contexts. We attribute this difference to children’s analysis of

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<sup>8</sup> We thank one of the anonymous reviewers for pointing this out to us.

the relevant Mandarin sentences with the focus-sensitive operator *dou*, as their English counterparts with ‘bare’ quantificational expressions. This explains why these sentences were accepted in both contexts by children.

We explained the pattern of behavior by English-speaking adults in response to ‘not...every’ sentences to be a consequence of two factors: (a) a ‘bare’ structural analysis of the quantificational expressions, and (b) the application of conversational implicatures. English-speaking children, as far as we know, have not been assessed using the kind of ‘not...every’ sentences under consideration. It has been documented, though, that English-speaking children lack sensitivity to conversational implicatures, at least in many experimental contexts. We expect that English-speaking children’s lack of sensitivity to conversational implicatures would mean that they would accept ‘not...every’ sentences in both of the discourse contexts used in Experiment 1, including the ‘none’ contexts. If so, then English-speaking children would not behave in the same way as English-speaking adults, who have difficulty assigning the inverse scope reading to ‘not...every’ sentences. This is exactly the pattern of behavior we observed with Mandarin-speaking children.

One piece of the puzzle that remains missing is evidence that Mandarin-speaking children resemble English-speaking children in their lack of sensitivity to conversational implicatures. We discussed two examples in section 5. When children are presented with sentences with logical expressions such as *some* and *or*, these expressions appear to be interpreted using their unadorned meanings, as in classical logic. So, young English-speaking children interpret *some* to mean ‘at least’, rather than meaning ‘some, but not all,’ which is the interpretation ordinarily assigned by adults. Similarly, young English-speaking children interpret *or* as inclusive-*or*, rather than carrying an implicature of exclusivity, as it does in ordinary contexts for adult speakers. The source of the differences in interpretations of these logical words by children and adults is the subject of a great deal of controversy. According to

one account, by Noveck (2001), the ability to compute implicatures becomes operative only when children reach a certain maturational stage. Another account suggests that the requisite knowledge for computing conversational implicature is in place, but young children lack the computational resources to compare the alternative representations that are required in order to license pragmatic implicatures (Reinhart, 2006). For example, in responding to statements with *or*, children must generate the alternative representation with *and*, in order to assess whether the statement with *and* would be ‘stronger’ (more informative) than the statement with *or*. Based on other literature, Reinhart (2006) contends that children cannot hold alternative representations in verbal working memory long enough to make the comparison, due to their limitations in computational resources as compared to older children and adults.

To evaluate this processing deficit account of pragmatic implicatures, Chierchia et al. (2001) designed an experimental technique called Felicity Judgment Task. This task was designed to see if children could compute pragmatic implicatures if the prerequisite alternative representations were made transparent to them and, hence, children were not required to compute the alternative representations themselves. To make the alternatives transparent, the task involved two puppets, each of whom produced a statement describing the experimental context, one using a statement with a ‘weaker’ term and the other using a statement with a ‘stronger’ term. For example, one puppet produced a statement with *or* and one puppet produced a similar statement, except with *and*. The child’s task was to indicate which puppet described the situation better. The findings were that children often thought that both puppets made true statements, but that the puppet who used the ‘stronger’ term (in the present case, *and*) said it better. Experiment 2 was designed to see if the same pattern of responses would be elicited from Mandarin-speaking children in response to ‘not...every’ sentences.

## Experiment 2

In this experiment, we looked at whether children can compute conversational implicatures when the relevant alternatives are produced overtly.

### *Subjects*

The nine younger children in the first experiment, who accepted sentences like (9) and (10) in both the surface scope and the inverse scope scenarios, were tested in this experiment.

### *Method and Procedures*

We used Felicity Judgment Task. The child subjects were introduced to the task individually and then tested individually. They were given two practice items before the actual test, one in which the puppet's statement was obviously true and one in which it was obviously false, so that children knew the puppet could say something wrong.

### *Materials*

Both the 'every...not' and the 'not...every' sentences were presented in a 'none' scenario which corresponded to the surface scope reading of the former and the inverse scope reading of the latter. They were presented as alternative descriptions of the 'none' scenario.

On one trial, children were told a story about three cats who were going to buy some fish and biscuits for lunch. They all bought some biscuits, but none of them bought fish, because the fish were not as fresh as they had expected. When the story concluded, the two puppets provided an alternative description of the story using sentences like (22) and (23).

(22) Mei-zhi   xiaomao dou   mai-le   binggan, danshi mei-zhi   xiaomao dou  
every-CL cat   all buy-ASP biscuit   but   every-CL cat   all

meiyou mai yu.

not buy fish

‘Every cat bought biscuits, but every cat didn’t buy fish.’

(23) Mei-zhi xiaomao dou mai-le binggan, danshi bushi mei-zhi xiaomao

every-CL cat all buy-ASP biscuit but not-be every-CL cat

dou mai-le yu.

all buy-ASP fish

‘Every cat bought biscuits, but not every cat bought fish.’

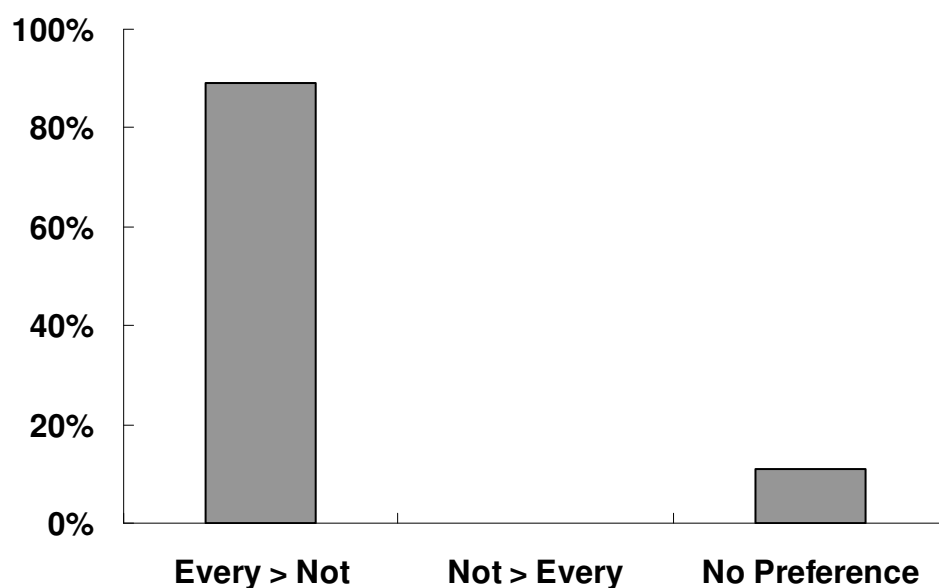
Children were then asked to judge whether the two puppets said the right thing and which one said it better. If children are incapable of computing conversational implicatures, then they should judge both (22) and (23) to be true and display no preference for either of the two sentence types. But if children are able to compute scalar implicatures, at least when the alternatives are presented overtly for consideration, then they should favor (22) as a description of the ‘none’ scenario, although (23) may also be judged to be true, if its inverse scope interpretation is available to children.

Control items were included to investigate whether children can tell a general term from a specific one. On these items, we asked the two puppets to describe the things we put on the mat, say, an apple. One puppet described it using a general term, i.e., ‘it is a kind of fruit’ and the other using a more specific one, i.e., ‘it is an apple’. Children were asked to decide whether both of them said the right thing and which one said it better.

Altogether three test items and three controls were created and they were arranged in a pseudo-random order.

### *Results and Discussion*

In response to the control items, all nine children judged both puppets to be right, but they indicated that the puppet who used a more specific term had better expressed what had happened. On the test items, all nine children judged both puppets' statements to be accurate descriptions of the scenarios. When asked which one said it better, eight children consistently favored the puppet who used the 'every...not' sentences. One child was confused, which we recorded as indicating no preference. And no child preferred the 'not...every' sentences. Friedman Test demonstrated that this difference reached significance ( $\chi^2 (2, N=9) = 14.89, p < .001$ ). Figure 3 displays children's preference rates for the two types of sentences in the 'none' scenario.



**FIGURE.3. Children's Preference Rates for the Two Types of Sentences in the 'None' Scenario, Experiment 2**

The results from this experiment showed that children are able to compute conversational implicatures when the relevant alternatives are produced overtly. Otherwise, they shouldn't have displayed a preference for the 'every...not' sentences. These results are consistent with the findings by Chierchia et al. (2001), and they provide evidence for our proposal that Mandarin-speaking children resemble English-speaking children in their lack of sensitivity to conversational implicatures. The results also confirmed that Mandarin-speaking children interpret the relevant test sentences ambiguously.

### **General Discussion and Conclusion**

In this study, we investigated Mandarin-speaking children's knowledge of the scope relations between the universal quantifier and negation in sentences like (9) and (10). We attributed the lack of the inverse scope reading of these sentences to the focus-sensitive properties of *dou* and *shi*. Based on this analysis, two possibilities were put forward as to how Mandarin-speaking children understand the relevant sentences. If, on the one hand, Mandarin-speaking children have adult-like knowledge of *dou* and *shi*, i.e., they are sensitive to the focus-sensitive properties of these two words, then they should interpret the relevant sentences unambiguously. If, on the other hand, Mandarin-speaking children are initially insensitive to the focus-sensitive properties of *dou* and *shi*, then they don't represent sentences like (9) and (10) as cleft-like focus structures. Instead, they represent these sentences as the corresponding English sentences containing 'bare' quantificational expressions, *every* and *not*. This leads to the prediction that Mandarin-speaking children should interpret sentences with the universal quantifier and negation as English-speaking children interpret the corresponding English sentences. Two experiments were conducted to assess these two possibilities. The first experiment investigated how Mandarin-speaking children interpret sentences like (9) and (10). The results showed that Mandarin-speaking children, like their English-speaking counterparts,



find sentences like (9) to be ambiguous. Sentences like (10) have not been tested in English, as far as we know, but we found that Mandarin-speaking children access both interpretations of such sentences as well. These findings ruled out the first possibility and confirmed that Mandarin-speaking children initially interpret the relevant sentences ambiguously. The second experiment investigated Mandarin-speaking children's sensitivity to conversational implicatures. The results showed that Mandarin-speaking children, like their English-speaking counterparts, are able to compute conversational implicatures, but only when the alternative representations are provided overtly. The second experiment also confirmed the conclusion reached in the first experiment, that Mandarin-speaking children find the relevant sentences ambiguous.

At this point, one question remains to be answered, that is, will Mandarin-speaking children encounter a learnability problem if they start with both the surface scope and the inverse scope readings for sentences like (9)<sup>9</sup>. Because the surface scope reading asymmetrically entails the inverse scope reading; whenever the former is true, the latter is also true, but not vice versa. This means that the inverse scope reading of (9) will never be falsified for children who permit this reading, because adults will consistently produce sentences like (9) in scenarios corresponding to the surface scope reading, and when the surface scope reading is true, the inverse scope reading is also true. In order to jettison the inverse scope reading from their grammars, children would need to become cognizant of the fact that adults refrain from using (9) in scenarios that match the inverse scope reading. As far as we know, children do not keep records of such 'negative' experiences. How, then, can children expunge the non-adult inverse scope reading in order to converge on the adult grammar?

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<sup>9</sup> No learnability problem will arise in the case of sentences like (10), because the surface scope reading does not entail the inverse scope reading. Therefore, children can easily use positive evidence to expunge the non-adult inverse scope reading and converge on the adult reading, i.e., they hear adult use them in a situation which makes the surface scope reading true and the inverse scope reading false.

This learnability problem can be solved on our analysis. Following Pinker (1989) and Goro (2007), we propose a learnability scenario that proceeds as follows. Suppose a certain property Q is a consequence of another property P. Then as long as the learner knows that P entails Q and as long as P can be learned from the input, the learner does not need independent evidence attesting to property Q. The acquisition of Q effectively piggybacks on the acquisition of P. Applied to the present study, we propose that scope rigidity for these sentences in Mandarin is the consequence of the focus-sensitive property of *dou* and *shi*. Therefore, once Mandarin-speaking children acquire the focus-sensitive property of these words, they will automatically expunge the non-adult inverse scope readings associated with sentences in which these expressions appear, and they will converge on the adult grammar. This obviates the need for negative evidence informing children that the inverse scope readings for sentences like (9) and (10) are impossible. The crucial question is, then, whether the focus-sensitive property of *dou* and *shi* can be learned from the input. We contend that the data attesting to the focus-sensitive properties of *dou* and *shi* are abundant in the input, because *dou* and *shi* are often used as focus operators in adult language. We anticipate, therefore, that the acquisition of scope rigidity for these sentences directly follows from the acquisition of the focus-sensitivity of *dou* and *shi*. We must leave this prediction for future research.

To conclude, previous research found that English-speaking children, like adults, have access to both surface scope and inverse scope relations between the universal quantifier and negation, based on which, children are claimed to have the same grammatical competence as adults do. But our study showed that Mandarin-speaking children differ from adults in scope interpretation in that they initially do not assign a unique scope reading to sentences involving the universal quantifier and negation, but rather they behave like English-speaking children, initially assigning a flexible scope relation between the universal quantifier and negation.

These findings invite the conclusion that children start off with a flexible scope relation between the universal quantifier and negation. Children's grammar allows flexibility in the mappings from syntax to semantics. But they narrow down their interpretations, if need be, to those of the local language, as in Mandarin, using observable properties which give rise to the scope constraint in the local language.

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## **Conclusions**





## Conclusions

This chapter aims to summarize the major findings and to discuss the relevance of these findings for issues of language development. Obviously, one hopes that there is as much science as there is myth in this work, and that the science will yield at least a modest number of general conclusions that will stand up against new evidence. That said, I will take some risks and make some guesses at which of these conclusions will stand the test of time, and what their implicit prophecies might be.

In this thesis, we investigated how interface conditions are represented in child language, using data from child Mandarin. Three interface phenomena were examined: focus interpretation, *wh*-quantification and scope assignment. The investigation of each phenomenon centred around three related questions.

- (i) What's the nature of linguistic representations underlying children's understanding of this interface phenomenon?
- (ii) To what extent do these representations differ from those of adults?
- (iii) What developmental processes underlie the differences between children and adults?

### **Focus interpretation in child Mandarin (Chapter 2 and Chapter 3).**

By looking at focus interpretation in child Mandarin, we investigated two of these interfaces: the syntax-semantics interface and the syntax-phonology interface. Five experiments were conducted. First we looked at how Mandarin-speaking children understand focus structures like (1) and (2).

- (1) Zhiyou Yuehan chi-le pingguo.

only John eat-ASP apple

‘Only John ate an apple.’

a. Presupposition: John ate an apple.

b. Assertion: Everyone other than John didn’t eat an apple.

(2) Shi Yuehan chi-de pingguo.

be John eat-DE apple

‘It is John who ate an apple.’

a. Presupposition: x ate an apple.

b. Assertion: x = John; everyone else didn’t eat an apple.

For a child to understand these two structures, he/she first has to identify the correct focus associated with the focus particle using c-command constraint. Once the focus is identified, the relevant presupposition and assertion can then be computed. So children may make errors at either of the two steps. The results of our experiments show that children and adults differ in the interpretation of these two structures. In both structures, where adults associated the focus particle with the subject NP, children were found to associate the focus particle with the VP. Children’s problem lies in the first step. These findings provide cross-linguistic evidence in favor of the proposal advanced by Crain et al. (1994) -- that children initially associate the focus particle with the VP.

We then offered an account of why children tend to associate the focus particle with the VP. We propose the following analysis. Sentences (3a) and (4a) are used to illustrate. For adults, when the focus particle *zhiyou* appears in presubject position, as in (3a), it is used to modify the subject NP, as indicated in the tree diagram (3b), where the focus particle *zhiyou* c-commands the subject NP *Yuehan* ‘John’, but not the VP. In this case, *zhiyou* is treated as a determiner and forms a constituent with the subject NP *Yuehan* ‘John’, which we have

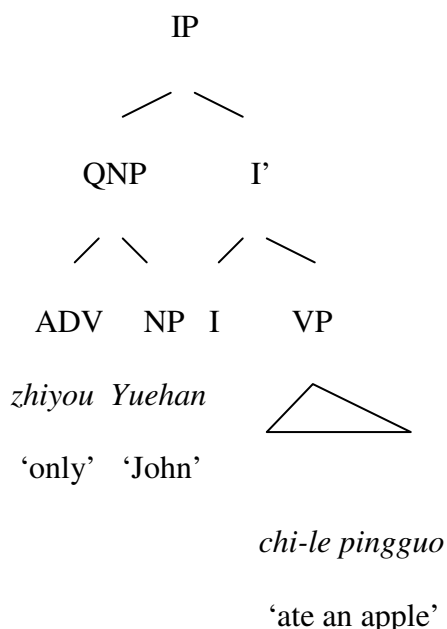
labelled Quantified Noun Phrase (QNP). When *zhiyou* occurs in preverbal position, as in (4a), it is treated as an adverbial, which c-commands and is adjoined to the VP, as indicated in (4b). In contrast to adults, children initially treat *zhiyou* as an adverbial both when it occurs in presubject position, and when it appears in preverbal position. When it occurs in presubject position, the focus structure is represented as in (3c), in which *zhiyou* is adjoined to the whole sentence as a sentential adverbial, rather than a determiner which forms a constituent with the subject NP as in adult language. So, the VP is still in the c-command domain of the pre-subject focus particle *zhiyou*. Children didn't violate the c-command constraint.

(3) a. Zhiyou Yuehan chi-le pingguo.

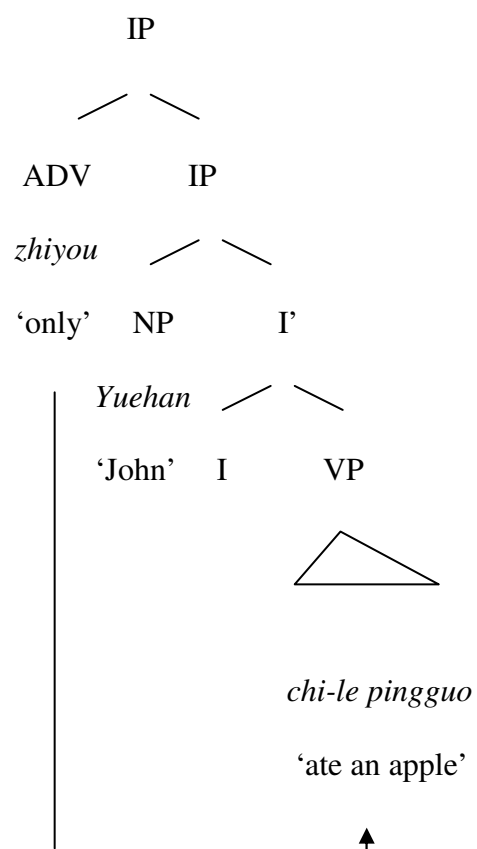
only John eat-ASP apple

'Only John ate an apple.'

b.



c.

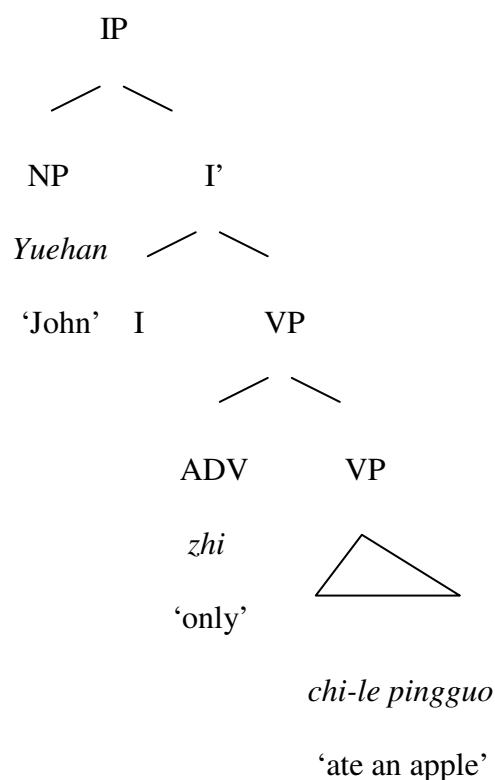


(4) a. Yuehan zhi chi-le pingguo

John only eat-ASP apple

‘John only ate an apple.’

b.



Our motivation for this analysis of the child grammar was based on the observation that many adverbs of quantification, like *sometimes*, *usually*, *funnily*, *interestingly*, and so on, tend to take sentential scope and, therefore, are not typically associated with the subject NP. If children form the (incorrect) generalization that *zhiyou* is a sentential adverb, then they will suppose that it, too, takes sentential scope. A second observation is that the association of sentential adverbs with the VP is attested across a variety of human languages. So the present proposal is that children initially analyse focus adverb *zhiyou* in the same way as typical sentential adverbs (both in Chinese and across languages). They therefore tend to associate it with the VP.

Pursuing this analysis, we predicted that children should be able to access the adult-like interpretation (i.e., associating the focus particle with the subject NP), in certain conditions, since the focus particle *zhiyou* still c-commands the subject NP *Yuehan* ‘John’

(see (3c)), though *zhiyou*, as a quantificational adverb, tends to associate with the VP in child Mandarin. We investigated two types of conditions that could conceivably assist children in accessing the adult-like interpretation. In one condition, strong contextual cues were presented to children. In the other, strong syntactic cues were presented. More specifically, we looked at whether children can access the adult-like interpretation, using contextual cues (i.e., children were presented with a context in which focus on the subject NP was emphasized) as well as syntactic cues (i.e., children were presented with a focus structure in which negation was positioned between the focus particle and the VP). It was found that children are able to use both types of cues to access the adult-like interpretation.

In addition to the syntax-semantics interface, focus interpretation also involves the syntax-phonology interface. We wanted to see whether Mandarin-speaking children are sensitive to this interface. Sentence (5) is used to illustrate.

(5) *Zhiyou Yuehan de pingguo shi hongde.*

only John DE apple is red

‘Only John’s apple is red.’

a. Only [John’s apple]<sub>F</sub> is red.

b. Only [John]<sub>F</sub>’s apple is red.

In Mandarin Chinese, sentences like (5) are ambiguous. The focus particle *zhiyou* in (5) can either associate with the entire subject NP *Yuehan de pingguo* ‘John’s apple’, as in (5a), or with an element inside the subject NP, i.e., the modifier of the subject NP *Yuehan* ‘John’, as in (5b), since both elements are in the c-command domain of the focus particle. As a consequence, the sentence is ambiguous, in the absence of additional information about which element is the intended focused element. When the focus particle *zhiyou* associates with the

subject NP *Yuehan de pingguo* ‘John’s apple’, the sentence conveys the meaning that John’s apple is red and nothing else (in the established discourse context) is red. When *zhiyou* associates with the modifier *Yuehan* ‘John’, the sentence conveys the meaning that John’s apple is red and no one else’s apple (in the established discourse context) is red. Phonological cues can be used to distinguish between these two interpretations. Specifically, a pitch accent on the head noun *pingguo* ‘apple’, encourages the association in (5a), and a pitch accent on the modifier *Yuehan* ‘John’ encourages the association in (5b).

Using off-line judgement tasks, previous research found that 4- to 5-year-old English-speaking children are not sensitive to pitch accent in identifying the correct focus associated with the focus particle *only* (Gualmini et al., 2002; Halbert et al., 1995). In our study, we used a more sensitive measure, eye-movement recordings, to make an on-line assessment of Mandarin-speaking children’s use of pitch accent in identifying the correct focus associated with the focus particle *zhiyou*. We found that 4- to 5-year-old Mandarin-speaking children are sensitive to pitch accent in identifying the correct focus, but they are not able to use this phonological cue immediately, or as effectively as adults are. We attribute the processing difficulty experienced by children, as compared to adults, to a delay in establishing the mapping between prosody and syntax. More specifically, we propose that the mapping between prosody and syntax in 4- to 5-year-old children is fragile and not yet automatic, and thus cannot be used immediately and effectively in identifying the correct focus associated with the focus particle. Children start out with a default association between the focus particle and the elements in its c-command domain, i.e., children initially associate the focus particle *zhiyou* ‘only’ with the modifier. As their sensitivity to the mapping between pitch accent and syntax develops, they come to appreciate that a pitch accent on the head noun encourages the association between the focus particle and the head noun, whereas a pitch accent on the modifier encourages the association between the focus particle and the modifier. However,

this mapping between pitch accent and syntax is not firmly established in child language, so it cannot be used effectively to make desired judgements. This explains why children failed to use pitch accent to identify the correct focus in previous off-line judgement tasks. Our findings are consistent with the findings of a recent study by Höhle et al. (2009). These researchers used eye-tracking to investigate how German-speaking children interpret sentences with accented and unaccented focus particle *auch* ‘also’ and found that children exhibited adult-like comprehension, in contrast to previous studies (e.g., Hüttner et al., 2004), which used off-line tasks and found that German-speaking children were not sensitive to accent in understanding sentences with *auch* ‘also’.

*Generalizations:*

- (i) On the basis of our findings in child Mandarin, in conjunction with previous work on English-speaking children, we propose that VP-orientation is not language-specific, but will appear at least in SVO languages. Children from SVO languages pass through a stage in which they associate the focus particle with the VP. This generalization can, of course, be challenged by investigating SVO languages other than Mandarin and English, and this is a necessary next step in the evaluation of our proposal.
- (ii) Based on the findings that children exhibited on-line sensitivity to phonological cues in resolving syntactic ambiguities, but not in off-line judgement tasks, we propose that the mapping between syntax and phonology in young children is not as firmly established as in adult language. So in order to observe and measure children’s knowledge of the mapping between syntax and phonology, more sensitive tasks are required than used in adult experiments. Of course, further investigations of other syntax-phonology interface phenomena are required before a more conclusive generalization can be made.



### ***Wh*-quantification in child Mandarin (Chapter 3 and Chapter 4)**

Mandarin Chinese differs from English in the interpretation of *wh*-words. *Wh*-words in Mandarin Chinese exhibit quantificational variability. Aside from a typical interrogative reading, *wh*-words such as *shei* ‘who’ and *shenme* ‘what’ can also be interpreted as existential indefinites, or as having a universal reading, the choice of which interpretation depends on the linguistic environments in which they occur (Cheng, 1991, 1994, 2009; Huang, 1982; Li, 1992; Lin, 1996; 1998). This is the semantics-discourse interface. Three experiments were conducted to investigate whether young Mandarin-speaking children are sensitive to the linguistic environments which license the non-interrogative use of *wh*-words: the existential indefinite reading and the universal reading. In order to test this, a new experimental methodology was introduced, which we called Question-Statement task. The results of our experiments show that 3- to 5-year-old Mandarin-speaking children exhibited adult-like sensitivity to the licensing environments for the non-interrogative use of *wh*-words. We then asked the question: how do Mandarin-speaking children establish the connection between the semantic interpretation of *wh*-words and the linguistic environments in which they occur?

One possibility is that children use distributional cues in the input to learn the semantic interpretation of *wh*-words. But note that in learning the interpretation of *wh*-words, what children learn is that the same *wh*-word functions as an interrogative word in certain linguistic contexts, but it is interpreted as a non-interrogative indefinite in some other linguistic contexts. It is not the distribution of the *wh*-word that is at issue for children, but its interpretive properties. So, it seems impossible that children use distributional cues to establish the connection between the semantic interpretation of *wh*-words and the linguistic contexts in which they occur. Given the difficulty that children may experience in using distributional cues to learn the semantic interpretation of *wh*-words, and the early emergence of this knowledge in child Mandarin, we propose that the licensing mechanism for the non-

interrogative use of *wh*-words is innately specified and, therefore, readily accessed by children learning languages that incorporate *wh*-indefinites, including Mandarin.

We propose the following learning scenario. *Wh*-words are treated as variables in child Mandarin. Therefore, the interpretation of *wh*-words is governed by a variable-binding relation. For example, when *wh*-words occur in linguistic environments such as in yes-no questions, A-not-A questions, etc., they are licensed as polarity items and get the existential indefinite reading by being bound by an existential operator. In this case, the existential operator is introduced by existential closure. When *wh*-words appear in the scope of the universal quantifier *dou*, they are bound by *dou*, and thus interpreted as having a universal reading. In this case, the universal quantifier *dou* is the binder. We propose that this variable-binding mechanism in child Mandarin is innately specified, as part of Universal Grammar. So children don't need to learn how these linguistic environments license the non-interrogative use of *wh*-words. In other words, they don't need to learn whether an indefinite reading or a universal reading is licensed in certain linguistic contexts. The innate variable-binding mechanism assists children in accessing the proper interpretation.

Children do need to learn the semantic properties of these different linguistic environments. For instance, they need to learn what a yes-no question is, what a A-not-A question is, and what the property of *dou* is. Once children acquire the semantic properties of these different linguistic environments, the innate variable-binding mechanism will help them get the semantic interpretation of *wh*-words automatically, i.e., whether an indefinite reading is licensed or a universal reading is licensed. In other words, once children acquire the semantic properties of these different linguistic environments, they can draw on the innate variable-binding mechanism to establish the interpretation of *wh*-words and the linguistic contexts in which they occur.

Studying children's knowledge of *wh*-quantification could also shed light on the nature of the semantics-phonology interface. Negative sentences with a *wh*-word like (6) are ambiguous in Mandarin Chinese.

(6) Yuehan meiyou chi shenme shuiguo.

John not eat what fruit

a. What kind of fruit didn't John eat?

b. John didn't eat any fruit.

When the *wh*-word *shenme* 'what' is interpreted as an interrogative word, the sentence poses a question, as in (6a): "What kind of fruit didn't John eat?" Alternatively, when the same *wh*-word is interpreted as an indefinite, the sentence makes a statement, as in (6b): "John didn't eat any fruit". Phonological cues can be used to distinguish between the two interpretations. A rising intonation on the *wh*-phrase *shenme shuiguo* 'what fruit' indicates the question reading, whereas a level intonation (the absence of rising intonation) on the same *wh*-phrase signals the statement reading. Notice that in this structure the same *wh*-phrase can be used to perform two different speech acts: posing a question vs. making a statement. Which it is depends on intonation. So we took advantage of this special property of Mandarin Chinese to look at whether young Mandarin-speaking children can use intonational cues to resolve ambiguities involving different speech acts. It was found that 3- to 5-year-old Mandarin-speaking children know that a rising intonation on the *wh*-phrase turns the sentences into questions, whereas a level intonation on the *wh*-phrase turns them into statements. This is compelling evidence that Mandarin-speaking children can reliably use intonational cues to resolve such ambiguity. When the nature of the speech act being performed depends on children's sensitivity to

prosodic cues, Mandarin-speaking children are even sensitive to the fact that a level intonation indicates that the speaker is making a statement, rather than asking a question.

*Generalization:*

(i) The special properties of *wh*-words in Mandarin Chinese are related to one of the most important typological features of this language, that is, Mandarin Chinese is a *wh*-in-situ language. So we predict that children's early mastery of *wh*-quantification should be observed in other *wh*-in-situ languages as well (e.g., Vietnamese and Japanese). Some studies of Japanese-speaking children's knowledge of *wh*-quantification seem to support this prediction (see, e.g., Yamakoshi, 2002; Kabuto, 2007).

(ii) On the basis of our findings that Mandarin-speaking children exhibited adult-like sensitivity to intonational cues in resolving ambiguities involving different speech acts, we propose that the mapping between semantics and phonology in young children is already well established. This generalization can, of course, be challenged by investigating other semantics-phonology interface phenomena, and we will leave this for future research.

**Scope assignment in child Mandarin (Chapter 5)**

Scope interpretation is another interface phenomenon. Consider sentence (7), for example.

(7) Every horse did not jump over the fence.

This sentence is ambiguous. The universal quantifier *every* and negation *not* can each take scope over the other. Thus the sentence can mean either that (i) none of the horses jumped over the fence, or (ii) not all of the horses jumped over the fence. This difference in interpretation is referred to as a 'scope phenomenon'. It is said that the 'none' reading arises

when *every* takes scope over *not* (EVERY > NOT), and the ‘not all’ meaning arises when *not* takes scope over *every* (NOT > EVERY).

In contrast to English, Mandarin Chinese has been argued to exhibit scope rigidity, in the sense that scope is determined exclusively by the surface structural relations between quantificational expressions (Aoun & Li, 1989; Huang, 1982; Lee, 1986). Therefore, the Mandarin sentence (8), corresponding to the English example (7), is unambiguous. In sentence (8), the universal quantifier *mei* ‘every’ c-commands the expression for negation *meiyou* ‘not’ in overt syntax, so the only reading available in Mandarin Chinese is the EVERY > NOT reading, i.e., ‘none of the horses jumped over the fence’. The NOT > EVERY reading, i.e., ‘not all of the horses jumped over the fence’, is judged by many linguists to be unavailable in Mandarin Chinese. This is the syntax-semantics interface.

- (8) Mei-pi      ma      dou meiyou tiaoguo      liba.  
every-CL horse all not-have jump-over fence  
‘Every horse didn’t jump over the fence.’

This difference between English and Mandarin Chinese makes it especially interesting to look at Mandarin-speaking children’s knowledge of scope phenomena. It is well established that English-speaking children have access to both interpretations (i.e., the EVERY > NOT reading and the NOT > EVERY reading) for sentences with the universal quantifier and negation like (7) (Gualmini, 2004, 2005/2006; Musolino & Lidz, 2002, 2006). So we wanted to know how Mandarin-speaking children interpret sentences with a universal quantifier and negation like (8). Do they only access the EVERY > NOT reading, as Mandarin-speaking adults do? If not, which means that Mandarin-speaking children access both readings, this will raise a learnability issue. Because the EVERY > NOT reading asymmetrically entails the

NOT > EVERY reading; whenever the former is true, the latter is also true, but not vice versa (i.e., if none of the horses jumped over the fence, then it is true that not all of the horses jumped over the fence, but not vice versa). This means that the NOT > EVERY reading will never be falsified for children who permit this reading, since adults will consistently produce sentences like (8) in scenarios corresponding to the EVERY > NOT reading, and when the EVERY > NOT reading is true, the NOT > EVERY reading is also true. In order to jettison the NOT > EVERY reading from their grammars, children would need to become cognizant of the fact that adults refrain from using (8) in scenarios that match the NOT > EVERY reading. As far as we know, children do not keep records of such ‘negative’ experiences. How, then, can children expunge the non-adult NOT > EVERY reading in order to converge on the adult grammar?

We conducted two experiments to investigate Mandarin-speaking children’s knowledge of the scope relation between the universal quantifier and negation, using sentences like (8). The results showed that young Mandarin-speaking children, like English-speaking children, have access to both interpretations for sentences like (8). Then the learnability problem came up: how can Mandarin-speaking children get rid of the non-adult NOT > EVERY reading to reach the adult-like interpretation?

We propose the following analysis. We attributed the lack of the NOT > EVERY reading of sentences like (8) to the focus-sensitive property of the quantifier *dou*. Example (8) is used to illustrate, repeated here as (9).

(9) Mei-pi     ma    dou   meiyou   tiaoguo     liba.

every-CL horse all not-have jump-over fence

‘It was every horse that didn’t jump over the fence.’

a. Presupposition: some *x*, *x* = horse, *x* didn’t jump over the fence

b. Assertion: every  $x$ ,  $x = \text{horse}$ ,  $x$  didn't jump over the fence

(10) Logical form:  $\exists x [\text{horse}'(x) \wedge \neg \text{jumped over the fence}'(x)] \wedge$

$\forall x [\text{horse}'(x) \rightarrow \neg \text{jumped over the fence}'(x)]$

Specifically, we propose that *dou*, as a focus-sensitive operator, induces a cleft-like structure. So the Mandarin sentence (9) corresponds to the English cleft construction *It was every horse that didn't jump over the fence*. According to this analysis, the Mandarin sentence (9) can be decomposed into two conjoined propositions, which we will call the presupposition and the assertion, as described in Horn (1969). The presupposition claims that some horses have the property denoted by the predicate (i.e., at least one horse didn't jump over the fence), as in (9a), the assertion in (9b) makes the claim that the focused element, *every horse*, has the relevant property (i.e., didn't jump over the fence). Based on these considerations, the logical form of sentence (9) is given in (10). Using this logical form, sentence (9) is true only in circumstances in which none of the horses jumped over the fence. The sentence cannot be true if some of the horses jumped over the fence. In short, this linguistic analysis accounts for why Mandarin sentences like (9) have only the EVERY > NOT reading. This is due to the focus-sensitive property of *dou*.

On the present analysis, the learnability problem can now be solved. Following Pinker (1989) and Goro (2007), we propose the following learnability scenario. Suppose a certain property  $Q$  is a consequence of another property  $P$ . Then as long as the learner knows that  $P$  entails  $Q$  and as long as  $P$  can be learned from the input, the learner does not need independent evidence attesting to property  $Q$ . The acquisition of  $Q$  effectively piggybacks on the acquisition of  $P$ . Applied to the present study, we propose that the scope rigidity for Mandarin sentences like (8) is the consequence of the focus-sensitive property of *dou*. Therefore, once Mandarin-speaking children acquire the focus-sensitive property of *dou*, they

will automatically expunge the non-adult NOT > EVERY reading and reach the adult-like interpretation. This obviates the need for negative evidence informing children that the NOT > EVERY reading for sentences like (8) is impossible. The crucial question is, then, whether the focus-sensitive property of *dou* can be learned from the input. We contend that the data attesting to the focus-sensitive property of *dou* are abundant in the input, because *dou* is often used as a focus operator in adult language. We anticipate, therefore, that the acquisition of the scope rigidity for sentences like (8) directly follows from the acquisition of the focus-sensitivity of *dou*. We must leave this prediction for future research.

#### *Generalization:*

On the basis of our findings in child Mandarin, in conjunction with previous work on English-speaking children, we propose that children might start out with a flexible scope assignment for sentences involving multiple quantificational expressions. But they will narrow down their interpretations, if need be, to those of the local language, as in Mandarin, using observable properties which give rise to the scope constraint in the local language. Children's grammar allows flexibility in the mappings between syntax and semantics.

#### **Interfaces in child language**

By looking at three interface phenomena, this thesis investigated four interfaces in child language: syntax-semantics interface, syntax-phonology interface, semantics-phonology interface and semantics-discourse interface. We found that interfaces are not monolithic (equally represented) in child language in that some interfaces are better established than others. Our studies show that children exhibited adult-like knowledge of the semantics-phonology and the semantics-discourse interfaces, but not the syntax-semantics and the syntax-phonology interfaces. Of course, we can not simply generalize our results to other



interface phenomena, since it is possible that different linguistic phenomena pertaining to the same interface might not necessarily behave alike. The knowledge we have now is really only the beginning of an effort to understand how interface conditions are represented in child language.

### **Future directions**

We propose to extend the present studies using children with typical language development to children with SLI. We have now established when and how typically developing Mandarin-speaking children understand the three interface phenomena: focus interpretation, *wh*-quantification and scope assignment. The next step is to determine when and how children with SLI understand the same interface phenomena. A comparison of the understanding of the same interface phenomena in children with typical language development versus children with SLI will provide insights into the nature of their deficits.

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