The Children's Acquisition of *shenme* in Mandarin Chinese

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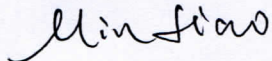# TABLE OF CONTENTS

Appendix: Ethics approval

Thesis Abstract

Mandarin Chinese is known as an *in-situ* language. In Mandarin, *wh*-questions are not formed by displacing *wh*-phrases, as in English. Rather, Mandarin *wh*-phrases remain in their argument positions in the surface syntax. Attesting to this characterization of Mandarin is the fact that *wh*-words can be used both to ask questions and to make statements. In statements, the *wh*-word *shenme* 'what' is similar in meaning to the existential expression *renhe* (English 'any'), and it is semantically related to the disjunction word *huozhe* (English 'or'). This thesis explores Mandarin-speaking children's interpretations of the *wh*-word *shenme* 'what' by comparing its interpretation to that of *renhe* 'any' and *huozhe* 'or' in three formally distinct linguistic contexts. The distributional and interpretive patterns of these expressions are used in a series of experimental investigations to assess children's knowledge of the semantic properties of these contexts. In one set of (upward entailing) contexts, *shenme* 'what' is a question marker, *renhe* 'any' is prohibited, and the disjunction word *huozhe* 'or' has disjunctive truth conditions. In the second set of contexts (downward entailing, but not anti-additive), *shenme* remains a question marker, and *huozhe* continues to be assigned disjunctive truth conditions; however, *renhe* is permitted in these contexts. The third set of (downward entailing, anti-additive) contexts includes the Mandarin adverbial quantifier *dou* 'all.' In such contexts, *shenme, renhe, and huozhe* are all licensed, but they yield a 'conjunctive' meaning that is different in character from the meanings of these expressions in the other linguistic contexts. Despite this intricate pattern, the findings from the experimental studies demonstrated Mandarin-speaking children's mastery of the semantics of *shenme, renhe* and *huozhe.* The findings are interpreted as evidence of the linguistic competence by young children to compose the complex meanings of sentences with multiple logical expressions. This study offers new data on the acquisition of logical expressions, and reveals the importance of the principles of linguistic theory, and logic, in explaining the course of child

language development. The study also sheds new light on the special linguistic properties of

Mandarin.

Statement of Candidate

I certify that the work in this thesis entitled "The children's acquisition of *shenme* in Mandarin Chinese" has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree to any other university or institution other than Macquarie University. I also certify that the thesis is an original piece of research and it has been written by me. In addition, I certify that all information sources and literature used are indicated in the thesis. The research presented in this thesis was approved by Macquarie University Ethics Review Committee, reference number: 5201100220D on 13 April, 2011.

Signed: *Min Liao*

Min Liao (Student ID number: 42217520)

June, 2014

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Statement of the exact contributions of other authors

My thesis 'The children's acquisition of *shenme* in Mandarin Chinese' is co-authored by my principal supervisor Associate Professor Rosalind Thornton and my associate supervisor Distinguished Professor Stephen Crain. Rosalind and Stephen are the most productive principle/associate supervisor teams that I could have worked with. Rosalind is the 'methodological' specialist and Stephen is the 'content' specialist. Together, they have made significant intellectual and practical contributions to the thesis.
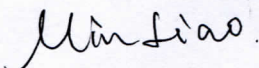
In the first half year of my Ph.D. study, Rosalind and Stephen directed me to set up a viable project and they ensured that I had a clear idea of aims and objectives and an initial work-plan. During the same period, Rosalind involved a lot in my Ethics application for this project. In my first year, Rosalind and Stephen also guided me extensively on designing the experiments and running the pilot experiments. They supported me in designing all the necessary materials (toys, audio and visual recorders, etc.) Through repeated discussions with them and other members of our research group, the experiments were soon ready to be conducted. At the same time, Rosalind also involved a lot in my Research Enhancement Fund application.

The experiments needed a large number of monolingual Mandarin-speaking children to participate. Rosalind and Stephen had previously established a long-term research collaboration with researchers at the Beijing Language and Culture University (BLCU), so I was able to draw upon these contacts to carry out the experiments, complete the data collection. I also received considerable assistance from the teachers and the Principal of the Kindergarten affiliated with BLCU. After the data collection, I discussed intensively on the analysis and interpretation of the data both in meetings with Rosalind and Stephen and in our lab meetings. They gave me intelligent comments, and helped me out whenever I became stuck. The free exchange of ideas also promoted my research.

Rosalind and Stephen encouraged me to attend leading international conferences. They edited my abstracts and asked me to present practice talks several times before presenting at the conferences, so as to develop my skills in oral presentations. Stephen also funded me from his own ARC Discovery grant to attend one of the conferences. They also nominated me to attend the Extensive Writing Course, in order to develop my skills in technical writing.

When I wrote up my thesis by publication, Rosalind and Stephen insisted that I take lead authorship on all chapters, and they insisted that I attempt to make all the necessary revisions. However, they critically reviewed the successive drafts of each chapter and they continually made constructive comments on both style and intellectual content. They edited the manuscript carefully before the final deadline to send the thesis out to external reviewers, and they even contributed to the final proof-reading stage.

In summary, Rosalind and Stephen contributed a great deal to the thesis, and both of them are creditable co-authors on the papers that will hopefully come from the submissions of these chapters to international refereed journals.

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June, 2014

CHAPTER 1

Introduction

Introduction

How do children acquire the syntax of their first language? Do they construct their grammar based mainly on the input from parents and caretakers, or does language acquisition also depend on biological factors, such as an innate 'universal' grammar? These and many other questions are often discussed in the literature on language acquisition, but the answers are far from settled, and considerable differences of opinion are held even by researchers who actively study how language develops in children acquiring their first language.

There are two main approaches to the emergence of children's linguistic abilities: the nativist approach and the experience-based approach. The nativist approach is grounded in Chomsky's (e.g., 1965, 1975, 1980) description of language as a rich and complex system of domain-specific linguistic principles that determine how linguistic knowledge is represented in the human mind, and how it emerges in children. With regard to language acquisition, linguists working within Chomsky's theory of generative grammar have often reached the conclusion that children possess a universal grammar that enables them to acquire any human language. According to Chomsky, children acquire language 'on relatively slight exposure and without specific training' (Chomsky, 1975, p. 4). According to the nativist approach, then, language acquisition consists of two parts, the core and the periphery. The periphery consists of the idioms and quirky constructions of the particular language. These are acquired by the same 'normal' learning mechanisms used by children to acquire knowledge in all cognitive domains. In addition, however, there are core linguistic structures that are innately provided by a universal grammar.

By contrast, a central tenet of the alternative experience-based approach is that language structure emerges from language use (e.g., Givón, 1995; Goldberg, 1995; see Tomasello, 2003). The experience-based approach holds that the essence of language is its symbolic dimension, with grammar being derivative. According to this view, there is no such

thing as universal grammar. The experience-based approach maintains that children learn language by attending to the form and function of the language used by their parents and caretakers in context. Children acquire language in a piecemeal way, by gradually adding constructions to their repertoire, according to their frequency of use. This approach highlights children's use of information that is readily available to them through the input that surrounds them.

Chomsky has asserted that the general-purpose learning mechanisms that operate on input alone are insufficient for children to construct the grammar of any language. This conclusion is based on what is called 'the logical problem of language acquisition' (Baker & McCarthy, 1981). The logical problem of language acquisition takes into account the complexity of the knowledge that children acquire, and the primary linguistic input. In view of these two aspects of language acquisition, the learning mechanisms that have been proposed in the literature appear to be woefully inadequate to explain children's rapid and uniform mastery of language. Arguments that lead to this conclusion are termed 'poverty of the stimulus' arguments. For example, one poverty-of-the-stimulus argument highlights the fact that the speech children encounter is full of errors, false starts and has no clear indications of abstract structures, whereas children acquire an abstract grammar that is capable of generating a potentially infinite set of sentences, the majority of which children have not been exposed to.

The nativist solution to this problem attributes innate linguistic knowledge to the child in the form of a universal grammar that contains the core principles that underpin all human languages. This putatively universal knowledge guides the child in constructing the language-particular instantiation of those universal principles, based on limited input provided by other speakers of the local language. By contrast, advocates of the experience-based approach believe it more plausible to assume that language acquisition is achieved without innate language-specific knowledge. By positing less abstract constructs, this approach argues that

the child's task of language learning is just one of many tasks that require induction of knowledge based on experience (Quine 1992; Brandom 2000).

In accounting for the acquisition of sentences with logical expressions, the experience-based approach is essentially an input-matching account of language development. This account anticipates that children's use of logical statements will mirror their use by adult speakers. Children must refine their usage of logical expressions as they accrue more and more relevant experience, so as to comport fully with adult usage. From this perspective, the experience-based approach expects cross-linguistic variation, rather than cross-linguistic generalizations (Dummett 1978; Brandom 2007). By contrast, the nativist approach expects cross-linguistic generalizations. According to logical nativism, children do not have sufficient evidence from experience to learn the meaning of logical expressions by observing how adult speakers use them. Rather, children are biologically fitted, as part of the human genome, with a theory of Universal Grammar (Chomsky 1965; 1975; 1986; Luria 1973). Universal Grammar contains the core principles of language which children access by virtue of their genetic endowment. These principles enable children to attain full linguistic competence in using logical expressions, by invoking core principles and parameters (Crain 2008; Crain and Pietroski 2001, 2002; Crain 2012).

This thesis is an extended study of the acquisition of *wh*-words by Mandarin-speaking children. These studies compare the acquisition of the interpretation of the *wh*-word *shenme* with that of the polarity sensitive word *renhe* 'any' and the disjunction word *huozhe* 'or' in three formally distinct linguistic contexts. As we will see, the *wh*-word *shenme* has a variety of interpretations, depending on the context. It would be very challenging for children to learn these different interpretations just by attending to the input, and it could be expected that children would take a long time to master the complete range of facts. Nevertheless, we find that children have mastered the complexities of sentences containing the logical operators with the *wh*-word *shenme*, *renhe* 'any', and the disjunction word *huozhe* 'or'. The findings of

these experimental investigations provide compelling support for the nativist approach of language acquisition.

As a *wh*-in-situ language, Mandarin *wh*-words are not 'fronted' as in English (Huang, 1982a, 1982b; Cheng 1991; Aoun and Li 1993; Huang, Li, & Li, 2009). Moreover, Mandarin *wh*-words have both an interrogative interpretation and a non-interrogative interpretation, albeit usually in different linguistic contexts. Consider example (1). In example (1a), the *wh*-word *shenme* 'what' has interrogative force and the sentence is interpreted as a question. In this linguistic context, the polarity sensitive item *renhe* 'any' is not permitted in the same position, as shown by the ungrammaticality of (1b). As we will see later in example (3), there are other linguistic contexts where both *shenme* and *renhe* are both permitted. Once again, we can point out the difficulty of this task for children if they were acquiring language by attending to the input. Even with considerable attention to the input, it would be difficult for children to figure out when *shenme* is permitted, but not *renhe*, and when both operators are allowed.

(1) a. Yuehan chi-le   **shenme** shuiguo?

     John   eat-ASP what   fruit

    'What fruit did John eat?'

  b. *Yuehan chi-le   **renhe** shuiguo.

     John   eat-ASP any   fruit

    'John ate any fruit.'

When the Mandarin disjunction word *huozhe* 'or' appears in a similar sentence, it has disjunctive truth conditions, as shown in (2). The sentence in (2) is true in three circumstances, where (i) John ate apples but not pears, or (ii) John ate pears but not apples, or (iii) John ate

both apples and pears. The third set of circumstances, in which John ate both apples and pears, gives a context that is difficult to access for most people, because hearers generally assume that if a speaker uses *or*, he or she is not in a position to use the stronger term *and* to describe the situation under consideration (Grice 1975). This means it is difficult to get the interpretation on which John ate the apples *and* the pears for (2).

(2) Yuehan chi-le   pingguo **huozhe** li.

　　John   eat-ASP apple   or   pear

　　'It is apples or pears (and possibly both) that John ate.'

In contrast to example (1), both the *wh*-word *shenme* 'what' and the polarity sensitive word *renhe* 'any' are permitted in sentences with the negative quantificational expression *mei-you* 'not-have,' as illustrated in (3). Moreover, *shenme* and *renhe* contribute the same meaning in this example.

(3) a. Mei-you xuesheng mai **shenme** shu.

　　　not-have student   buy what   book

　　　'No student bought any book.'

　　 b. Mei-you xuesheng mai **renhe** shu.

　　　not-have student   buy any book

　　　'No student bought any book.'

When the disjunction word *huozhe* is in the scope of the negative quantificational expression *mei-you* 'not-have', in contrast to example (2), *huozhe* generates a 'conjunctive' entailment, as shown in (4), so the statement entails both that *Mei-you xuesheng he pijiu* 'No student

drank beer' and that *Mei-you xuesheng he hongjiu* 'No student drank wine.' This is yet another difficult puzzle for children. As we saw, in (2), *huozhe* receives a disjunctive interpretation and is true in 3 sets of circumstances. By contrast, in (4), is only true in the circumstance in which no student drank either alcoholic beverage. How do children learn the different contexts in which *huozhe* gets a disjunctive interpretation or a conjunctive interpretation? If children had to learn this by experience, one can imagine that it would take some trial and error, and that children might make many errors at first. However, in this thesis, we will show that children are very accurate in their interpretation of these logical operators.

(4) Mei-you xuesheng he   pijiu **huozhe** hongjiu.

   not-have student   drink beer or   wine

   'No student drank beer and no student drank wine.'

A similar pattern is exhibited in (5). Example (5a) shows that when *shenme* 'what' is licensed in the antecedent of a conditional, it receives a non-interrogative interpretation. It has the same meaning as (5b), in which *renhe* 'any' is licensed. When the disjunction *huozhe* is in this context, it is assigned a conjunctive interpretation.

(5) a. Ruguo you **shenme** ren   qifu ni, qing   gaosu wo.

      if   have what   person bully you please tell   me

      'If anybody bullies you, please let me know.'

   b. Ruguo you **renhe** ren   qifu ni, qing gaosu wo.

      if   have any person bully you please tell   me

      'If anybody bullies you, please let me know.'

c. Ruguo Yuehan chi huasheng **huozhe** yu, ta   jiu   hui shengbing.

   if   John   eat peanut   or   fish he then will ill

   'If John eats peanuts, he will be ill and if John eats fish, he will be ill.'

Notice what happens, however, if the negative quantificational expression *mei-you* 'not-have'
from example (3) and (4) is replaced by the 'positive' quantificational expression *mei* 'every'.
In this case, the polarity expression *renhe* is not tolerated (as shown by the ungrammaticality
of (6b)), the *wh*-word *shenme* reverts to its function as a question marker as illustrated in (6a),
and the disjunction word *huozhe* reverts to be assigned disjunctive truth conditions as shown
in (6c).

(6) a. Mei-ge   xuesheng dou mai-le   **shenme** shu?

       every-CL student   all buy-ASP what   book

       'What book did every student buy?'

   b. *Mei-ge   xuesheng dou mai-le   **renhe** shu.

       every-CL student   all buy-ASP any   book

       'Every student bought any book.'

   c. Mei-ge   xuesheng dou he-le   pijiu **huozhe** hongjiu.

      every-CL student   all drink-ASP beer or   wine

      'It is beer or wine (and possibly both) that every student drank.'

A similar pattern is shown in (7). When the *wh*-word *shenme* appears in the consequent of a
conditional, rather than in the antecedent of a conditional in (5), *shenme* is a question marker,

as shown in (7a), *renhe* 'any' is prohibited in this case, as shown in (7b), and huozhe 'or' has a disjunctive meaning, as shown in (7c).

(7) a. Ruguo Yuehan yudao kunnan, ta   jiu zhao **shenme** ren   bangmang?

    if   John   meet difficult   he then find what   person help

   'Who did John ask for help if he came across difficulties?'

  b. *Ruguo Yuehan yudao kunnan, ta   jiu zhao **renhe** ren   bangmang.

    if   John   meet difficult   he then find any person help

   'If John came across difficulties, then he asked anyone for help.'

  c. Ruguo Yuehan yudao kunnan, ta   jiu zhao Tangmu **huozhe** Mali bangmang.

    if   John   meet difficult   he then find Tom   or   Mary help

   'It is Tom or Mary (and possibly both) that John asked for help if he came across

    difficulties.'

The pattern revealed in examples (1)-(7) is witnessed in a number of different linguistic contexts in Mandarin. In linguistic contexts where the polarity expression *renhe* is not tolerated, the *wh*-word *shenme* only serves as a question marker, and the disjunction word *huozhe* 'or' has disjunctive truth conditions. We refer to this pattern as Type I. In contexts that license *renhe*, *wh*-words are also permitted, with the same meaning, *huozhe* yields a conjunctive interpretation. We call this Type II.

There is one further pattern, which we call type III. The type III contexts license *renhe*, but only the interrogative interpretation of *wh*-words. For example, both the *wh*-word *shenme* and *renhe* are permitted in sentences with *bi ... xian* 'earlier than' (a comparative adjective), as in (8). However, in contrast to Type II contexts where both *shenme* and *renhe* are licensed,

and both are assigned a similar semantic interpretation, the *wh*-word *shenme* can only function as a question marker in the linguistic contexts in (8a); *wh*-words can only be assigned an interrogative interpretation.

(8) a. Yuehan bi **shenme** xuesheng xian dao?

    John than what   student early arrive

    'Which student did John arrive earlier than?'

  b. Yuehan bi **renhe** xuesheng xian dao.

    John   than any   student   early arrive

    'John arrived earlier than any other students.'

Example (9) shows that in the scope of the comparative adjective *bi … xian* 'earlier than', the disjunction *huozhe* 'or' is assigned disjunctive truth conditions. Mandarin adults judge (9) to mean that 'John arrived earlier than Mary *or* John arrived earlier than Tom.' So (9) is true in three circumstances, where (i) John arrived earlier than Mary but not Tom, or (ii) John arrived earlier than Tom but not Mary, or (iii) John arrived earlier than both Mary and Tom.

(9) Yuehan bi Mali **huozhe** Tangmu xian   dao.

  John   than Mary or   Tom   earlier arrive

  'It's Mary or Tom (and possibly both) that John arrived earlier than.'

Sentences with the temporal operator *zai…zhiqian* 'before' are also type III contexts. As shown in (10), the interrogative interpretation of *wh*-word *shenme*, the polarity sensitive expression *renhe* 'any' and the disjunctive interpretation of the disjunction *huozhe* are all licensed in sentences with *zai…zhiqian* 'before'.

(10) a. Yuehan zai **shenme** ren   zhiqian dao?

John   at what   person before   arrive

'Who did John arrive before?'

b. Yuehan zai **renhe** ren   zhiqian dao.

John   at any   person before arrive

'John arrived before anybody.'

c. Yuehan zai Mali **huozhe** Tangmu zhiqian laidao xuexiao.

John   at Mary or   Tom   before   arrive school

'It's Mary or Tom (and possibly both) that John arrived at school before.'

Note that languages differ in the ways in which words for disjunction are interpreted in Type III contexts. Consider the English statement in (11) and (12), when English disjunction word *or* is in the scope of the comparative adjective *earlier than* and the temporal operator *before,* the disjunction *or* generates a conjunctive interpretation.

(11) John arrived earlier than Tom **or** Mary.

⇒ John arrived earlier than Tom and John arrived earlier than Mary.

(12) John arrived at school before Tom **or** Mary.

⇒ John arrived at school before Tom and John arrived at school before Mary.

So far, we have observed three patterns of linguistic behaviour. In Type I linguistic contexts, the *wh*-word *shenme* 'what' is a question marker, *renhe* 'any' is prohibited, and the disjunction word *huozhe* 'or' has disjunctive truth conditions. (see examples (1), (2), (6), and

(7)). In Type II linguistic contexts both *shenme* and *renhe* are licensed, and both are interpreted as Negative Polarity Items (NPIs), *huozhe* yields a conjunctive reading (see examples (3), (4) and (5)). In Type III linguistic contexts, both *wh*-words and *renhe* are admissible, but *wh*-words serve as question markers, whereas *renhe* 'any' is analysed as an NPI. *Huozhe* is assigned disjunctive truth conditions (see examples (8), (9) and (10)). The compatibility of *shenme* 'what', *renhe* 'any' and *huozhe* 'or' with the three different types of linguistic contexts is illustrated in Table (1)

Table 1. *Shenme* 'what', *renhe* 'any' and *huozhe* 'or' in different linguistic contexts

Linguistic contexts	*Shenme* 'what'	*Renhe* 'any'	*Huozhe 'or'*
Type I	Question	*	Disjunctive
Type II	NPI	NPI	Conjunctive
Type III	Question	NPI	Disjunctive

Type II contexts includes the Mandarin adverbial quantifier *dou* 'all'. In the scope of the adverbial quantifier *dou*, *shenme* 'what', *renhe* 'any', and *huozhe* 'or' are all licensed, *shenme* and *renhe* receive a same universal reading, and *huozhe* has a conjunctive reading, as shown in (13).

(13) a.Yuehan **shenme** shu dou kan.

    John　　what　book all read

    'John reads every book.'

b. Yuehan **renhe** shu   dou kan.

   John   any   book all read

  'John reads every book.'

c. Yuehan pingguo **huozhe** li   dou maiwan-le.

   John   apple   or   pear all   sell.out-ASP

  'John sold out of both the apples and the pears.'

In a finite domain, the *wh*-word *shenme* 'what', the polarity sensitive expression *renhe* 'any', and the disjunction word *huozhe* 'or' are logically equivalent to each other, we call them ∃-items, adopting the logical symbol for the existential quantifier (cf. Karttunen 1977; Jackendoff 1972; Jayaseelan 2001; Rooth and Partee 1982; Chierchia 2006, 2010). Here is the intuition. Suppose there are two people in a room: John and Mary. Then, the sentence *Someone laughed.* is logically equivalent to the corresponding disjunctive statement, *John laughed or Mary laughed*. The truth conditions associated with the disjunctive statement are also possible answers of the *wh*-question *Who laughed*?

    Not only are existential NPs logically equivalent to corresponding statements with disjunction in a finite domain, but universal NPs are logically equivalent to corresponding statement with conjunction in a finite domain. To see this, suppose that there are three people in a room: John, Mike and Mary. In this circumstance, the sentence *Everyone laughed* is true if and only if the corresponding conjunctive statement is true, namely *John laughed and Mike laughed and Mary laughed*.

    This thesis consists of two main components. First, there is a theoretical component, where we investigate the semantics of the *wh*-word *shenme* 'what', as distinguished from that of the polarity sensitive expression *renhe* 'any' and the disjunction word *huozhe* 'or'. We will refer to them, together, as ∃-items. Based on the semantic analysis of these three ∃-items, we

validate a theoretically motivated account of the distribution and interpretation of the three ∃-items. The theoretical part of the thesis is followed by our experiments with Mandarin-speaking children. We investigate whether Mandarin-speaking children understand the ∃-items *shenme*, *renhe* and *huozhe*, and how they comprehend them in different linguistic contexts. We have pointed out above that the differences in the linguistic contexts are very subtle, and this would be an extremely difficult set of facts to master if children were relying only on the positive input to try and figure out the pattern. We present six experiments to probe children's knowledge of the logical operators in the linguistic contexts that we have outlined above. Anticipating our overall findings, children make few errors in interpretation, a finding that supports the view that their understanding of these logical operators is guided by Universal Grammar. The experiments presented in the thesis are outlined next.

Chapter 2 reports two experiments investigating Mandarin-speaking children's comprehension of the *wh*-word *shenme* 'what' in Type III contexts, where *shenme* and *renhe* are not equivalent in meaning. One linguistic context consisted of sentences with the comparative operator *bi…xian* 'earlier than', as shown in (14) and (15), and the other consisted of sentences with the temporal operator *zai…zhiqian* 'before', as shown in (16) and (17). We ask whether children understand the distinction between *shenme* 'what' and *renhe* 'any' in these contexts, namely where the *wh*-word *shenme* can only function as a question marker whereas *renhe* 'any' is analysed as a negative polarity item.

(14) Yazi zai **shenme** dongwu zhiqian youdao zhongdian?

   duck at   what   animal before swim finishing.line

  'Which animal did the duck reach the finishing line before?'

(15) Yazi zai **renhe** dongwu zhiqian youdao zhongdian.

    duck at any   animal before swim   finishing.line

    'The duck reached the finishing line before any other animals.'

(16) Zi-huoche   bi **shenme** huoche xian yun-wan   shitou?

    purple- train than what   train   early carry-finish stone

    'Which train did the purple train finish carrying stones earlier than?'

(17) Zi-huoche   bi **renhe** huoche xian yun-wan shitou.

    purple- train than any   train   early carry-finish stone

    'The purple train finished carrying stones earlier than any other trains.'

The results are that three-to-five-year-old Mandarin-speaking children interpreted *shenme* 'what' as a *wh*-question marker in both Type III contexts, whereas they interpreted the sentences with *renhe* 'any' as statements. The same pattern was observed for adults.

Chapter 3 investigates the semantic properties of the Mandarin quantificational expression *dou* 'all'. We compare children's responses to sentences with the comparative expression *bi..xian*, both with *dou* (*bi…dou xian*) (a Type II context), as shown in (18-19), and without *dou* (*bi…xian*) (a Type III context), as shown in (16-17) (in Chapter 2). We assess whether Mandarin-speaking children know the distributional patterns of the alternative interpretations of *wh*-words in these two types of contexts. The experimental results are used as further evidence that *dou* licenses both the non-interrogative meaning of the *wh*-word *shenme* 'what' and *renhe* 'any'.

(18) Xiongmao bi **shenme** dongwu dou xian laidao xuexiao.

   panda   than what   animal all early arrive school

   'The panda arrived at school earlier than every animal.'

(19) Xiongmao bi **renhe** dongwu dou xian laidao xuexiao.

    panda   than any   animal all   early arrive school

   'The panda arrived at school earlier than every animal.'

The main finding is that children (and adults) assigned the non-interrogative universal meaning to the *wh*-word *shenme* in (18), and they assigned the same universal meaning to *renhe* 'any' in (19). The results reported in Chapter 2 revealed that, in sentences with the comparative expression *bi…xian* 'earlier than' alone, children interpreted *shenme* as a question marker whereas they interpreted *renhe* as an NPI in the same context. These findings demonstrate that, by age 4, Mandarin-speaking children know that *dou* belongs to Type II contexts which licenses the non-interrogative meaning of *shenme*, similar in meaning to *renhe* 'any', whereas in sentences with *bi…xian* in which *dou* is not present in the structure, which is a Type III context, *shenme* is simply treated as a question marker. These results indicate that children are sensitive to different types of contexts, and show the early mastery of adult-like linguistic knowledge of *wh*-words in child Mandarin.

Chapter 4 is devoted to a theoretically motivated account of the distribution and interpretation of the three ∃-items: the disjunction word *huozhe* 'or', the *wh*-word *shenme* 'what' and the polarity sensitive expression *renhe* 'any.' Moreover, we investigate how young Mandarin-speaking children interpret the disjunction word *huozhe* 'or' in contexts of two different types, namely sentences with the comparative expression *bi..xian*, both with *dou* (*bi…dou xian*) (a Type II context), as shown in (21), and without *dou* (*bi…xian*) (a Type III context), as shown in (20).

(20) Xiaoyang bi   xiaogou **huozhe** shizi xian padao   shuding.

   sheep   than dog   or   lion early climb   tree.top

   'The sheep will reach the top of the tree earlier than the dog or the lion.'

(21) Xiaoyang bi   xiaogou **huozhe** shizi dou xian padao shuding.

   sheep   than dog   or   lion all early climb tree.top

   'The sheep will reach the top of the tree earlier than both the dog and the lion.'

The results show that Mandarin-speaking adults assign a disjunctive interpretation of *huozhe* in (20), a Type III context; but a conjunctive interpretation of *huozhe* in (21), a type II context. However, Mandarin-speaking children assign a conjunctive interpretation of the disjunction *huozhe* in both of the two contexts, the same as English-speaking children and adults do.

The findings of the series of experimental studies we report provided evidence that Mandarin-speaking children, by age 4, master the semantics of the ∃-items *shenme, renhe* and *huozhe*. They have the knowledge of the distributional and interpretive patterns of these ∃-items. The findings are interpreted as evidence of the linguistic competence by young children to compose the complex meanings of sentences with multiple logical expressions.

These experimental findings support for the nativist approach. First, the findings from the present study show that, by age 4, Mandarin-speaking children have mastered the complex semantics of the *wh*-word *shenme, renhe* 'any' and *huozhe* 'or', the early emergence of these knowledge doubts the learning-theoretic scenarios. Second, Mandarin-speaking children manifest adult-like distributional and interpretive patterns of *shenme* and *renhe*; however, it does not appear plausible that children have sufficient evidence from input to learn these patterns (MacWhinney 2000). The most compelling evidence of innateness comes from the observation that Mandarin-speaking children sometimes make non-adult interpretation of disjunction. In such cases, children exhibit patterns of usage of the disjunction word *huozhe*

quite different from those of adults. Moreover, we found that Mandarin-speaking children's interpretation of disjunction is the same as that of English-speaking children and adults. This supports the continuity hypothesis, as stated by Pinker (1984), Crain (1991) and Crain & Pietroski (2001). The continuity hypothesis expects that the ways children differ from adults should be limited to the ways in which adult languages differ from each other. Again, these findings provide evidence in favour of the theory of Universal Grammar.

As a final note in this introduction, we would point out that there are two main repetitions in the thesis. These repetitions are unavoidable, as the format of thesis by publication requires each chapter to stand alone, as a self-contained paper. One repetition concerns the description of research methodology. We used the same experimental method (i.e., the Question Statement Task (Zhou and Crain 2009)) for the experiments in Chapter 2 and Chapter 3. We have to give a full description of research methodology in each of relevant chapters. Second, Chapter 4 repeats the main theoretical issues proposed in Chapter 3 on the distributional and interpretive patterns of the three ∃-items to prepare for the discussion of the scope assignments in Chapter 4.

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CHAPTER 2

On the acquisition of different kinds of NPIs in

Mandarin

Abstract

In previous research, Mandarin-speaking children (and adults) have been found to assign the same interpretation to the *wh*-words like *shei* 'who' and *shenme* 'what' and the negative polarity item (NPI) *renhe* 'any'. In several linguistic contexts, *wh*-words received a non-interrogative meaning, such that the sentences containing them are understood to be statements rather than questions. These findings have led some researchers to conclude that Mandarin *wh*-words serve dual semantic functions, as question markers and as NPIs. It has been supposed that the NPI interpretation of *wh*-words is licensed in the same linguistic contexts as the NPI *renhe* 'any'. The present study uncovered two linguistic contexts in which Mandarin-speaking children (and adults) only interpret *shenme* 'what' as a *wh*-question marker, but where the NPI *renhe* 'any' is licensed. One context is sentences with the temporal operator *zai…zhiqian* 'before'. The other is sentences with the comparative operator *bi… xian* 'earlier than'. We propose that *wh*-words like *shenme* are 'strong' NPIs, whereas *renhe* is a 'weak' NPI. According to the literature, strong NPIs can only be interpreted within the scope of linguistic expressions that are anti-additive, as well as downward entailing, whereas weak NPIs are licensed in downward entailing linguistic environment, and do not require that the contexts be anti-additive. On this analysis, the temporal operator *zai…zhiqian* 'before' and the comparative operator *bi… xian* 'earlier than' are 'merely' downward entailing. Because *wh*-words are strong NPIs, children and adults are not expected to interpret *wh*-words within the scope of these operators; these expressions are expected to only function as *wh*-question markers in these linguistic contexts. These research hypotheses were evaluated in two experiments with Mandarin-speaking children and adults.

Keywords   Child language · *Wh*-words · Strong/weak negative polarity item · Downward entailing · Anti-additive

1. Introduction

Mandarin *wh*-words are used to ask questions and to make statements, albeit usually in different linguistic structures. Consider example (1). In example (1a), the *wh*-word *shenme* 'what' has interrogative force. Note that the Mandarin *wh*-word *shenme* 'what' remains *in-situ* in (1a), and is not 'fronted' as in English (Huang 1982a, 1982b; Huang, Li, and Li 2009). Example (1b) indicates that the Mandarin polarity expression *renhe* 'any' is not tolerated in this linguistic context.[1]

(1) a. Ta chi-le   **shenme** dongxi?

    he eat-ASP what   thing

    'What did he eat?'

  b. *Ta chi-le   **renhe** dongxi.

    he eat-ASP any   thing

    'He ate anything.'

In contrast to example (1), both *shenme* 'what' and *renhe* 'any' are permitted in A-not-A questions as illustrated in (2), and in the antecedent of a conditional statement, as in (3). Moreover, *shenme* and *renhe* contribute the same meaning in these examples.

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[1] For now, we will refer to Mandarin *renhe* simply as a 'polarity expression,' to indicate that it is licensed in 'negative' (downward entailing) linguistic environments, including the antecedent of conditionals. We will offer a more refined analysis in Section 2.

(2) a. Yuehan chi-mei-chi **shenme** shuiguo?

    John   eat-not-eat   what   fruit

    'Did John eat any fruit or not?'

   b. Yuehan chi-mei-chi **renhe** shuiguo?

    John   eat-not-eat   any   fruit

    'Did John eat any fruit or not?'

(3) a. Ruguo you **shenme** shengyin chaodao ni, qing gaosu wo.

    if   have what   noise   bother you please tell me

    'If any noise bothers you, please tell me.'

   b. Ruguo you **renhe** shengyin chaodao ni, qing gaosu wo.

    if   have   any   noise   bother you please tell me

    'If any noise bothers you, please tell me.'

A similar pattern is exhibited in (4). Example (4a) shows that *shenme* 'what' is licensed in the predicate phrase of sentences with the *mei-you-ren* 'nobody' and (4b) shows that the polarity expression *renhe* is also permitted in this context. The sentences are both statements, and they have the same meaning.

(4) a. Mei-you-ren   chi **shenme** shuiguo.

    not-have-person eat what   fruit

    'Nobody ate any fruit.'

b. Mei-you-ren   chi **renhe** shuiguo.

   not-have-person eat any   fruit

   'Nobody ate any fruit.'

Notice what happens, however, if the 'negative' quantificational expression *mei-you-ren* 'nobody' from example (4) is replaced by the 'positive' quantificational expression *mei-ge-ren* 'everybody'. In this case, the polarity expression *renhe* is not tolerated (as shown by the ungrammaticality of (5a)), and the *wh*-word *shenme* reverts to its function as a question marker.

(5) a. *Mei-ge-ren   dou chi-le   **renhe** shuiguo.

      every-CL-person all eat-ASP any   fruit

      'Everybody ate any fruit.'

   b. Mei-ge-ren   dou chi-le   **shenme** shuiguo?

      every-CL-person all eat-ASP what   fruit

      'What fruit did everybody eat?'

The pattern revealed in examples (1)-(5) is witnessed repeatedly in Mandarin. In linguistic contexts where the polarity expression *renhe* is not tolerated, the *wh*-word *shenme* only serves as a question marker. In contexts that license *renhe*, *wh*-words are also permitted, with the same meaning. Based on this considerable distributional overlap, Mandarin-speaking children might be expected to reach the generalization in (6).

(6) The *wh*-word *shenme* and the polarity expression *renhe* are licensed in the same linguistic contexts, *salva veritate*. Where *renhe* is not licensed, *shenme* can only function as a question marker.

However, like most generalizations, (6) has exceptions. In some contexts, both the *wh*-word *shenme* and the polarity expression *renhe* are licensed, but *wh*-words can only function as question markers. One such context is in sentences with the temporal operator *zai……zhiqian* 'before', and the other is in sentences with the comparative operator *bi……xian* 'earlier than'. One aim of the present paper is to replace (6) with a generalization that explains the phenomena in (1)-(5) as well as these exceptions. Another aim is to investigate how young Mandarin-speaking children deal with the exceptions to the generalization in (6), when they first encounter them. Strict adherence by Mandarin-speaking children to the generalization in (6) would lead children to interpret *wh*-words as NPIs in sentences with these operators, unlike adults. However, if children are armed with the appropriate linguistic knowledge, then children should be found to handle the exceptions in the same way as adults do, as soon as they can be tested.

The paper is organized as follows. First we introduce some basic facts about the licensing conditions of Mandarin *wh*-words and the polarity expression *renhe*. We observe that previous research has concluded that both *wh*-words and *renhe* can be analyzed as Negative Polarity Items (NPIs) (Cheng 1991, 1994; Huang 1982b; Li 1992; Lin 1996, 1998). There is more than one kind of NPI, however. In the theoretical literature, a distinction is drawn between 'strong' and 'weak' NPIs. Following the theoretical section, we assess the generalization in (6) and the exceptions to it. We conclude that a new analysis is required, according to which the *wh*-word *shenme* 'what' is a strong NPI, whereas the polarity expression *renhe* 'any' is a weak NPI. We then review previous research on children's comprehension of NPIs. This is followed by a presentation of two experiments that were

designed to assess Mandarin-speaking children's comprehension of the *wh*-word *shenme* and the polarity expression *renhe.* One experiment investigates the interpretation assigned to these expressions in sentences with the temporal operator *zai…zhiqian* 'before.' The second experiment investigates these expressions in sentences with the comparative operator *bi…xian* 'earlier than'. The findings of these experiments support the distinction between strong and weak NPIs. Based on this distinction, we advance a new generalization that more fully explains when different kinds of NPIs, including *wh*-words, are licensed.

2. Negative Polarity Items

At a first cut, Negative Polarity Items (NPIs) are only licensed in negative contexts (cf. Seuren 1985; McCawley 1988; Horn 1989; Von Bergen and Von Bergen 1993, etc.). English *any* fits the bill, as illustrated in (7).

(7) a. No student saw any bird.

    b. *John saw any bird.

Mandarin *renhe* 'any' is the near equivalent of English *any*. Like English *any*, *renhe* is permitted to appear in the scope of the negative existential expression *mei-you* 'not-have', but is prohibited in simple affirmative statements. This is shown in (8a, b).

(8) a. Mei-you   xuesheng kandao **renhe** niao.

    not-have   student   see   any bird

    'No student saw any bird.'

b. *Zhangsan kandao **renhe** niao.

   Zhangsan   see   any bird

   'Zhangsan saw any bird.'

In Mandarin, as in English, the same kinds of 'negative' expressions typically license *wh-*words, on their non-interrogative interpretation. For instance, the negative marker *mei-you* 'not-have' licenses the *wh*-word *shenme* 'what' in (9a). When the negative existential expression *mei-you* 'not-have' is absent, two things happen. First, the sentence with *renhe* is ungrammatical, as in example (8b). Second, the *wh*-word *shenme* 'what' reverts to a question marker, as indicated in (9b).

(9) a. Mei-you   xuesheng kandao **shenme** niao.

      not-have   student   see   what   bird

      'No student saw any bird.'

   b. Zhangsan kandao **shenme** niao?

      Zhangsan   see   what bird

      'Which bird did Zhangsan see?

We tentatively conclude that both Mandarin *renhe* 'any' and the *wh*-word *shenme* 'what' are NPIs.

   Other linguistic environments that license NPIs do not have a negative cast (cf. Hoeksema 2000). For instance, English *any* is licensed in the antecedent of an *if*-conditional, as shown in (10). Similarly, Mandarin *renhe* 'any' and the *wh*-word *shenme* are licensed in the antecedent of *ruguo*-conditionals, as illustrated in (11) and (12).

(10) If any noise bothers you, please tell me.

(11) Ruguo you **shenme** shengyin chaodao ni, qing gaosu wo.

    if   have what   noise   bother you please tell me

    'If any noise bothers you, please tell me.'

(12) Ruguo you **renhe** shengyin chaodao ni, qing gaosu wo.

    if   have any   noise   bother you please tell me

    'If any noise bothers you, please tell me.'

Beginning with the seminal work by Ladusaw (1979, 1980), a generalization emerged about NPIs. The generalization was that NPIs are licensed in the scope of downward entailing expressions. By definition, downward entailing expressions validate inferences from general terms (terms referring to sets) to specific terms (terms referring to subsets of those sets). A formal definition, taken from Ladusaw (1980: 467) is given in (13).

(13) An expression δ is downward entailing iff $\forall X \ \forall Y (X \subseteq Y) \rightarrow [\delta(Y) \rightarrow \delta(X)]$

According to this definition, downward entailing expressions reverse entailment relations, so that valid inferences proceed from a 'superset' expression to a 'subset' expression. Ordinarily inferences are upward entailing, making it is valid to infer from the statement *John bought a Ferrari* to the statement *John bought a car*, but not vice versa. The opposite, downward entailing inference would be from a sentence with *car*, to one with *Ferrari*.

It is easy to see that the antecedent of conditionals is downward entailing, because it is valid to replace a set-referring term by a subset-referring term in the antecedent of a

conditional. For example, the set referring term in (14a), *bird*, has been replaced in (14b) by a subset referring term, *dove*. Clearly if (14a) is true, then so is (14b).

(14) a. If a student saved a bird, he got a reward.

    b. If a student saved a dove, he got a reward.

The Mandarin example (15) corresponds to (14). Example (15) shows that it valid to replace the set-referring term *niao* 'bird' by the subset-referring expression *gezi* 'dove' in the antecedent of a *ruguo*-conditional.

(15) a. Ruoguo yi-ge   xuesheng jiu-le   niao, ta jiu dedao-le   jiangli.

      if   one-CL student save-ASP bird, he then get-ASP   reward

      'If a student saved a bird, he got a reward.'

    b. Ruoguo yi-ge xuesheng jiu-le   gezi, ta jiu dedao-le   jiangli.

      if   one CL student save-ASP dove, he then get-ASP reward

      'If a student saved a dove, he got a reward.'

For the purposes of this paper, it is crucial to acknowledge two other downward entailing expressions. One is the temporal operator *zai…zhiqian* 'before,' and the other is the comparative operator *bi* 'than'. Examples are provided in (16) and (17). As these examples show, the set-referring terms (*nvhai* 'girls', *niao* 'birds') can be replaced by the corresponding subset-referring terms (*Mali* 'Mary', *gezi* 'doves') in sentences with either of these expressions, without alteration of the truth-value (i.e., *salva veritate*). These expressions were used in the experiments we conducted with Mandarin-speaking children and adults.

(16) a. Yuehan zai nvhai zhiqian paodao zhongdian.

John   at girl before run   finishing.line

'John reached the finishing line before the girls.'

   b. Yuehan zai Mali zhiqian paodao zhongdian.

John   at Mary before run   finishing.line

'John reached the finishing line before Mary.'

(17) a. Feiji   fei-de bi   niao kuai.

airplane fly-DE than bird fast

'Airplanes fly faster than birds.'

   b. Feiji   fei-de bi   gezi kuai.

airplane fly-DE than dove fast

'Airplanes fly faster than doves.'

3. Weak and Strong NPIs

Not all NPIs are equal. In English, the NPIs *any* and *ever* enjoy a wider distribution than the NPIs *in weeks*, *either*, and *until* (cf. Jespersen 1917; Fauconnier 1975; Linebarger 1980; Zwarts 1981; Von Bergen and Von Bergen 1993). The different distribution of *any* versus *until* is illustrated in (18) and (19). These examples indicate that *any* is acceptable in a greater number of linguistic contexts than *until*. More specifically, the NPI *any* is acceptable in sentences with *at most five*, whereas *until* cannot appear in combination with *at most five*.

(18) a. No student saw any bird.

b. John didn't see any bird.

c. At most five students saw any bird.

d. * Some students saw any bird.

(19) a. No student left until Christmas.

b. John didn't leave until Christmas.

c. * At most five students left until Christmas.

d. * Some students left until Christmas.

To explain why some NPIs are accepted in linguistic contexts where other NPIs are prohibited, linguists have partitioned NPIs into (at least) two classes - weak and strong (Hoeksema 1996; Giannakidou 1998; Van der Wouden 1997). According to this partition, weak NPIs include English *any* and *ever*, which are licensed in downward entailing linguistic environments, whereas strong NPIs, like *until,* require licensors that are both downward entailing and anti-additive (e.g., Zwart 1998). Anti-additivity is a logical equivalence between two formulas. In one formula, conjunction takes scope over both occurrences of the operator (Op), so we can render this formula as: Op (A) & Op (B). In the other formula, the operator takes scope over disjunction: Op (A v B).

More formally, a function f is anti-additive if it generates the following logical equivalence: $f(X \vee Y) = f(X) \wedge f(Y)$. Examples (20) and (21) show that *no* and *not* are anti-additive, whereas example (22) indicates that *at most n* is not anti-additive. Anyone who

regards (20a) as true, must also accept the truth of (20b), and vice versa. Similarly for (21a, b). By contrast, although the truth of (22a) entails the truth of (22b), the reverse does not hold. To see that (22b) does not entail (22a), suppose that (22b) is a true description of a situation in which five students smoke and five other students drink. In this situation, ten students are being referred to by (22b). In the same situation, however, (22a) is false, because this sentence can only be true if no more than 5 students either smoke or drink.

(20) a. No student smokes or drinks.

   b. No student smokes and no student drinks.

(21) a. John didn't eat onions or carrots.

   b. John didn't eat onions and John didn't eat carrots.

(22) a. At most five students smoke or drink.

   b. At most five students smoke and at most five students drink.

ON the other hand, *at most five* meets the test for being downward entailing. This is shown in example (23). The example indicates that it is valid to infer from truth of sentence (23a), with the general term *birds*, to the truth of sentence (23b), with the specific term *doves*.

(23) a. At most five birds were saved.

   b. At most five doves were saved.

Notice that if a function is anti-additive then it is downward entailing but not vice versa. The upshot is that both strong and weak NPIs are licenced in linguistic contexts that are both downward entailing and anti-additive, whereas weak NPIs, but not strong NPIs are licensed in linguistic contexts that are 'merely' downward entailing.

4. The *wh*-word *shenme* 'what' versus the NPI *renhe* 'any'

The Mandarin example (24) shows that when the Mandarin disjunction word *huozhe* 'or' appears in the scope of the negative existential *mei-you* 'not-have' as in (24a), it entails the conjunctive statement in (24b) (where the conjunction *bingqie* 'and' takes scope over both of the negative sentences *Mei-you xuesheng chou-yan.* 'No student smokes.' and *Mei-you xuesheng he-jiu.* 'No student drinks.') Example (24b) also entails (24a). Therefore, there is a logical equivalence between (24a) and (24b). This shows that the negative existential *mei-you* 'not-have' is anti-additive.

(24) a. Mei-you   xuesheng chou-yan **huozhe** he-jiu.

   not-have student   smoke   or   drink

   'No student smokes or drinks.'

   b. Mei-you xuesheng chou-yan bingqie mei-you xuesheng he-jiu.

   not-have student   smoke   and   not-have student drink

   'No student smokes **and** no student drinks.'

Since the negated existential *mei-you* 'no' is anti-additive, it licenses both the strong and weak NPIs. It follows that both the NPI *shenme* 'what' and the NPI *renhe* 'any' can appear in the scope of *mei-you* 'no', as illustrated in the examples in (25).

(25) a. Mei-you xuesheng kandao **shenme** niao.

    not-have student   see   what bird

    'No student saw any bird.'

  b. Mei-you xuesheng kandao **renhe** niao.

    not-have student   see   any bird

    'No student saw any bird.'

Next we will consider the antecedent of a conditional. 'If A or B, then C' is true in (i) If A, then C, or (ii) If B, then C. According to the Conjunction Introduction (the inference that if the proposition p is true, and proposition q is true, then the logical conjunction of the two propositions p and q is true), 'If A or B, then C' is logically equivalent to 'If A, then C and If B, then C' (Hurley 1991). Therefore, as illustrated in the examples in (26), when the disjunction *huozhe* 'or' appears in the antecedent of a *ruguo*-conditional as in (26a), it generates the conjunctive entailment in (26b), and vice versa. The logical equivalence between these two statements means that the antecedent of a conditional is anti-additive.

(26) a. Ruoguo Yuehan dian yangcong **huozhe** huluobo, Mali jiu dian daishu-rou.

    if   John   order onion   or   carrot   Mary then order kangaroo

    'If John orders onions or carrots, then Mary will order kangaroo.'

b. Ruoguo Yuehan dian yangcong, Mali   jiu dian daishu-rou; bingqie ruoguo

if   John   order onion   Mary then order kangaroo   and   if

yuehan dian huluobo, Mali   jiu dian daishu-rou.

John   order carrot   Mary   then order kangaroo

'If John orders onions, then Mary will order kangaroo **and** if John orders carrots, then

Mary will order kangaroo.'

Because the antecedent of a conditional is anti-additive, it is expected to license both the NPI *shenme* 'what' and the NPI *renhe* 'any', and the statements that result should have the same meaning. These expectations are both borne out, as shown in (27) (repeated from example 3 above).

(27) a. Ruguo you **shenme** shengyin chaodao ni, qing gaosu wo.

if   have what   noise   bother you please tell me

'If any noise bothers you, please tell me.'

b. Ruguo you **renhe** shengyin chaodao ni, qing gaosu wo.

if   have any   noise   bother you please tell me

'If any noise bothers you, please tell me.'

In (adult) Mandarin [2], neither the temporal operator *zai…zhiqian* 'before' nor the comparative operator *bi* 'than' are anti-additive operators. As we saw, in order to be anti-additive, there

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[2] Mandarin-speaking children have been found to initially generate the conjunctive interpretation of disjunction when it appears in the scope of any downward-entailing operator, so they generate this interpretation of disjunction in sentences with the temporal operator

must be a logical equivalence between two formulas. In one formula, conjunction takes scope over both occurrences of the operator, Op, i.e., Op(A) & Op(B). In the other formula, the operator takes scope over disjunction, i.e., Op(A v B).

First consider the temporal operator *zai…zhiqian* 'before'. The examples in (28), reveal that the temporal operator *zai…zhiqian* 'before' is not anti-additive. The problem lies in example (28a). As can be seen from the English translation, *zai…zhiqian* 'before' does not take scope over disjunction in (28a). Instead, disjunction takes scope over *zai…zhiqian* 'before'. This means that example (28b) entails (28a), but (28a) does not entail (28b).

(28) a. Yuehan zai Mali **huozhe** Tangmu zhiqian paodao zhongdian.

    John   at Mary or   Tom   before run   finishing.line

    'It's Mary or Tom (and possibly both) that John reached the finishing line before.'

  b. Yuehan zai Mali zhiqian paodao zhongdian bingqie Yuehan zai Tangmu

    John at Mary before run   finishing.line and   John   at   Tom

    zhiqian paodao   zhongdian.

    before run   finishing.line

    'John reached the finishing line before Mary and John reached the finishing line before Tom.'

The same line of reasoning holds for the comparative operator *bi* 'than'. This is shown in example (29). In (29a), the Mandarin disjunction word *huozhe* 'or' takes scope over the comparative operator *bi…xian* 'earlier than'. Adult speakers of Mandarin judge (29a) to mean

zai…zhiqian ('before'), and in sentences with comparative operators (cf. Goro 2004; Jing et al. 2005; Notley et al. 2011; Liao et al. 2013).

that 'John arrived earlier than Mary *or* John arrived earlier than Tom.' So (29a) is true in three circumstances, where (i) John arrived earlier than Mary but not Tom, or (ii) John arrived earlier than Tom but not Mary, or (iii) John arrived earlier than both Mary and Tom. This means that (29a) can be true in two circumstances that falsify (29b). Hence, the comparative *bi* 'than' cannot be regarded as anti-additive.

(29) a. Yuehan bi   Mali **huozhe** Tangmu xian   dao.

     John   than Mary or   Tom   early arrive

     'It's Mary or Tom (and possibly both) that John arrived earlier than.'

   b. Yuehan bi Mali xian   dao bingqie Yuehan bi Tangmu xian   dao.

     John   than Mary early arrive and   John   than Tom   early arrive

     'John arrived earlier than Mary and John arrived earlier than Tom.'

Despite not being anti-additive, the Mandarin temporal operator *zai…zhiqian* 'before' and comparative operator *bi* 'than' are downward entailing. Examples (30) and (31) (previous examples 16 and 17) show that these operators validate inferences from set-referring terms *nvhai* 'girls' or *niao* 'birds' to subset-referring terms *Mali* 'Mary' or *gezi* 'doves'.

(30) a. Yuehan zai nvhai zhiqian paodao zhongdian.

     John   at girl   before   run   finishing.line

     'John reached the finishing line before girls.'

   b. Yuehan zai Mali zhiqian paodao zhongdian.

     John   at Mary before   run   finishing.line

     'John reached the finishing line before Mary.'

(31) a. Feiji   fei-de   bi   niao kuai.

      airplane fly-DE than bird fast

      'Airplanes fly faster than birds.'

    b. Feiji   fei-de bi   gezi kuai.

      airplane fly-DE than dove fast

      'Airplanes fly faster than doves.'

We have established that the temporal operator *zai…zhiqian* 'before' and the comparative operator *bi* 'than' are downward entailing, but not anti-additive. This explains why *shenme* 'what' and *renhe* 'any' part company in sentences with these operators. Although the weak NPI *renhe* is licensed by both operators, the strong NPI *shenme* can function only as a question marker in the presence of these operators. Examples are provided in (32) and (33).

(32) a. Yuehan zai **shenme** ren   zhiqian paodao zhongdian?

      John   at   what person before   run   finishing.line

      'Whom did John reach the finishing line before?'

    b. Yuehan zai **renhe** ren   zhiqian paodao zhongdian.

       John   at any person before   run   finishing.line

      'John reached the finishing line before any other people.'

(33) a. Feiji   fei-de   bi   **shenme** niao kuai?

      airplane fly-DE than what   bird fast

      'Which bird do Airplanes fly faster than?'

b. Feiji   fei-de   bi **renhe** niao kuai.

   airplane fly-DE than any bird fast

   'Airplanes fly faster than any bird.'

Up to this point, we have made several observations. First, we observed that both *wh*-word *shenme* 'what' and *renhe* 'any' are interpreted as NPIs in anti-additive contexts. Although the *wh*-word *shenme* 'what' and the NPI *renhe* 'any' are both permitted in contexts that are downward entailing but not anti-additive, we observed that *shenme* functions as a question marker in such contexts, whereas *renhe* continues to be interpreted as an NPI. These observations led us to the following conclusion. The licensing operators for the *wh*-word *shenme* are a subset of those for *renhe*. For s*henme*, the licensor must be both downward entailing and anti-additive. For *renhe*, the licensor need only be downward entailing.

As far as we know, there has not been any previous empirical work demonstrating that Mandarin-speaking children or adults are aware of the intricate pattern involving the interpretation of *wh*-words and the interpretation of the NPI *renhe*. So, the experiments reported in Section 6 were design to investigate the linguistic knowledge of both Mandarin-speaking children and adults. The experiments were specifically designed to assess whether or not the participants know that, in anti-additive contexts, the *wh*-word *shenme* and the NPI *renhe* have the same meaning, whereas in contexts that are downward entailing but not anti-additive, the *wh*-word *shenme* is interpreted solely as a question marker, whereas *renhe* is interpreted as an NPI. Before we turn to the experiments, we briefly review relevant previous literature.

5. Children's comprehension of NPIs

English-speaking children have been found to adhere to the licensing conditions of the negative polarity item *any* (O'Leary and Crain 1994; Thornton 1995; Song 2003). In the

absence of negative evidence, children's knowledge of such 'negative' linguistic facts has been interpreted by several researchers as evidence for an innateness account of the acquisition of negative polarity items (cf. Crain 1991; Crain and Pietroski 2001, 2002; Marcus 1993; Pinker 1984). We will review some of the main findings.

Using a truth-value judgment task, O'Leary (1994) discovered that, by age four, English-speaking children appear to know that the NPI *any* is licensed in the subject phrase of sentences with the universal quantifier *every* or *all*, and in the predicate phrase of sentences with the focus operator *only*. In the O'Leary and Crain study, eleven children were presented with two types of target sentences. Sentences of both types were presented by a puppet, Kermit the Frog, following a short story. As it turned out, on the critical trials, Kermit's statements were incorrect descriptions of stories. The first type of trial is illustrated in (34). In trials of this kind, the test sentences that Kermit produced contained the negative determiner, *none*, and the NPI *anything*, e.g., *None of the Ninja Turtles got anything from Santa*. Because one of the Ninja Turtles did get a present from Santa in the story, children were expected to correct the puppet by producing an affirmative sentence. Since affirmative sentences are not downward entailing, children were not expected to repeat the NPI *anything* that Kermit used. Instead, children were expected to use the indefinite expression *something*, which is licensed in upward entailing linguistic contexts.

Type 1

(34) Story: One of the three Ninja turtles got a present from Santa.

Kermit: None of the Ninja Turtles got anything from Santa.

Child: *No, this one got something from Santa.*

The second type of test trial is illustrated in (35). Again, these sentences contained the NPI *anything*, but it appeared in the predicate phrase of a sentence with the focus operator *only,* as

in *Only one of the reindeer found anything to eat*. In the story, however, every reindeer found something to eat, so children were expected to replace the NPI *anything* in the Kermit's description of the story with the indefinite expression *something*, which is licensed in predicate phrase of the universal quantifier.

Type 2

(35) Story: All of the three reindeer found something to eat.

   Kermit: Only one of the reindeer found anything to eat.

   Child: *No, every reindeer found something to eat.*

Children had 88 chances to respond to the sentences with the NPI *anything*. Only once did any child's response contain a repetition of the NPI *anything*. The results show that, by four-years-old, English-speaking children are sensitive to the licensing conditions of the weak NPI *any*.

   Two previous studies have investigated children's knowledge of the licensing conditions for the non-interrogative use of *wh*-words in Mandarin Chinese. The first study was by Su, Zhou & Crain (2011) who investigated children's interpretation of the *wh*-word *shenme* 'what' in the predicate phrase of the negative quantificational expression *mei-you* 'not-have', comparing it with the interpretation of the same *wh*-word in the predicate phrase of *mei* 'every', which is not downward entailing. This study used a new experimental technique, which they called the Question-statement task. The task involved two experimenters. One acted out stories using toy characters and props, and the other played the role of a puppet that watched the stories alongside the subject. After each story, the puppet presented sentences like (36) and (37). The child subject then judged whether the puppet accurately described what happened in the story or, if the puppet asked a question about the story, the child was instructed to answer the question.

(36) Mei-you xiongmao chi shenme shuiguo.

    not-have panda   eat   what   fruit

    'None of the pandas ate any fruit.'

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

    every-CL panda   all eat-ASP what   fruit

    'What kind of fruit did every panda eat?

In (36), the *wh*-word *shenme* 'what' is in the predicate phrase of *mei-you xiongmao* 'none of the pandas'. This is an anti-additive context; therefore, it licenses the interpretation of the *wh*-word *shenme* as an NPI. For Mandarin adults, sentence (36) expresses a negative statement, meaning *None of the pandas ate any fruit*. By contrast, in (37), the *wh*-word *shenme* 'what' resides in the predicate phrase of the universally quantified phrase *mei-zhi xiongmao* 'every panda'. This is not a downward entailing linguistic context, so the *wh*-word *shenme* is interpreted as a question word by adult speakers, thereby rendering the sentence with a question reading, asking *What kind of fruit did every panda eat?*

The main finding was that children interpreted sentences like (36) as statements and interpreted sentences like (37) as questions 100% of the time. It provided evidence that Mandarin-speaking children have the knowledge that *wh*-word *shenme* 'what' has a non-interrogative reading in the predicate phrase of *mei-you* 'not-have' (an anti-additive operator) and turns into a question marker in the predicate phrase of *mei* 'every' (a non-downward entailing operator).

Using the same Question-statement task, a second study, by Zhou and Crain (2011), examined three-to-five-year-old Mandarin-speaking children's understanding of *wh*-word *shei* 'who' in the antecedent clause versus the consequent clause of a *dou*-conditional. It was found that children interpreted the *wh*-word *shei* 'who' as an NPI when it occurred in the

antecedent of a *dou*-conditional. And, children interpreted the *wh*-word *shei* as a question marker when it appeared in the consequent of a *dou*-conditional. The test sentences included (38) and (39).

(38) 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.'

(39) Eyu   qu yao xiaozhu, maotouying cunzhang   dou zhao-le   shei bangmang?

　　 crocodile go bite pig   owl   village.head all find-ASP who   help

　　 'Who did Mr. Owl ask for help when Mr. Crocodile went to bite Mr. Pig?'

In (38), the *wh*-word *shei* 'who' appears in the antecedent clause of the *dou*-conditional. This context is anti-additive and thus licenses *wh*-word *shei* 'who' as an NPI, making the sentence express a statement meaning *Whoever Mr. Crocodile went to bite, Mr. Owl asked Spiderman for help*. By contrast, in (39), when *wh*-word *shei* appeared in the consequent clause of the *dou*-conditional, which is not a downward entailing context, it is interpreted as a question marker. Consequently, (39) poses the question *Who did Mr. Owl ask for help when Mr. Crocodile went to bite Mr. Pig?* The results showed that children rejected the puppet's statements like (38) 88% of the time. In response to times like (39), children provided an answer to the question 100% of the time. This finding demonstrated that Mandarin-speaking children know that the non-interrogative *wh*-words are licensed in the antecedent clause of a conditional statement (an anti-additive context), but not in the consequent clause of a conditional (a non-downward entailing context).

6. Experiments

Based on previous findings, it appears that young children, across languages, know the licensing conditions for NPIs, including Mandarin *wh*-words. It has been found that Mandarin-speaking children assign non-interrogative interpretations to *wh*-words that appear in certain anti-additive environments (Su 2011; Zhou 2011). Moreover, Mandarin-speaking children know that the existential expression *renhe* 'any' is licensed in downward entailing contexts, including sentences with the temporal conjunction *zai...zhiqian* 'before' (Huang 2013).

There are unresolved issues, however. One issue has been called 'the diversity problem' by Israel (1996). The diversity problem (see Israel 1996) is concerned with the broad range of lexical items that count as polarity sensitive. It has been suggested that polarity expressions are as structurally and semantically diverse as the contexts that license them. For example, what counts as polarity items in a given language may include indefinite determiners, verbs, idioms, conjunctions, and aspectual adverbs. Moreover, not all items are sensitive to the same licensing environment, i.e., some polarity items are sensitive to one licensing environment, and others are sensitive to a different licensing environment. In the present study, we have tried to reduce some of the apparent diversity in the licensing conditions of two kinds of polarity sensitive expressions in Mandarin, *wh*-phrases and negative polarity items (NPIs). On the present analysis, the non-interrogative *wh*-word *shenme* 'what' is a strong NPI. As such, it only occurs in anti-additive contexts. In contrast, the existential expression *renhe* 'any' is a weak NPI, and is licensed in all downward-entailing (DE) contexts, not just ones that are anti-additive. The problem is how children figure out that different negative polarity items (NPIs) have different licensing conditions. Adopting a subset principle, the experimental hypothesis was that children should initially analyse all NPIs as strong, despite the fact that adult speakers distinguish strong and weak NPIs. By initially analysing all NPIs as strong, children will encounter positive evidence from

adult speakers informing them that some NPIs (i.e., weak NPIs) do not require Anti-additive licensors, but are able to be licensed in merely downward entailing linguistic environments.

We designed two experiments to investigate whether or not Mandarin-speaking children know that the weak NPI *renhe* 'any', but not the non-interrogative meaning of the *wh*-word *shenme* 'what' is licensed by the temporal operator *zai…zhiqian* 'before' as well as by comparative operators. Both experiments assessed children's interpretation of the *wh*-word *shenme* 'what' (a strong NPI) and the expistential expression *renhe* 'any' (a weak NPI). The test sentences in both experiments contained downward entailing operators, but not ones that were anti-additive.

Experiment 1 investigated Mandarin-speaking children's interpretation of the *wh*-word *shenme* 'what' and the NPI *renhe* 'any' in sentences with the temporal term *zai…zhiqian* 'before', which is downward entailing, but not anti-additive. The experiment contrasted minimal pairs of sentences like those in (40) and (41).

(40) Yazi zai shenme dongwu zhiqian youdao zhongdian?

    duck at what   animal before swim finishing.line

  'Which animal did the duck reach the finishing line before?'

(41) Yazi zai renhe dongwu zhiqian youdao zhongdian.

    duck at any animal before swim finishing.line

  'The duck reached the finishing line before any other animals.'

In (40), the *wh*-word *shenme* 'what' appears in the scope of the temporal term *zai…zhiqian* 'before'. Since *zai…zhiqian* 'before' is not anti-additive, we anticipated that participants would prohibit *shenme* from appearing within the scope of the temporal operator *zai…zhiqian* 'before.' Consequently, *shenme* should be analysed as a question marker. By contrast, we

anticipated that participants would permit the weak NPI *renhe* 'any' to be interpreted inside

the scope of *zai…zhiqian* 'before' in sentences like (41).

Experiment 2 was designed to assess whether Mandarin-speaking children also know

the disparate readings between the *wh*-word *shenme* and the NPI *renhe* when they appear in

sentences with a comparative operator. Comparative operators are also downward entailing,

but not anti-additive. In the present experiment, we chose the comparative *bi…xian* 'earlier

than'. A typical minimal pair of test sentences is given in (42) and (43). In (42), the *wh*-word

shenme 'what' appears in the scope of *bi…xian* 'earlier than' in the surface syntax. However,

because *bi…xian* 'earlier than' is downward entailing, but not anti-additive, we anticipated

that participants would interpret the *wh*-word *shenme* 'what' as a question marker. In (43), the

NPI *renhe* 'any' can appear within the scope of the comparative *bi…xian*, so the sentence

constitutes a statement.

(42) Zi-huoche   bi shenme huoche xian yun-wan   shitou?

purple- train than what   train   early carry-finish stone

'Which train did the purple train finish carrying stones earlier than?'

(43) Zi-huoche   bi renhe huoche xian yun-wan   shitou.

purple- train than any   train   early carry-finish stone

'The purple train finished carrying stones earlier than any other trains.'

6.1 Participants

In both experiments, we interviewed the same thirty Mandarin-speaking children. The child

subjects were between the ages of 3;10 and 5;2, with a mean age of 4;6. The children were

recruited from the kindergarten affiliated with Beijing Language and Culture University

(BLCU) in Beijing. In addition, forty Mandarin-speaking adults served as the control group. The adults were postgraduate students from BLCU.

6.2 Procedures

These experiments both used a Question-Statement task (Zhou and Crain 2009). In this task, the experimenter acted out stories in front of the child participant using toy characters and props. A puppet who appeared on a laptop computer screen watched the stories alongside the child. After each story, the puppet told the child participant what it thought had happened in the story, using one of test sentences. The test sentences were pre-recorded and presented through an external speaker of the laptop computer, to make it appear as if the puppet was talking. It was made clear to the child that sometimes the puppet didn't pay close attention to the story and thus was not sure about what happened. If that was the case, then the puppet would ask the child a question. Alternatively, the puppet would make an assertion, and the child's task was to judge whether or not the puppet 'said the right thing.'

If the child judged the puppet to be making a statement that was wrong, then the child was asked to explain what had really happened in the story. But if the puppet posed a question about the story, the child was instructed to answer the question and then ask the puppet to pay closer attention to the next story. Whenever the child subject judged that the puppet had said the 'right thing', the child rewarded the puppet a smile-face card. But if the child judged the puppet to have said the 'wrong thing', the child gave him a black cross. If the puppet didn't pay close attention, however, and asked a question, the child would give him a sad-face card. These procedures made it fun for children to play the game, and they encouraged children to attend to the test sentences.

The participants were introduced to the task individually and were tested individually. In order to familiarize children with the task, they were given four practice trials before the formal test session. On two of these practice trials, the puppet asked the child simple

questions with the *wh*-word *shenme* 'what', as in examples (44) and (45). These practice trials were included to verify that the child subjects could understand simple *wh*-questions. On the other two practice trials, the puppet produced the statements in (46) and (47). One was obviously true, and the other was obviously false. These trials were included to see whether subjects understand the expression *zai…zhiqian* 'before' and *bi* 'than' in simple statements. These practice trials were presented in a pseudo-random order. Only those child subjects who correctly distinguished between statements versus questions, and correctly judged the truth and falsity of the practice trials were permitted to proceed to the actual test session. On this basis, 4 of the 30 children were excluded. Two of them always said *Dui le.* 'Right.' to the practice trials, and 2 others experienced difficulty in understanding simple statements with *bi* 'than'. Adult controls were tested individually using the same task.

(44) Shenme dongwu shuaidao-le?

    what   animal fall.over-ASP

    'Which animal fell over?'

(45) Xiaomao chi-le   shenme?

    cat   eat-ASP what

    'What did the cat eat?'

(46) Xiaoxiong zai xiaozhu zhiqian shuizhao-le.

    bear   at pig   before fall.asleep-ASP

    'The bear fell asleep before the pig.'

(47) Xiongmao bi   daxiang gao.

    panda   than elephant tall

    'The panda is taller than the elephant.'

6.3 Materials

In each experiment, there were four test stories. Each story was about a competition among three characters. In each competition, one character came in first place, one came in second and one was last. At the end of the competition, the characters were rewarded according to their place in the competition (first, second or third). For each story, one test sentence contained the *wh*-word *shenme* 'what'. These will be called *shenme* sentences. Examples are given in (48) and (50). The other version of the test sentence contained *renhe* 'any', so these are called *renhe* sentences. Examples are given in (49) and (51).

(48) Yazi zai shenme dongwu zhiqian youdao zhongdian?

    duck at   what   animal before swim finishing.line

   'Which animal did the duck reach the finishing line before?'

(49) Yazi zai renhe dongwu zhiqian youdao zhongdian.

    duck at   any   animal before swim finishing.line

   'The duck reached the finishing line before any other animals.'

(50) Zi-huoche   bi   shenme huoche xian yun-wan   shitou?

    purple-train than what   train   early carry-finish stone

   'Which train did the purple train finish carrying stones earlier than?'

(51) Zi-huoche   bi   renhe huoche xian yun-wan   shitou.

    purple-train than any   train   early carry-finish stone

    'The purple train finished carrying stones earlier than any other trains.'

In the contexts associated with two of the four test sentences, the referent of the subject NP (e.g. the purple train) came first. We will call this the First-Place condition. The referent of the subject NP came second in the other two contexts, so we will call this the Second-Place condition. If children assign the correct interpretation of the weak NPI *renhe* 'any', then they were expected to judge (49) and (51) to be true descriptions of stories in the First-Place condition, but false descriptions of stories in the second-Place condition.

If children know the licensing conditions on strong NPI *shenme* 'what', then they should interpret all of the *shenme* trials as questions. In the Second-Place condition, the child was expected to refer to the third-place character, in answering the test sentence. In the First-Place condition, the child was expected to refer to both of the other characters. On the other hand, if children analysed the *wh*-word *shenme* as licensed by *zai…zhiqian* and *bi…xian*, then they would be expected to judge (48) and (50) to be statements in both conditions, and to provide appropriate true and false judgments. An example of a typical trial is as follows.

There are three trains in the station, the purple train, the blue train and the yellow train. Today, the stationmaster says to them: 'I have a new job for you. Everyone needs to transport three stones into the city. As a reward, the one who finishes the task first will get three gold coins; the one who finishes second will get two gold coins, and the last one will get a single coin.' The purple train takes three stones at one time. They are so heavy! But the purple train sticks it out and arrived in the city first. The yellow train says: 'I can make it like the purple train!' But these stones are so heavy that the carriage of the yellow train is broken! Too bad. A railroad worker comes to repair it. The blue train says:

'To be safe, I should take one stone first.' After unloading this stone, the blue train comes back and takes the other two stones. He finishes his work second. Finally, the yellow train has his carriage repaired and goes on to complete the job. When he arrives in the city, it was already dark. The stationmaster comes to check on the trains, he says: 'The purple train is first, so I reward you with three golden coins; the blue train is second, so you get two coins; and the yellow train is last, so you get just one coin.' (Figure 1 illustrates the scene at the conclusion of the story).

Fig.1. The last scene of the sample story

In each experiment, the child participants were divided into two groups. In Experiment 1, 13 child subjects and 10 adults were presented with the *shenme* sentences, and another group of 13 child subjects and 10 adults were presented with the *renhe* sentences. In Experiment 2, 13 children and 10 adults were presented with the *shenme* sentences, and the other 12 children[3]

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[3] In Experiment 2, one child was excluded due to experimenter error. The same group of children who heard the *shenme* sentences in one experiment also heard *shenme* sentences in

and 10 adults were presented with the *renhe* sentences. To control for prosody, the test sentences were pre-recorded. The recording was conducted in a sound-attenuated laboratory at Beijing Language and Culture University. The test sentences were produced by a female native speaker of Beijing Mandarin, who was asked to produce the test sentences using level intonation. In addition, the speaker was asked to produce the characters *shen* and *me* separately. Then, the two characters spliced together, to eliminate potential biases based on prosodic cues. [4]

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the other experiment. Likewise, the same group of children heard the *renhe* sentences in both experiments.

[4] *Wh*-words in Mandarin have both an interrogative interpretation and a non-interrogative interpretation. Typically, when *wh*-phrases are used as question markers, they receive stress and are associated with rising intonation. By contrast, when *wh*-phrases are used to make statements, they receive level intonation. Previous research has found that four- to five-year-old English-speaking children are not sensitive to such prosodic cues, however. For example, English-speaking children were unable to use such cues in resolving ambiguities that involved the focus particle *only* (Gualmini et al., 2002; Halbertet al., 1995). However, this was an off-line task. Using an on-line (eye-tracking) methodology, Zhou, Su, Crain, Gao and Zhan (2012) demonstrated that four- to five-year-old Mandarin-speaking children were sensitive to stress on-line, but were not able to incorporate this information into their final (off-line) response. Zhou, Su, Crain, Gao and Zhan (2012) also showed that four-year-old Mandarin-speaking children are sensitive to rising versus level intonation in deciding whether a wh-phrase is used as a question marker, or as a non-interrogative expression. They conclude that children are sensitive to intonational cues in resolving ambiguities that involve illocutionary force, but not in resolving structural ambiguities in sentences with the same illocautionary force. Based on the findings from previous research, the test sentences were pre-recorded using level intonation and the two characters *shen* and *me* were spliced into the test

In addition to the test trials, each subject witnessed four filler trials. On two of these filler trials, the puppet produced simple *wh*-questions. For example, in a long jump competition, the puppet produced the sentence *Shenme dongwu tiao de zui yuan?* 'Which animal jumped farthest?' On the other two filler trials, the puppet produced simple statements. In a car race, the puppet produced the sentence *Huang-qiche pao de zui kuai.* 'The yellow car ran fastest.' In total, the child subjects responded to eight items. The fillers were included to ensure that children were paying attention, to provide an equal number of questions and statements, and to provide an equal number of true and false statements. The experimental session took about 20 minutes, and was audio-recorded.

6.4 Results and discussion

The subjects' responses to the test sentences were recorded for subsequent analysis. All the subjects responded correctly to the filler trials, so we will report the results from Experiment 1, where the test sentences contained the temporal operator *zai…zhiqian* 'before'. The findings are graphically depicted in Figure 2. As this figure indicates, the adult controls judged the *renhe* sentences to be statements 100% of the time (40/40), and children judged the *renhe* sentences to be statements 96% of the time (50/52). There was no significant difference between the child group and the adult group (Mann-Whitney test, Z =0.877, p =.380). In response to the *shenme* sentences, adults always generated an interrogative interpretation, and children did so 92% of the time (47/51)[5] . A Mann-Whitney test showed that there was no significant difference between children and adults as well (Z =1.268, p = .205).

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snentences, to avoid providng the subjects with prosodic cues to the intended interpretation of the test sentences.

[5] The response to one test sentence of one child was excluded from the analysis, because he neither answered the question (if he judged it as a question) nor judged the truth or falsity of
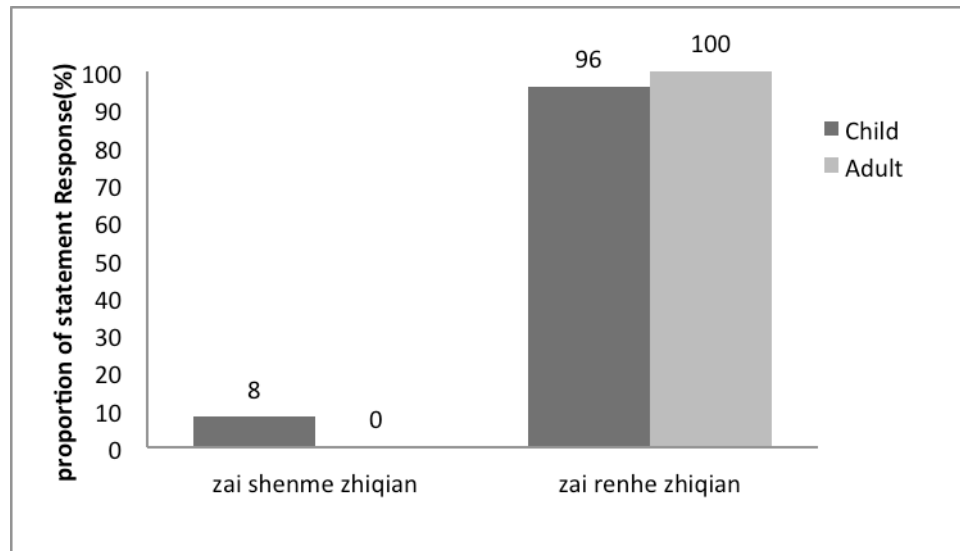
Figure 2: Proportion of statement responses in Experiment 1

This brings us to the findings from Experiment 2, with sentences containing *bi…xian* 'earlier than'. The results are summarized in Figure 3. As the figure indicates, both children and adults consistently judged sentences with *renhe* 'any' as statements. In response to sentences with *shenme* 'what', adults judged them to be questions 100% of the time, and children judged them to be questions 96% of the time (50/52 trials). There was no significant difference between the child group and the adult group (Mann-Whitney test, Z =0.877, p =.380).[6]

the test sentence (if he judged it as a statement). He just pointed to the puppet and said *Ta mei renzhen ting.* 'He didn't listen carefully.'

[6] The different patterns of judgements summarized in Fig. 2 and 3 were from different children. The children who were presented with the *shenme* sentences in Experiment 1 were presented with the *renhe* sentences in Experiment 2, and the children who were presented with the *renhe* sentences in Experiment 1 were presented with the *shenme* sentences in Experiment 2. In the *zai…zhiqian* 'before' contexts (Experiment 1), one child judged all the four *shenme* sentences as statements, and one child judged two of the four *renhe* sentences as
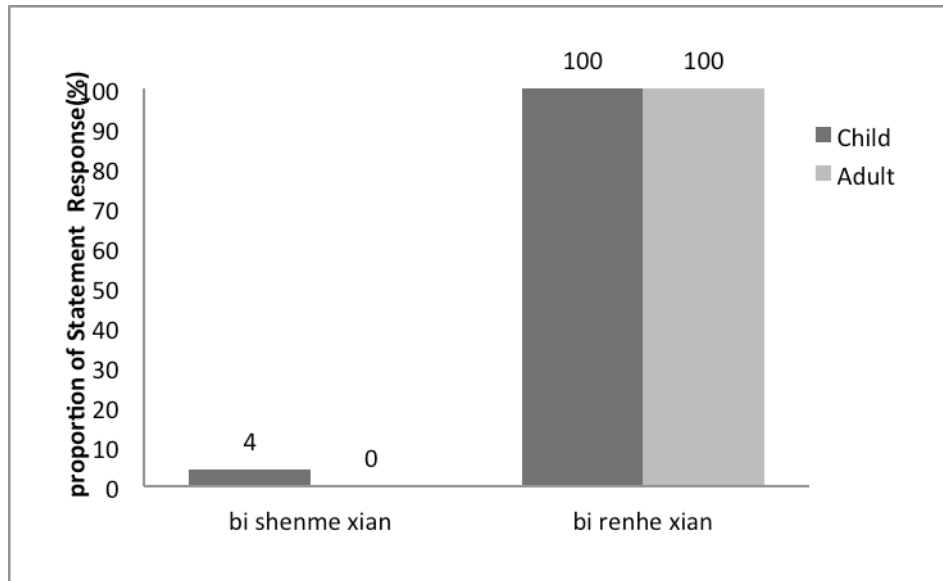
Figure 3: Proportion of statement responses in Experiment 2

In both experiments, children and adults consistently judged the *renhe* sentences to be true descriptions of stories in the First-Place condition, but false descriptions of stories in the Second-Place condition. In addition to overtly rejecting the *renhe* sentences in the Second-Place condition (saying *Cuo le.* 'Wrong.'), both children and adults pointed out that another character had come in first place. In the example story, children and adults rejected the puppet's statement in the Second-Place condition by referring to the fact that the purple train came in first.

When children and adults analysed the test sentences as questions in the Second-place condition, both groups responded with an answer that mentioned the character that came in last place in the competition. In the First-Place condition, adults produced the expected answer, which mentioned both of the other characters in the completion (e.g. *Lan-huoche he huang-huoche.* 'The blue train and the yellow train.'). In contrast to adults, children answered the puppet's question in one of two ways. Four of the 13 child subjects responded like adults,

questions. In the *bi…xian* 'earlier than' contexts (Example 2), a different child judged half of the four *shenme* sentences as statements.

and mentioned both of the other characters in the competition. Eight of the 13 child subjects [7] explicitly mentioned only one of the two other characters (e.g. *Lan-huoche.* 'The blue train.' or *Huang-huoche.* 'The yellow train.'). Only one character was mentioned in 16 of these children's responses; in 12 of these 16 responses, the character that was mentioned had come in second place. To conclude, both children and adults consistently generated an interrogative interpretation in response to the *shenme* sentences, and both groups judged *renhe* sentences to be statements. Children exhibited adult-like sensitivity to the different interpretations of *renhe* 'any' and the *wh*-word *shenme* 'what' in both downward entailing conditions. In short, Mandarin-speaking children know the distinction between strong NPIs and weak NPIs.

7. Conclusion

In previous research, Mandarin-speaking children (and adults) have been found to interpret *wh*-words such as *shenme* 'what' as being equivalent in meaning to the NPI *renhe* 'any'. The present study reported the findings of two experiments investigating Mandarin-speaking children's comprehension of the *wh*-word *shenme* 'what' in different linguistic contexts, where *shenme* and *renhe* did not turn out to be equivalent in meaning. One linguistic context consisted of sentences with the temporal operator *zai…zhiqian* 'before' (Experiment 1), and the other consisted of sentences with the comparative operator *bi…xian* 'earlier than' (Experiment 2). We found that *shenme* 'what' was not interpreted within the scope of these operators, and could only function as a *wh*-question marker in these contexts, despite the fact that the NPI *renhe* was licensed in the same sentences. More specifically, we found that three-to-five-year-old Mandarin-speaking children interpreted *shenme* 'what' as a *wh*-question marker in both contexts, whereas they interpreted the sentences with *renhe* 'any' as

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[7] One of the 13 children who was presented with the *shenme* sentences judged the sentences as questions 25% of the time and judged the sentences as statements 75% of the time.

statements. The same pattern was found for adults. We interpreted these findings as evidence for a distinction made in the theoretical literature between strong and weak NPIs. On this analysis, children know that *shenme* 'what' is a strong NPI and that *renhe* 'any' is a weak NPI. Both the strong NPI *shenme* and the weak NPI *renhe* are licensed in linguistic contexts that are downward entailing and anti-additive contexts, *salva veritate*. However, *shenme* can only function as a question marker in contexts that are downward entailing but not anti-additive. In these contexts, *shenme* functions solely as a question marker.

The remaining question is how children converge on the target language. It is worth asking, in this regard, whether there are relevant triggering data in the adult input to enable children to distinguish the difference between strong and weak NPIs. To address this question, we conducted a search of 52,554 parental utterances in three Mandarin corpuses on the Child Language Data Exchange System (CHILDES) database (the Beijing 2 corpus, the Zhou 1 and Zhou 2 corpuses) (MacWhinney 2000). We found no occurrences of *shenme* 'what' or *renhe* 'any' in sentences that contained either the temporal operator *zai...zhiqian* 'before' or the comparative operator *bi* 'than'. The absence of decisive input makes it unlikely that children learn the distinction between *shenme* 'what' and *renhe* 'any' based on a distributional analysis of the input data. We propose the following acquisition scenario. To avoid potential subset problems, children initially assume that both *wh*-words and *renhe* are strong NPIs. This means that, at the early stages of language acquisition, *wh*-words are question markers and *renhe* is not tolerated in linguistic contexts that are downward entailing, but not anti-additive, such as the ones investigated in the present study. On the basis of positive evidence (which is, apparently, not easy to come by), children witness adults using the NPI *renhe* in such contexts, so they change the value of *renhe* from a strong NPI to a weak NPI. However, they do not witness *wh*-words used in the same contexts to make statements, so they maintain their initial assignment of *wh*-words as strong NPIs. At this second stage, child and adult Mandarin have converged.

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Appendix 1

Test sentences used in Experiment 1 (the first four sentences are *shenme* sentences, sentences

(5-8) are *renhe* sentences)

(1) Yazi zai shenme dongwu zhiqian youdao zhongdian?

    duck at what animal before swim finishing.line

    'Which animal did the duck reach the finishing line before?'

(2) Shizi zai shenme dongwu zhiqian padao shuding?

    lion at what animal before climb tree.top

    'Which animal did the lion reach the top of the tree before?'

(3) Xiaozhu zai shenme dongwu zhiqian likai shamo?

    pig at what animal before leave desert

    'Which animal did the pig leave the desert before?'

(4) Daxiang zai shenme dongwu zhiqian paodao zhongdian?

    elephant at what animal before run finishing.line

    'Which animal did the elephant reach the finishing line before?'

(5) Yazi zai renhe dongwu zhiqian youdao zhongdian.

    duck at any animal before swim finishing.line

    'The duck reached the finishing line before any other animals.'

(6) Shizi zai renhe dongwu zhiqian padao   shuding.

   lion at any   animal before climb tree.top

   'The lion reached the top of the tree before any other animals.'

(7) Xiaozhu zai renhe dongwu zhiqian likai shamo.

    pig   at any   animal before   leave desert

   'The pig left the desert before any other animals.'

(8) Daxiang zai renhe dongwu zhiqian paodao zhongdian.

   elephant at any   animal before run   finishing.line

   'The elephant reached the finishing line before any other animals.'

Appendix 2

Children's responses on the Second-Place condition of the example trial, Experiment 1

Participant	Age	*Shenme* 'what' in sentence with *zai…zhiqian* 'before'
		Responses
Girl	4;2	The frog.
Boy	4;7	Pointing to the frog.
Girl	4;10	Before the frog.
Girl	4;9	The frog.
Boy	4;6	Before the frog.
Girl	4;11	Before the frog.
Boy	5;2	The frog.
Boy	4;9	Pointing to the frog
Girl	4;9	Wrong, the turtle is the first.
Boy	5;0	Before the frog.
Girl	4;10	Before the frog.
Girl	4;8	The frog.
Boy	4;10	Before the frog.

Participant	Age	*Renhe* 'any' in sentence with *zai…zhiqian* 'before'
		Responses
Girl	3;10	Wrong, the turtle reached first.
Girl	4;4	Wrong, the duck is the second.
Boy	4;7	Wrong, the turtle reached first.
Girl	4;9	Wrong, he is the first (pointing to the turtle), he is the second (pointing to the duck).

Boy	4;10	Wrong, the turtle reached first.
Boy	4;3	Wrong, the duck reached second.
Girl	4;10	Wrong, the turtle reached first.
Boy	4;1	Wrong, the turtle reached first.
Boy	5;0	Wrong, the duck is the second.
Girl	4;4	Wrong, the turtle is the first.
Girl	4;10	Wrong, the turtle reached first.
Boy	4;6	Wrong, the duck is the second.
Girl	4;9	Wrong, the turtle reached first.

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

(1) Qingwa.

   frog

  'The frog.'

(2) Zai qingwa zhiqian.

   at frog   before

  'Before the frog.'

(3) Cuo   le.

  wrong SFP

  'Wrong.'

(4) Wugui di-yi-ge dao.

   turtle   first-CL arrive

   'The turtle reached first.'

(5) Yazi di-er.

   duck second

   'The duck is the second.'

(6) Yazi di-er-ge   dao.

   duck second-CL arrive

   'The panda reached second.'

(7) Wugui di-yi.

   turtle   first

   'The turtle is the first.'

Appendix 3

Test sentences used in Experiment 2 (the first four sentences are *shenme* sentences, sentences

(5-8) are *renhe* sentences)

(1) Xiongmao bi shenme dongwu xian laidao xuexiao?

    panda   than what animal early arrive school

    'Which animal did the panda arrived at school earlier than?'

(2) Zi-huoche   bi shenme huoche xian yun-wan   shitou?

    purple-train than what   train   early carry-finish stone

    'Which train did the purple train finish carrying stones earlier than?'

(3) Xiaoma bi shenme dongwu xian chi-wan xiangchang?

    pony   than what   animal early eat-finish sausage

    'Which animal did the pony finish eating sausage earlier than?'

(4) Xiaoxiong bi shenme dongwu xian zhuodao yu?

    bear   than what   animal early catch   fish

    'Which animal did the bear catch the fish earlier than?'

(5) Xiongmao bi renhe dongwu xian laidao xuexiao.

    panda   than any animal early arrive school

    'The panda arrived at school earlier than any other animals.'

(6) Zi-huoche   bi   renhe huoche xian   yun-wan   shitou.

   purple-train than any   train   early carry-finish stone

   'The purple train finished carrying stones earlier than any other trains.'

(7) Xiaoma bi renhe dongwu xian chi-wan xiangchang.

   pony   than any   animal early eat-finish sausage

   'The pony finish eating sausage earlier than any other animals.'

(8) Xiaoxiong bi renhe dongwu xian zhuodao yu.

   bear   than any   animal early catch   fish

   'The bear caught the fish earlier than any other animals.'

Appendix 4

Children's responses on the First-Place condition of the example trial, Experiment 2

Participant	Age	*Shenme* 'what' in sentence with *bi…xian* 'earlier than'
		Responses
Girl	4;2	The blue train.
Boy	4;7	Pointing to the blue train and the yellow train.
Girl	4;10	Before the yellow train.
Girl	4;9	The blue train and the yellow train.
Boy	4;6	Pointing to the blue train
Girl	4;11	Before the blue train.
Boy	5;2	The blue train and the yellow train.
Boy	4;9	The yellow train.
Girl	4;9	The blue train and the yellow train.
Boy	5;0	Right.
Girl	4;10	The blue train.
Girl	4;8	Pointing to the blue train
Boy	4;10	The blue train.

Participant	Age	*Renhe* 'any' in sentence with *bi…xian* 'earlier than'
		Responses
Girl	3;10	Right.
Girl	4;4	Right.
Boy	4;7	Right.
Girl	4;9	Right.
Boy	4;10	Right.
Boy	4;3	Right.

Girl	4;10	Right.
Boy	4;1	Right.
Boy	5;0	Right.
Girl	4;4	Right.
Girl	4;10	Right.
Boy	4;6	Right.

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

(1) Lan-huoche.

　blue-train

　'The blue train.'

(2) Zai huang-huoche zhiqian.

　at　yellow-train　before

　'Before the yellow train.'

(3) Lan-huoche he huang-huoche.

　blue-train　and yellow-train

　'The blue train and the yellow train.'

(4) Zai lan-huoche zhiqian.

　at　blue-train　before

　'Before the blue train.'

(5) Huang-huoche.

  yellow-train

  'The yellow train.'

(6) Dui le.

  right SFP

  'Right.'

CHAPTER 3

Mandarin-speaking children's knowledge of

dou

Abstract

In Mandarin, *wh*-words have both interrogative and non-interrogative meanings. On its non-interrogative use, the *wh*-word *shenme* 'what' is similar in meaning to *renhe* (English *any*). The distributional pattern of the alternative interpretations of *wh*-words in Mandarin can be used to evaluate the influence of different linguistic contexts on semantic interpretation. In upward entailing contexts, *shenme* 'what' is only licensed as a question marker, and *renhe* 'any' is not tolerated. In linguistic contexts that are downward entailing, but not anti-additive, *shenme* and *renhe* are both licensed, but *shenme* is a question marker. In contexts that are both downward entailing and anti-additive, both *shenme* and *renhe* are licensed and both yield similar interpretations.

These distributional and interpretive properties are invoked in present study to investigate the semantic properties of the Mandarin quantificational expression *dou* 'all'. One of the main findings is that *dou* behaves like anti-additive operators, licensing both the non-interrogative meaning of the *wh*-word *shenme* 'what' and *renhe* 'any'. This is shown by Question-Statement Tasks employed to compare children's responses to sentences with the downward entailing (but not anti-additive) comparative expression *bi..xian*, both with *dou* (*bi...dou xian*) and without *dou* (*bi...xian*). The main finding was that children interpreted the *wh*-word *shenme* differently in these two linguistic contexts. In sentences with *dou*, children interpreted *shenme* as similar in meaning to *renhe* 'any.' By contrast, in sentences without *dou*, children interpreted *shenme* as a question marker. These findings demonstrate that, by age 4, Mandarin-speaking children know that *dou* licenses the non-interrogative meaning of *shenme*, whereas in sentences with *bi…xian* in which *dou* is not present in the structure, *shenme* is simply treated as a question marker.

1. Introduction

In Mandarin, *wh*-words such as *shenme* 'what' have both an interrogative interpretation and a non-interrogative interpretation. On the interrogative interpretation, *wh*-words are licensed by a covert *wh*-operator and yield *wh*-questions (Liao 2011). One linguistic environment that licenses the interrogative interpretation of the *wh*-word *shenme* is indicated in (1). The basic structure of the sentence in (1) is: *John reads _ book*. Although *wh*-words can fill the gap '_' position, the polarity sensitive item *renhe* 'any' is not tolerated in this position, as shown by the ungrammaticality of (2). We will refer to this pattern as Type I.

(1) Yuehan kan **shenme** shu?

    John   read what   book

    'What book does John read?'

(2) *Yuehan kan **renhe** shu.

    John read any book

    'John reads any book.'

There is another pattern, which we call Type II. In Type II sentences, *wh*-words like *shenme* are licensed by a certain class of non-*wh*-operators, as shown in (3a) and (4a). When *wh*-words like *shenme* are licensed by these operators, they do not receive an interrogative interpretation (cf. Cheng 1991, 1994; Huang 1982a; Li 1992a; Lin 1996, 1998; Liao 2011). For example, in (3a), the *wh*-word *shenme* appears in the scope of the negative quantificational expression *mei-you* 'not-have'. In example (4a), *shenme* appears in the antecedent of a conditional statement. In contrast to example (2), examples (3b) and (4b)

demonstrate that the polarity sensitive item *renhe* 'any' is permitted in both of these linguistic environments.

(3) a. Mei-you xuesheng mai **shenme** shu.

    not-have student buy what book

  'No student bought any book.'

  b. Mei-you xuesheng mai **renhe** shu.

    not-have student buy any book

  'No student bought any book.'

(4) a. Ruguo you **shenme** ren   qifu   ni, qing gaosu wo.

    if   have what   person bully you please tell   me

  'If anybody bullies you, please let me know.'

  b. Ruguo you **renhe** ren   qifu   ni, qing gaosu wo.

    if   have any person bully you please tell   me

  'If anybody bullies you, please let me know.'

Both of the sentences in (3) and in (4) have the same meaning; that is, the *wh*-word *shenme* has the same interpretation as *renhe*. For this reason, the meaning of the *wh*-word *shenme* 'what' and the polarity sensitive item *renhe* 'any' have both been analysed as existential expressions, i.e., ∃-items (cf. Jackendoff 1972; Hamblin 1973; Karttunen 1977; Jayaseelan 2001; Chierchia 2006, 2010; Fox 2007; Liao 2011). One of the aims of the present paper is to explain why the quantificational expression *dou* (roughly English *all*) licenses both ∃-items,

that is, the polarity sensitive item *renhe* 'any' and the non-interrogative interpretation of the *wh*-word *shenme* 'what'.

Despite considerable overlap in the distribution of the *wh*-word *shenme* and the polarity sensitive item *renhe*, certain linguistic contexts reveal a difference. In contrast to the class of linguistic operators that license both *renhe* 'any' and the non-interrogative interpretation of *wh*-words, another class of linguistic operators licenses *renhe*, but only the interrogative interpretation of *wh*-words. For example, both the *wh*-word *shenme* and *renhe* are permitted in sentences with *bi ... xian* 'earlier than' (a comparative adjective), as in (5). Both the *wh*-word *shenme* and *renhe* are also permitted in sentences with the temporal operator *zai...zhiqian* 'before,' as shown in (6). However, in contrast to examples (3) and (4), the *wh*-word *shenme* can only function as a question marker in the linguistic contexts in (5) and in (6); *wh*-words can only be assigned an interrogative interpretation. So, the comparative adjective *bi ... xian* 'earlier than' and the temporal conjunction *zai...zhiqian* 'before' must somehow be distinguished from the negative existential *mei-you* 'no' and the antecedent of conditional statements, where both *shenme* and *renhe* are licensed, and both are assigned a similar semantic interpretation. We call this third linguistic environment Type III.

(5) a. Yuehan bi **shenme** xuesheng xian dao?

    John   than what   student   early arrive

    'Which student did John arrive earlier than?'

    b. Yuehan bi **renhe** xuesheng xian dao.

    John   than any   student   early arrive

    'John arrived earlier than any other students.'

(6) a. Yuehan zai **shenme** ren   zhiqian dao?

     John   at   what   person before arrive

     'Who did John arrive before?'

  b. Yuehan zai **renhe** ren   zhiqian dao.

     John   at   any   person before arrive

     'John arrived before anybody.'

So far, we have observed three patterns of linguistic behaviour. In Type I linguistic contexts, *wh*-words are licensed, but *renhe* 'any' is not tolerated. In these linguistic contexts, *wh*-words can only serve as question markers (see examples (1) and (2)). In Type II linguistic contexts both *wh*-words and *renhe* are licensed, and both are interpreted as Negative Polarity Items (NPIs) (see examples (3) and (4)). In Type III linguistic contexts, both *wh*-words and *renhe* are admissible, but *wh*-words serve as question markers, whereas *renhe* 'any' is analysed as an NPI (see examples (5) and (6)).

Type I: *Wh*-words are licensed, but only as question markers, and NPIs are not licensed.

Type II: *Wh*-words and NPIs are both licensed, and both serve as NPIs.

Type III: *Wh*-words and NPIs are both licensed, *wh*-words are question markers.

In order to distinguish among these three linguistic contexts, we will draw upon two formal semantic distinctions, which we discuss in more detail in the next section. The first distinction is between upward versus downward entailing linguistic contexts. Type I sentences, such as (1) and (2), are representative of the linguistic behavior of Mandarin *wh*-words and existential expressions like *renhe* 'any' in upward entailing linguistic contexts. By contrast, Type II and Type III contexts are both downward entailing. There is a difference, however. Type II

linguistic contexts are both downward entailing and anti-additive, whereas Type III are downward entailing but not anti-additive. These formal semantic distinctions can be invoked to explain the observed differences in the linguistic behavior of Mandarin *wh*-words and *renhe*.

Type I: Upward entailing

Type II: Downward entailing and anti-additive

Type III: Downward entailing, but not anti-additive

The remainder of the paper is organized as follows. First we introduce some basic facts about the licensing conditions of the *wh*-word *shenme* 'what' and *renhe* 'any'. Then we provide evidence that the quantificational expression *dou* behaves like the class of linguistic expressions that also contains the negative existential *mei-you* 'no' and the antecedent of conditionals. That is, the quantifier *dou* is a Type II linguistic context; *dou* is like a both downward entailing and anti-additive operator. This brings us to the main topic – Mandarin-speaking children's understanding of the semantic properties of the quantificational adverb *dou*. In particular, we are interested to find out if Mandarin-speaking children know that *dou* licenses *renhe* 'any' as well as the non-interrogative interpretation of *wh*-words.

Before we turn to the experiments, we will review previous research on children's comprehension of NPI-licensing contexts. This is followed by a report of two experiments designed to investigate children's comprehension of the *wh*-word *shenme* and *renhe* 'any' in the scope of *dou*. These experiments take advantage of the distinctions introduced in the introduction. We compare children's interpretation of the *wh*-word *shenme* and *renhe* 'any' in two linguistic contexts. First, we present the *wh*-word *shenme* and *renhe* 'any' to children in sentences with downward entailing, but not anti-additive, operator *bi…xian* 'earlier than.'

Second, we present the *wh*-word *shenme* and *renhe* 'any' to children in sentences with *bi…dou xian* 'earlier than all'. If children know the distinction between Type II and Type III contexts, they should interpret the *wh*-word differently in these two linguistic contexts. In sentences with *dou*, children should interpret the wh-word *shenme* as similar in meaning to *renhe* 'any'. By contrast, in sentences with *bi…xian* 'earlier than,' children should interpret the *wh*-word *shenme* as a question marker.

2. NPI-licensing contexts

We will refer to contexts that license negative polarity items (NPIs) such as English *any* as NPI-licensing contexts. An important observation is that not all NPIs are licensed in all NPI-licensing contexts (Zwarts 1981; van der Wouden 1997; Blaszczak 2001). For instance, *at most n* and the negative existential expression *no* are both NPI-licensors, as evidenced by (7a) and (8a). As these examples show that both the numerical phrase *at most n* and the negative existential *no* license the Negative Polarity reading of *any*. But the NPI *yet* is not licensed by *at most n*, as illustrated in (7b), although *yet* is acceptable in sentences with the negative existential *no,* as illustrated in (8b).

(7) a. At most five professors have talked about any of these facts.

   b. *__At most five__ professors have talked about these facts yet.

(8) a. No student has talked about any of these facts.

   b. __No__ student has talked about these facts yet.

The difference between *at most* and *no* indicates that not all NPI-licensing contexts are equal. This difference led Van der Wouden (1997) to conclude that some NPI-licensing contexts are 'stronger' than others. For example, the negative existential *no* is somehow stronger licensors than *at most n*, since *at most n* cannot license the NPI *yet*. The intuition is that NPI-licensing contexts vary according to their strength, roughly the number of entailments that they generate.

These properties were used to construct a hierarchical typology of NPI-licensing contexts by Zwarts (1998). According to this hierarchy, there are (at least)[8] two classes of NPI licensors. These classes can be distinguished according to the number of de Morgan's laws they validate. The more of de Morgan's laws a given expression satisfies, the stronger it is (Zwarts 1996; Van der Wouden 1997; Jespersen 1917). Two levels of strength are relevant for present purposes. These are NPI-licensing contexts known as downward entailing and ones known as anti-additive. The hierarchy is shown in Figure 1, with English examples. Figure 1 also illustrates the relationship between the two properties of downward entailment and anti-additivity.

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[8] Zwarts (1998) distinguishes a third level of NPI-licensing strength, called anti-morphic. A function f is antimorphic if it generates the following two logical equivalences: $f(X \wedge Y) \Leftrightarrow f(X) \vee f(Y)$ and $f(X \vee Y) \Leftrightarrow f(X) \wedge f(Y)$. The three levels of NPI-licensing strength stand in a subset-superset relation. From strongest (subset) to weakest are (a) anti-morphic operators, which are both anti-additive and downward entailing, (b) anti-additive operators, which are downward entailing, and (c) downward entailing operators.
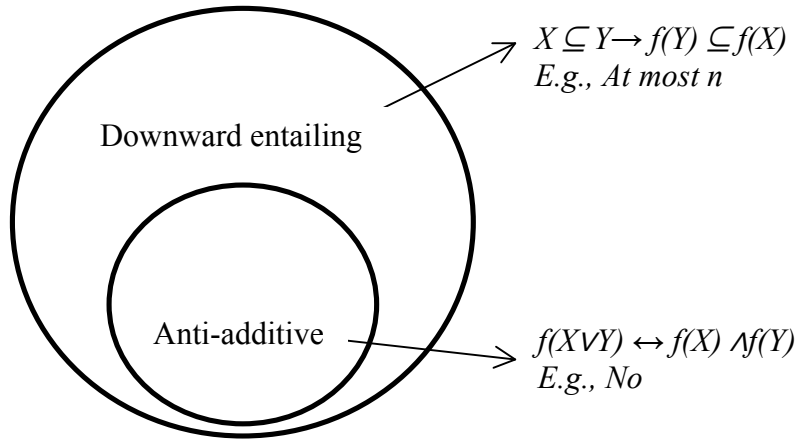
$X \subseteq Y \rightarrow f(Y) \subseteq f(X)$
E.g., At most n

$f(X \lor Y) \leftrightarrow f(X) \land f(Y)$
E.g., No

Figure 1. NPI-licensing contexts

Downward entailing contexts that are also anti-additive are said to be 'strong,' whereas merely downward entailing contexts are said to be 'weak.' By definition, downward entailing (DE) contexts license inferences from general terms (terms that refer to sets) to specific terms (terms that refer to subsets of those sets) (Ladusaw 1980). To illustrate, *at most n* is downward entailing. Consider the statement *At most five fish escaped.* This statement contains the general term *fish*. Because the expression *at most n* is downward entailing*,* the set-referring term *fish* can be replaced by the subset-referring term *salmon* without altering the truth of the original statement, i.e., *salva veritate.* So, if the statement *At most five fish escaped* is true, it follows (logically) that the statement *At most five salmon escaped* is true.

It is easy to see that the negative existential *no* is also downward entailing, because sentences with *no* also validate inferences from sentences with set-referring terms to ones with subset-referring terms, as illustrated in example (9). Clearly if (9a) is true, then so is (9b).

(9) a. No student eats fish.

   b. No student eats salmon.

Formally, a function f is anti-additive if it generates the following logical equivalence: $f(A \lor B) \Leftrightarrow f(A)\ \&\ f(B)$. Anti-additivity is a logical equivalence. In one member of the equivalence, conjunction takes scope over both occurrences of some relevant logical operator, Op. We can render this symbolically as Op(A) & Op(B). In the other member of the equivalence, the operator, Op, takes scope over disjunction: Op(A v B). We can use this equivalence to determine which linguistic expressions are anti-additive in human languages.

Example (10) indicates that the negative existential *no* is anti-additive. Anyone who regards (10a) as true must also accept the truth of (10b), and vice versa.

(10) a. No student drank beer or wine.

   b. No student drank beer and no student drank wine.

Example (11) shows that the logical expression *at most n* is not anti-additive. Although (11a) entails (11b), the reverse does not hold.

(11) a. At most five students drank beer or wine.

   b. At most five students drank beer and at most five students drank wine.

To see that (11b) does not entail (11a), suppose that (11b) is a true description of a situation in which five students drank beer and a different five students drank wine. In this situation, ten students are being referred to by (11b). In the same situation, however, (11a) is false, because this sentence can only be true if no more than five students either drank beer or drank wine. Although *at most n* is downward entailing, it is not anti-additive, whereas the negative

existential *no* is both. More generally, any function that is anti-additive is downward entailing, but not *vice versa*.

According to the compatibility with these two contexts, NPIs are classified into two types (weak and strong) (Hoeksema 1996; Giannakidou 1998; Van der Wouden 1997): *any* is a weak NPI and *yet* is a strong NPI. The compatibility of NPIs with the two types of NPI-licensing contexts is illustrated in Table (1), where '√' denotes grammaticality and '*' ungrammaticality. An anti-additive licensor is indicated by assigning the [+AA] value, and the lack of anti-additivity is indicated by assigning the [-AA] value.

Table 1. The compatibility of NPIs with NPI-licensing contexts

Type of NPI-licensing contexts	Type of NPIs	
	Strong	Weak
Merely Downward Entailing [-AA]	*	√
Anti-additive [+AA]	√	√

The NPI-licensing operator with the [+AA] value ($O_{[+AA]}$) is both downward entailing and anti-additive. The NPI-licensing operator with the [-AA] value ($O_{[-AA]}$) is downward entailing but not anti-additive. Table 1 shows that the $O_{[+AA]}$ licenses both strong and weak NPIs, whereas the $O_{[-AA]}$ only licenses weak NPIs.

3. NPI-licensing contexts in Mandarin

In Mandarin, both the negative existential expression *mei-you* 'not-have' and the antecedent of conditionals are anti-additive. As we saw, in order to be anti-additive, there must be a logical equivalence between two formulas. In one, conjunction takes scope over both occurrences of a logical operator, $O_{[+AA]}$. This can be represented as $O_{[+AA]}$ (A) & $O_{[+AA]}$ (B).

In the second formula, the operator Op takes scope over disjunction. This can be represented as $O_{[+AA]}(A \lor B)$. So an anti-additive operator, $O_{[+AA]}$, is one that satisfies the following biconditional formula:

$$O_{[+AA]}(A) \,\&\, O_{[+AA]}(B) \Leftrightarrow O_{[+AA]}(A \lor B).$$

First consider the negative existential expression *mei-you* 'not-have'. When the Mandarin disjunction operator *huozhe* 'or' appears in the scope of the negative existential *mei-you* 'not-have' as in (12a), it generates the conjunctive entailment in (12b) (where conjunction *bingqie* 'and' takes scope over both of the negative sentences *Mei-you xuesheng he pijiu* 'No student drank beer.' and *Mei-you xuesheng he hongjiu* 'No student drank wine.'). Example (12b) also entails (12a). The logical equivalence of (12a) and (12b) means that the negative existential expression *mei-you* 'not-have' is anti-additive.

(12) a. Mei-you xuesheng he   pijiu huozhe hongjiu.

    not-have student   drink beer or   wine

    'No student drank beer or wine.'

   b. Mei-you xuesheng he   pijiu bingqie mei-you xuesheng he hongjiu.

    not-have student   drink beer and   not-have student   drink wine

    'No student drank beer and no student drank wine.'

Next consider the antecedent of conditional statements. Example (13) shows that when the disjunction operator *huozhe* 'or' appears in the antecedent of a *ruguo*-conditional ('if'-conditional) as in (13a), it entails the conjunctive statement in (13b). In example (13b), the conjunction operator *bingqie* 'and' takes scope over both of the conditionals *Ruguo Yuehan*

chi huasheng, ta jiu hui shengbing 'If John eats peanuts, he will be ill' and *Ruguo Yuehan*

chi yu, ta jiu hui shengbing. 'If John eats fish, he will be ill'). Example (13b) also entails

(13a). This shows that the antecedent of a conditional statement is anti-additive.

(13) a. Ruguo Yuehan chi huasheng huozhe yu, ta jiu   hui shengbing.

    if   John   eat peanut   or   fish he then will ill

  'If John eats peanuts or fish, he will be ill.'

   b. Ruguo Yuehan chi huasheng, ta jiu hui shengbing; bingqie ruguo yuehan chi yu, ta

    if   John   eat peanut he then will ill   and   if   John   eat fish he

    jiu   hui shengbing.

    then will ill

    'If John eats peanuts, he will be ill and if John eats fish, he will be ill.'

So far, we have determined that anti-additive and (merely) downward entailing operators

stand in a subset-superset relation, and that the negative existential expression *mei-you* 'not-

have' and the antecedent of conditionals are anti-additive. It follows that *mei-you* 'not-have'

and the antecedent of conditionals are also downward entailing. This is verified, using the

defining characteristic of downward entailment, in examples (14) and (15). These examples

show that the set-referring term *yu* 'fish' can be replaced by the corresponding subset-

referring term *sanwenyu* 'salmon' in both sentences, without altering the truth-value (i.e.,

salva veritate).

(14) a. Mei-you xuesheng chi yu.

    not-have student   eat fish

    'No student eats fish.'

b. Mei-you xuesheng chi sanwenyu.

not-have-student   eat salmon

'No student eats salmon.'

(15) a. Ruguo Yuehan chi yu, ta jiu hui shengbing.

if   John   eat fish he then will ill

'If John eats fish, he will be ill.'

b. Ruguo Yuehan chi sanwenyu, ta jiu hui shengbing.

if   John   eat salmon   he then will ill

'If John eats salmon, he will be ill.'

We will show next that neither the Mandarin comparative operator *bi…xian* 'earlier than' nor the temporal operator *zai…zhiqian* 'before' are anti-additive, although both are downward entailing. First consider the comparative operator *bi…xian* 'earlier than'. Example (16a) shows that *bi…xian* 'earlier than' does not take scope over disjunction *huozhe* 'or'. Instead, disjunction takes scope over *bi…xian* 'earlier than'. Mandarin adults judge (16a) to mean that 'John arrived earlier than Mary *or* John arrived earlier than Tom.' So (16a) is true in three circumstances, where (i) John arrived earlier than Mary but not Tom, or (ii) John arrived earlier than Tom but not Mary, or (iii) John arrived earlier than both Mary and Tom. This means that (16a) can be true in two of the circumstances that falsify (16b). Therefore, the comparative *bi* 'than' is not anti-additive.

(16) a. Yuehan bi Mali huozhe Tangmu xian   dao.

John   than Mary or   Tom   earlier arrive

'It's Mary or Tom (and possibly both) that John arrived earlier than.'

b. Yuehan bi Mali xian   dao bingqie Yuehan bi Tangmu xian   dao.

   John than Mary earlier arrive and   John   than Tom   early arrive

   'John arrived earlier than Mary and John arrived earlier than Tom.'

The temporal operator *zai…zhiqian* 'before' is also not anti-additive. This is shown in example (17). The problem lies with (17a). As can be seen from the English translation, *zai…zhiqian* 'before' does not take scope over disjunction in (17a). Instead, disjunction takes scope over *zai…zhiqian* 'before'. This means that example (17b) entails (17a), but (17a) does not entail (17b). Hence, the temporal operator *zai…zhiqian* 'before' is not an anti-additive operator.

(17) a. Yuehan zai Mali huozhe Tangmu zhiqian laidao xuexiao.

      John   at Mary or   Tom   before arrive school

      'It's Mary or Tom (and possibly both) that John arrived at school before.'

   b. Yuehan zai Mali zhiqian laidao xuexiao bingqie Yuehan zai Tangmu zhiqian laidao

      John   at Mary before arrive   school   and   John   at Tom   before   arrive

      xuexiao.

      school

     'John arrived at school before Mary and John arrived at school before Tom.'

Although the comparative operator *bi…xian* 'earlier than' and the temporal operator *zai…zhiqian* 'before' are not anti-additive, both are downward entailing. Examples (18) and (19) show that these operators validate inferences from sentences that contain the set-referring term *nvhai* 'girls' to ones that contain the subset referring term *Mali* 'Mary'.

(18) a. Yuehan bi   nvhai xian dao.

   John   than girl early arrive

   'John arrived earlier than girls.'

   b. Yuehan bi   Mali xian dao.

   John   than   Maryearly arrive

   'John arrived earlier than Mary.'

(19) a. Yuehan zai nvhai zhiqian laidao xuexiao.

   John   at girl   before arrive school

   'John arrived at school before girls.'

   b. Yuehan zai Mali zhiqian laidao xuexiao.

   John   at Mary before   arrive school

   'John arrived at school before Mary.'

We have established that the negative existential expression *mei-you* 'not-have' and the antecedent of conditionals are both downward entailing and anti-additive [+AA]; whereas the comparative operator *bi…xian* 'earlier than' and the temporal operator *zai…zhiqian* 'before' are downward entailing but not anti-additive [-AA]. The *wh*-word *shenme* 'what' and the Negative Polarity Item (NPI) *renhe* 'any'[9] part company in sentences with the two types of operators. Examples (20) and (21) (previous examples (3) and (4)) show that in sentences with $O_{[+AA]}$, the *wh*-word *shenme* 'what' and *renhe* 'any' are both licensed, and both are analysed as NPIs (Cheng 1991, 1994; Huang 1982b; Li 1992; Lin 1996, 1998).

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[9] Later we will see that *renhe* 'any' also has a 'free choice' reading. For now, we limit the discussion to its Negative Polarity interpretation.

(20) a. Mei-you[+AA] xuesheng mai **shenme** shu.

        not-have   student buy what book

    'No student bought any book.'

   b. Mei-you[+AA] xuesheng mai **renhe** shu.

      not-have   student buy any book

    'No student bought any book.'

(21) a. Ruguo[+AA] you **shenme** ren   qifu ni, qing   gaosu wo.

      if   have what person bully you please tell   me

    'If anybody bullies you, please let me know.'

   b. Ruguo[+AA] you **renhe** ren   qifu   ni, qing gaosu wo.

      if   have any person bully you please tell me

    'If anybody bullies you, please let me know.'

However, in sentences with O[-AA], as illustrated in examples (22) and (23) (repeated from examples (5) and (6)), the *wh*-word *shenme* 'what' and NPI *renhe* 'any' are both licensed, here *wh*-word *shenme* can only function as a question marker.

(22) a. Yuehan bi[-AA] **shenme** xuesheng xian dao?

      John than   what   student   early arrive

     'Which student did John arrive earlier than?'

b. Yuehan bi[-AA] **renhe** xuesheng xian dao.

   John   than   any student   early arrive

   'John arrived earlier than any other students.'

(23) a. Yuehan zai[-AA] **shenme** ren   zhiqian dao?

   John   at   what   person before arrive

   'Who did John arrive before?'

b. Yuehan zai[-AA] **renhe** ren   zhiqian dao.

   John   at   any   person before arrive

   'John arrived before anybody.'

Let us summarize some of the observations we have made. First, anti-additive operators license both the *wh*-word *shenme* 'what' and the NPI *renhe* 'any'. In this kind of linguistic context, *shenme* and *renhe* generate the same NPI interpretation, and in this kind of linguistic context, the Mandarin disjunction word *huozhe* 'or' receives a conjunctive interpretation. The second observation is that downward entailing, but not anti-additive, operators license both the interrogative interpretation of *shenme* 'what' and *renhe* 'any'. *Shenme* functions as a question marker in such contexts, whereas *renhe* is interpreted as an NPI. Nevertheless, the disjunction word *huozhe* 'or' continues to generate a disjunctive interpretation.

Let us recap. In upward entailing contexts, *shenme* 'what' is licensed as a question marker while *renhe* 'any' is not licensed. The compatibility of *shenme* 'what', *renhe* 'any' and *huozhe* 'or' with the three different types of linguistic contexts is illustrated in Table (2)

Table 2. *Shenme* 'what', *renhe* 'any' and *huozhe* 'or' in different linguistic contexts

Linguistic contexts	*Shenme* 'what'	*Renhe* 'any'	*Huozhe 'or'*
Upward entailing	Question	*	Disjunctive
Merely Downward Entailing [-AA]	Question	NPI	Disjunctive
Anti-additive [+AA]	NPI	NPI	Conjunctive

4. Mandarin *dou*

Mandarin *dou* is an adverbial quantifier that has been the topic of extensive theoretical research (cf. Huang 1982, 1983; Lee 1986; Yeh 1986; Sportiche 1988; Liu 1990; Chiu 1993; Cheng 1995; Li 1995; Huang 1996; Liao 2011). Despite continuing controversy about the syntax and semantics of *dou*, there is general agreement about certain of its properties. It is generally agreed that *dou* is a distributive universal quantifier that quantifies over plural expressions to its left (Huang 1982b; Cheng 1995; Lee 1986; Yeh 1986; Pan 2006). Consider the sentences (24) and (25). In (24), without *dou*, the sentence means that they, as a group, collectively bought a house. The sentence is true even if one or two members in the group did not contribute to the purchase. In (25), by contrast, *dou* quantifies over the entire set of individuals, giving the sentence a distributive reading. Thus sentence (25) means that each of the relevant individuals bought their own house.[10] The sentence is false if even a single individual failed to purchase a house.

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[10] *Dou* behaves somewhat differently form English *each*, but the differences are not critical to our study. For a useful discussion of the differences between *dou* and *each*, see Xiang (2008).

(24) Tamen mai-le   yi-dong   fangzi.

    they   buy-ASP one-CL   house

   'They bought a house (collectively).'

(25) Tamen dou mai-le   yi-dong   fangzi.

    they   all buy-ASP one-CL   house

   'They bought a house (individually).'

The second observation to note is that *dou* requires the preceding anaphoric expression to be plural. The sentence (26) is ungrammatical, because the only expression that precedes *dou* is a singular noun. [11]

(26) *Yuehan dou mai-le   yi-dong   fangzi.

    John   all buy-ASP one-CL   house

   'John all bought a house.'

The third observation is that quantificational expression *dou* is downward entailing. To see this, we draw your attention to the validity of the inference from the truth of sentence (27a), with the general term *yu* 'fish', to the truth of sentence (27b), with the specific term *sanwenyu* 'salmon'.

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[11] In this case, *dou* can only rendered as similar in meaning to English *even*. So, *dou* in (26) convey takes that John was the least likely person to buy a house. In (25), to assign a reading that they collectively bought a house, the meaning of *dou* must be shifted to the even-like one. In that case, (25) means that <u>even </u>they bought a house.

(27) a. Yuehan yu dou maiwan-le.

    John   fish all sell.out-ASP

   'John sold out all the fish.'

  b. Yuehan sanwenyu dou maiwan-le.

    John   salmon   all sell.out-ASP

   'John sold out all the salmon.'

We have seen that the operators that are both downward entailing and anti-additive license both the *wh*-word *shenme* 'what' and the polarity sensitive expression *renhe* 'any' and, when licensed in such contexts, both *shenme* and *renhe* have the same existential (NPI) reading. We have also seen that, when the disjunction word *huozhe* 'or' appears in such contexts, it receives a conjunctive interpretation. Symbolically, this can be cast as the '¬∃' interpretation.[12]

The polarity sensitive expression *renhe* 'any' and the disjunction word *huozhe* 'or' are assigned a different interpretation in sentences that contain modals. Consider sentence (28), for example. In example (28), the polarity sensitive *renhe* 'any' is licensed by the modal *keyi* 'can'. The speaker of (28) is asserting that John has been given permission to drink all kinds of alcohol. In this context, *renhe* 'any' has universal force, and does not, at first glance,

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[12] Disjunctions are also logically equivalent to existential quantified items, i.e., ∃-items (cf. Chierachia 2013; Jayaseelan 2001; Rooth and Partee 1982). Therefore, the *wh*-word *shenme* 'what', the polarity sensitive expression *renhe* 'any' and the disjunctive word *huozhe* 'or' are all ∃-items, and are logically equivalent to each other in a finite domain (cf. Chierchia 2010; Liao 2011).

appear to be an ∃-item. This interpretation of *renhe* 'any' is called a 'free choice' reading, to accord with the intuition that John is free to choose what alcohol to drink. If the modal *keyi* 'can' is removed, as in (29), the sentence becomes ungrammatical, because there is no licensor.

(28) Yuehan keyi he   renhe jiu.

    John can drink any   alcohol

    'John can drink any alcohol.'

(29) *Yuehan he   renhe jiu.

    John   drink any   alcohol

    'John drinks any alcohol.'

Next consider sentence (30a), which combines the modal *keyi* 'can' and the disjunction word *huozhe* 'or'. The sentence is true in three circumstances, (i) if John can drink beer but not wine, (ii) if John can drink wine but not beer, or (iii) if John can drink both beer and wine. When the Mandarin conjunction word *bingqie* 'and' is introduced, as in (30b), a conjunctive inference is generated, meaning that John can drink both beer and wine.

(30) a. Yuehan keyi he   pijiu huozhe hongjiu.

    John   can drink beer   or   wine

    'John can drink beer or wine.'

  b. Yuehan keyi he   pijiu bingqie yuehan keyi he hongjiu.

    John   can drink beer   and   John   can drink wine

    'John can drink beer and John can drink wine.'

If the modal *keyi* 'can' is removed from (30a), we are left with a plain disjunction word *huozhe* 'or' as in (31). A scalar implicature of 'exclusivity' is generally associated with (31), so the implication is that John drinks beer or wine, but not both beer and wine (Grice 1975; Horn, 1996).

(31) Yuehan he   pijiu huozhe hongjiu.

    John   drink beer   or   wine

  'John drinks beer or wine.'

When the *wh*-word *shenme* 'what' appears in sentences with the modal *keyi* 'can', it is a question marker, as illustrated in (32). If *keyi* 'can' is removed, as in (33), the sentence is upward entailing, the *wh*-word *shenme* is still a question marker.

(32) Yuehan keyi he   **shenme** jiu?

   John   can drink what alcohol

  'Which alcohol can John drink?'

(33) Yuehan he   **shenme** jiu?

   John   drink what   alcohol

  'Which alcohol does John drink?'

We can see that the three ∃-items under discussion, the *wh*-word *shenme* 'what', the polarity expression *renhe* 'any' and the disjunction word *huozhe* 'or' are all licensed in sentences with the modal verb *keyi* 'can.' In this linguistic context, however, *renhe* 'any' and the disjunction word *huozhe* have a free choice reading, and the *wh*-word *shenme* 'what' functions as a question marker.

Now, we will investigate the distributional and interpretive properties of the same three ∃-items in sentences with the quantificational expression *dou* 'all'. First, consider example (34). Here the disjunction word *huozhe* 'or' generates a conjunctive reading.[13]

(34) Yuehan pingguo **huozhe** li dou maiwan-le.

    John apple   or   pear all sell.out-ASP

    'John sold out all the apples and pears. '

The quantification expression *dou* also licenses *renhe* 'any'. Here, *renhe* has a universal force, as illustrated in (35).

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[13] The conjunctive interpretation of disjunction in sentences with *dou* is different with the ordinary conjunctive interpretation. As can be seen from the English translation of (i) and (ii), the conjunctive interpretation in (i) is stronger than the conjunctive interpretation in (ii).

(i) Gongfuxiongmao zai xiaomao **huozhe** xiaogou shenbian dou zhong-le shu.

    Kung-Fu-Panda at cat   or   dog   next   all plant-ASP tree

    'Kung-Fu-Panda planted trees next to both a cat and a dog.'

(ii) Zhiyou Gongfuxiongmao zai xiaomao **huozhe** xiaogou shenbian zhong-le shu.

    Only   Kung-Fu-Panda at cat   or   dog   next   plant-ASP tree

    'Only Kung-Fu-Panda planted trees next to a cat and only Kung-Fu-Panda planted trees next to a dog.'

(35) Yuehan **renhe** shuiguo dou chi.

   John   any   fruit   all   eat

   'John eats every fruit.'

Perhaps most surprisingly is the fact that *dou*, unlike the modal verb *keyi,* licenses a non-interrogative interpretation of *wh*-words. When bound by *dou*, *wh*-words receive universal force (Huang 1982b; Cheng 1991; Li 1992). The important point is that the *wh*-word *shenme* in (36) contributes the same meaning as *renhe* 'any' in (35), namely a universal interpretation.[14]

(36) Yuehan **shenme** shuiguo dou chi.

   John   what   fruit   all   eat

   'John eats every fruit.'

In Mandarin, *wh*-words have two semantic functions. They can be question markers or they can be interpreted as existential indefinites, similar in meaning English *some*. In English, only

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[14] By the way, when the modal *keyi* 'can' is introduced in sentences like (36) and (35), the *wh*-word *shenme* and renhe 'any' resemble Free Choice Items, as shown in (iii) and (iv).

(iii) Yuehan **shenme** shuiguo dou keyi chi.

   John   what   fruit   all   can eat

   'John can eat any fruit.'

(iv) Yuehan **renhe** shuiguo dou keyi chi.

   John   any   fruit   all   can eat

   'John can eat any fruit.'

a small class of *wh*-words can be assigned a non-interrogative interpretation. These non-interrogative *wh*-words are limited to ones that end in *–ever,* such as *whoever, whatever, whenever,* etc. Interestingly, these *wh*-words have a free choice interpretation. Consider example (37), which contains the *wh*-word *whatever*. Notice that the *wh*-word *whatever* can be replaced by the existential indefinite, *anything*, with no apparent change in meaning. In fact, it can also be replaced by *everything*, which attests to its Free Choice interpretation. This shows the universal force of existentials and *wh*-expressions in such cases.

(37) They say that you can buy whatever/anything/everything you desire at Harrods, as long as you have the money.

In a finite domain, existential statements are logically equivalent to statements with disjunction. Here is the intuition. Suppose there are two people in a room: John and Mary. Then, the sentence *Someone laughed* is logically equivalent to the corresponding disjunctive statement, *John laughed or Mary laughed*.

Not only are existentials are equivalent to a disjunction in a finite domain, but universals are equivalent to conjunction in a finite domain. To see this, suppose that there are three people in a room: John, Mike and Mary. In this circumstance, the sentence *Everyone laughed* is true if and only if the corresponding conjunctive statement is true, namely *John laughed and Mike laughed and Mary laughed*.

Recently it has been proposed that the conjunctive, universal readings of ∃-items can be derived using a process known as Recursive Exhaustification (Fox 2007; Chierchia 2013; Liao 2011). In this analysis, *dou* is an exhausitivity operator, the *wh*-word *shenme* in (36), *renhe* 'any' in (35) and the disjunction *huozhe* in (34) receive conjunctive (universal) interpretations through Recursive Exhaustification. It is beyond the scope of this paper to go into this process in detail. It will suffice to point out that the experiments described in section

6 investigate children's knowledge that *dou* licenses the non-interrogative meaning of *wh*-words, as compared to linguistic contexts like the comparative *bi…xian* 'earlier than'.

Examples (34)-(36) indicate that the quantificational expression *dou* behaves like linguistic expressions which are both downward entailing and anti-additive (i.e., O$_{[+AA]}$). For example, just like the negative existential *mei-you* 'not have' and the antecedent of conditionals, which are O$_{[+AA]}$, *dou* can license all the three ∃-items: the non-interrogative interpretation of the *wh*-word *shenme* 'what', the polarity sensitive expression *renhe* 'any' and the disjunction *huozhe* 'or'. But when licensed by *dou*, these ∃-items are no longer Negative Polarity Items (NPIs), they are converted into conjunctions (universals). [15]

Example (38) (repeated from example (22)) shows that in the scope of *bi…xian* 'earlier than', which is downward entailing but not anti-additive, the *wh*-word *shenme* can only function as a question marker as in (38a), while *renhe* 'any' is interpreted as an NPI as in (38b).

(38) a. Yuehan bi$_{[-AA]}$ **shenme** xuesheng xian dao?

    John   than   what   student   early   arrive

    'Which student did John arrive earlier than?'

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[15] The adverbial quantifier *dou* is always associated with plural expressions to its left. When *dou* is removed form examples such as (34)-(36), several things happen. First, the *wh*-word *shenme* 'what' in example (36) reverts to a question marker. For example, sentence (36) is changed to *Yuehan chi shenme shuiguo*? 'What fruits does John eat?' Second, the sentence with *renhe* 'any' is ungrammatical, *Yuehan chi renhe shuiguo. 'John eats any fruit.'. Finally, the disjunction word *huozhe* in example (34) no longer generates a conjunctive reading; rather, it has disjunctive truth conditions. Without *dou* these sentences are no longer downward entailing. Instead, they are upward entailing, i.e., examples of Type I.

b. Yuehan bi$_{[-AA]}$ **renhe** xuesheng xian dao.

　　John　　than　　any　student　early arrive

　　'John arrived earlier than any other students.'

Notice what happens, however, if *dou* is added to (38). The result is shown in (39). In this case, *dou* is stronger than *bi*$_{[-AA]}$...*xian* 'earlier than', both the non-interrogative interpretation of *shenme* 'what' and *renhe* 'any' are licensed in the scope of *dou* and they generate the same conjunctive (universal) reading.

(39) a. Yuehan bi$_{[-AA]}$ **shenme** xuesheng dou xian dao.

　　　John　　than　　what　student　all　early arrive

　　　'John arrived earlier than every student.'

　　b. Yuehan bi$_{[-AA]}$ **renhe** xuesheng dou xian dao.

　　　John　　than　　any student　all early arrive

　　　'John arrived earlier than every student.'

Let us summarize these observations. First, the quantificational expression *dou* behaves like anti-additive operators which license the non-interrogative *wh*-word *shenme* 'what', *renhe* 'any' and the conjunctive interpretation of disjunction *huozhe* 'or'. The second observation is that the merely downward entailing contexts like the comparative operator *bi...xian* 'earlier than' license the interrogative interpretation of *shenme* 'what' and *renhe* 'any', *shenme* functions as a question marker. In this linguistic context, the disjunction *huozhe* or generates a disjunctive reading. A comparison of examples (38) and (39) reveal that in the NPI-licensing contexts, *dou* won't make difference with *renhe* 'any', but will make difference with the *wh*-

word *shenme* 'what'. Children's knowledge of this change in the interpretation of *wh*-words was investigated in this study.

There is no previous empirical work demonstrating that Mandarin speaking children or adults are aware of the distinction between the *wh*-word *shenme* and *renhe* 'any' with downward entailing operators that are not anti-additive, versus an anti-additive-like operator *dou*. In Chapter 2, we found that three-to-five-year-old Mandarin-speaking children know that in sentences with the comparative operator $bi_{[-AA]}...xian$ 'earlier than', the *wh*-word *shenme* is interpreted as a *wh*-question marker, whereas *renhe* 'any' is interpreted as an existential indefinite. The experiments reported in Section 6 are designed to assess whether or not children know that the quantificational expression *dou* is anti-additive, and *dou* suffices to turn the *wh*-word *shenme* from a question marker to a non-interrogative existential but won't make a difference with *renhe* 'any'. Before we turn to the experiments, we briefly review the relevant literature on child language.

5. NPI-licensing contexts in child Mandarin

Two previous studies have investigated whether Mandarin-speaking children assign different interpretations to *wh*-words depending on whether these words appeared in downward entailing contexts which are also anti-additive [+AA] as compared to upward entailing contexts. The first study was by Su, Zhou & Crain (2011) who examined children's interpretation of the *wh*-word *shenme* 'what' in sentences with the negative existential expression *mei-you* 'not-have', which is anti-additive [+AA]. The experiment compared the interpretation of the *wh*-word *shenme* in the predicate phrase of *mei* 'every', which is upward entailing. They used a Question-statement task. The task involved two experimenters. One acted out stories using toy characters and props, and the other played the role of a puppet that watched the stories alongside the child subject. After each story, the puppet presented sentences like (40) and (41). The child then judged whether the puppet accurately described

what happened in the story or, if the puppet asked a question about the story, the child was instructed to answer the question.

(40) Mei-you xiongmao chi shenme shuiguo.

    not-have panda   eat   what   fruit

    'None of the pandas ate any fruit.'

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

    every-CL panda   all eat-ASP what   fruit

    'What kind of fruit did every panda eat?'

In (40), the *wh*-word *shenme* 'what' is in the scope of the negative existential *mei-you* 'not-have'. Since the negative existential *mei-you* 'not-have' is anti-additive, it licenses the interpretation of *shenme* 'what' as a negative polarity item (NPI). Therefore, sentence (40) expresses a negative statement, meaning *None of the pandas ate any fruit.* By contrast, the *wh*-word *shenme* 'what' in (41) occurs in the predicate phrase of *mei* 'every'. This is an upward entailing context, so the *wh*-word *shenme* is interpreted as a question marker, thereby assigning the sentence with a question reading, asking *What kind of fruit did every panda eat?*

The main findings were that children, and adults, interpreted sentences like (40) as statements and interpreted sentences like (41) as questions 100% of the time. The results clearly show that three-to-five-year-old children analyse the *wh*-word *shenme* 'what' as a non-interrogative existential in the negative existential *mei-you* 'not-have' (an anti-additive operator), whereas they interpret it as a question marker in the predicate phrase of *mei* 'every' (an upward entailing operator).

Using the same Question-statement task, a second study, by Zhou and Crain (2011), reported the findings of two experiments investigating Mandarin-speaking children's

knowledge of the quantificational expression *dou*. The first experiment in Zhou and Crain (2011) investigated children's interpretation of the *wh*-word *shei* 'who' in the scope of *dou* in simple sentences in comparing with the interpretation of the same *wh*-word in the same simple sentences where *dou* is absent. Examples (42) and (43) illustrate this contrast.

(42) Shei dou meiyou pa-shang dashu.

    who all   not   climb-up big.tree

  'Nobody climbed up the big tree.'

(43) Shei meiyou pa-shang dashu?

   who not   climb-up big.tree

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

In (42), the *wh*-word *shei* 'who' is in the scope of the quantificational expression *dou* and generates a universal interpretation. Thus sentence (42) expresses a negative statement, meaning *Nobody climbed up the big tree*. When *dou* is absent, as in (43), the structure of the sentence is upward entailing, so the *wh*-word *shei* 'who' is interpreted as a question marker, thereby rendering a question reading, asking 'Who didn't climb up the big tree?'

      Here are the main findings of the Zhou and Crain study. Both children and adults interpreted sentences with *dou* as statements in sentences like (42) (children 96% of the time; adults 100% of the time), and both groups interpreted the sentences without *dou*, as in (43), as questions (children 95% of the time; adults 100% of the time). The findings provide evidence that children have the knowledge that the *wh*-word *shei* 'who' has a non-interrogative universal reading in the scope of the quantifier *dou* (an anti-additive-like operator) and turns into a question marker in the same sentences without *dou* (an upward entailing context).

The second experiment in Zhou and Crain (2011) investigated children's understanding of the *wh*-word *shei* 'who' in the scope of the quantificational expression *dou* in different clauses, as illustrated in (44), comparing with the interpretation of the *shei* 'who' in the same sentences without *dou*, as shown in (45).

(44) 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.'

(45) 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?'

The only difference between (44) and (45) is the presence or absence of the quantificational expression *dou*. In (44), the *wh*-word *shei* 'who' and *dou* appear in different clauses, *shei* 'who' is in the scope of *dou*. *Dou* licenses the interpretation of the *wh*-word shei as a free choice item, thus the sentence expresses a statement, meaning *Whoever Mr. Crocodile went to bite, Mr. Owl asked Spiderman for help.* When *dou* is removed from (44) as in (45), the context is upward entailing, hence the *wh*-word *shei* 'who' is interpreted as a question marker, rendering the sentence with a question reading, asking 'Who did Mr. Owl ask Spiderman to help when Mr. Crocodile went to bite?'

The results showed that both children and adults interpreted sentences with *dou* like (44) as statements (children: 88% of the time, adults: 90% of the time), and they analysed sentences without *dou* like (45) as questions (children: 88% of the time, adults 100% of the time).This experimental finding demonstrated that, by around 4 years of age, Mandarin-speaking children know that *dou* can license *wh*-words in different clauses to generate a non-

interrogative free choice interpretation, and in the same sentences without *dou*, *wh*-words function as question markers.

6. Experiments

Based on previous findings, it has been found that Mandarin-speaking children assign non-interrogative interpretations to *wh*-words that appear in the scope of the anti-additive operator, the negative existential *mei-you* 'not-have' (Su, Zhou and Crain 2011) as well as in the scope of the quantificational expression *dou* (Zhou and Crain 2011). Moreover, Mandarin-speaking children know that *renhe* 'any' is licensed in downward entailing contexts, including sentences with the temporal conjunction *zai…zhiqian* 'before' (Huang and Crain 2013).

In Chapter 2, we investigated Mandarin-speaking children's comprehension of the *wh*-word *shenme* 'what' and the NPI *renhe* 'any' in sentences with the comparative operator *bi…xian* 'earlier than', which is downward entailing but not anti-additive. The test sentences included (46) and (47).

(46) Xiongmao bi$_{[-AA]}$ shenme dongwu xian laidao xuexiao?

    panda   than   what animal early arrive school

  'Which animal did the panda arrived at school earlier than?'

(47) Xiongmao bi$_{[-AA]}$ renhe dongwu xian laidao xuexiao.

    panda   than   any animal early arrive school

  'The panda arrived at school earlier than any other animals.'

In (46), the *wh*-word *shenme* 'what' appears in the scope of the comparative operator *bi…xian* 'earlier than' in the surface syntax. Since *bi…xian* 'earlier than' is downward entailing, but not anti-additive, for adult speakers, *shenme* should be analysed as a question marker. By contrast, the existential *renhe* 'any' should be analysed as an NPI as shown in (47).

The results showed that both children and adults consistently judged sentences with *renhe* 'any' in (47) as statements. In response to sentences with *shenme* 'what' in (46), adults judged them to be questions 100% of the time, and children judged them to be questions 96% of the time. It provided evidence that three-to-five-year-old Mandarin-speaking children know that in sentences with the comparative operator $bi_{[-AA]}...xian$ 'earlier than', *wh*-word *shenme* is interpreted as a *wh*-question marker, whereas *renhe* 'any' is interpreted as an NPI.

We designed two experiments to assess whether or not children know that the quantificational expression *dou* is like an anti-additive operator in that it suffices to turn the *wh*-word *shenme* from a question marker to a non-interrogative existential but will not have any effect with *renhe* 'any', in NPI-licensing contexts.

Experiment 1 investigates how Mandarin-speaking children interpret the *wh*-word *shenme* 'what' when the quantificational expression *dou* is added to sentence (46), as shown in (48).

(48) Xiongmao bi$_{[-AA]}$ shenme dongwu dou xian laidao xuexiao.

    panda   than   what   animal all   early arrive school

    'The panda arrived at school earlier than every animal.'

In (48), the quantificational expression *dou* is an anti-additive-like operator whereas the comparative operator *bi...xian* 'earlier than' is downward entailing but not anti-additive. Since *dou* is stronger than $bi_{[-AA]}...xian$ 'earlier than', we anticipated that participants would permit the *wh*-word *shenme* 'what' to be interpreted in the scope of *dou* and generate a universal reading.

Experiment 2 was designed to assess whether Mandarin-speaking children know that when the quantificational expression *dou* is added to sentence (47) as illustrated in (49), *renhe*

'any' can be licensed and receives a same universal reading as the *wh*-word *shenme* 'what' in (48).

(49) Xiongmao bi$_{[-AA]}$ renhe dongwu dou$_{[+AA]}$ xian laidao xuexiao.

     panda   than   any animal all   early arrive school

   'The panda arrived at school earlier than every animal.'

6.1 Participants

Experiment 1 tested twenty-five Mandarin-speaking children between the ages of 3;9 and 5;1, with a mean age of 4;3. In Experiment 2, the participants were fifteen Mandarin-speaking children between the ages of 4;2 and 4;9, with a mean age of 4;5. All of the child participants were recruited from the kindergarten affiliated with Beijing Language and Culture University (BLCU), Beijing. They had no reported history of speech, hearing or language disorders. In addition, we tested thirty monolingual Mandarin-speaking adults (age range 38 to 51) in a suburban region of Beijing as the control group, fifteen adults for each experiment.

6.2 Procedures

These experiments both used the Question-Statement task developed by Zhou and Crain (2009). In this task, the experimenter acted out stories in front of the child participant using toy characters and props. A puppet, who appeared on a laptop computer screen, watched the stories alongside the child. After each story, the puppet told the child participant what it thought had happened in the story, using one of test sentences. The test sentences were pre-recorded and presented through an external speaker of the laptop computer, to make it appear as if the puppet was talking. It was made clear to the child that sometimes the puppet didn't pay close attention to the story and thus was not sure about what happened. If that was the

case, then the puppet would ask the child a question. Alternatively, the puppet would make an assertion, and the child's task was to judge whether or not the puppet 'said the right thing.'

If the child judged the puppet to be making a statement that was wrong, then the child was asked to explain what had really happened in the story. On the other hand, if the puppet posed a question about the story, the child was instructed to answer the question and then ask the puppet to pay closer attention to the next story. Whenever the child subject judged that the puppet had said the 'right thing', the child rewarded the puppet a smile-face card. But if the child judged the puppet to have said the 'wrong thing', the child gave him a black cross. If the puppet didn't pay close attention, however, and asked a question, the child would give him a sad-face card. These procedures made it fun for children to play the game, and they encouraged children to attend to the test sentences.

The participants were introduced to the task individually and were tested individually. In order to familiarize children with the task, in each experiment, the child subjects were given four practice trials before the formal test session. On two of these practice trials, the puppet asked the child simple questions with the *wh*-word *shenme* 'what,' as in examples (50) and (51). These practice trials were included to verify that the child subjects could understand simple *wh*-questions. On the other two practice trials, the puppet produced the statements in (52) and (53). One was obviously true, and the other was obviously false. These trials were included to see whether subjects understand the expression *bi* 'than' and *dou* 'all' in simple statements. These practice trials were presented in a pseudo-random order. Only those child subjects who correctly distinguished between statements versus questions, and correctly judged the truth and falsity of the practice trials were permitted to proceed to the actual test session. On this basis, 3 of the 40 children were excluded, one of them always said *Dui le.* 'Right.' to the practice trials, and 2 others experienced difficulty in understanding simple statements with *bi* 'than'. Adult controls were tested individually using the same task.

(50) Shenme dongwu shuaidao-le?

     what   animal fall-over-ASP

    'Which animal fell over?'

(51) Xiaomao chi-le   shenme?

     cat   eat-ASP what

   'What did the cat eat?'

(52) Xiongmao bi   daxiang gao.

     panda   than elephant tall

    'The panda is taller than the elephant.'

(53) Xiaoxiong he xiaozhu dou shuaizhao-le.

     bear   and pig   both fall asleep-ASP

    'The bear and the pig both fell asleep.'

6.3 Materials

In each experiment, there were four test stories. Each story was about a competition among

three characters. In each competition, one character came in first place, one came in second

and one was last. At the end of the competition, the characters were rewarded according to

their place in the competition (first, second or third). For each story, the test sentence in

Experiment 1 contained the *wh*-word *shenme* 'what' with the comparative operator *bi…xian*

'earlier than' and the quantificational expression *dou* as in (54) (repeated from (48)); the test

sentence in Experiment 2 contained *renhe* 'any' with *bi…xian* 'earlier than' and *dou* as in (55)

(repeated from (49)).

(54) Xiongmao bi$_{[-AA]}$ shenme dongwu dou xian laidao xuexiao.

    panda   than   what animal all early arrive school

    'The panda arrived at school earlier than every animal.'

(55) Xiongmao bi$_{[-AA]}$ renhe dongwu dou xian laidao xuexiao.

    panda   than   any animal all early arrive school

    'The panda arrived at school earlier than every animal.'

In the contexts associated with two of the four test sentences, the referent of the subject NP (e.g. the panda) came first, that is, was the first to arrive at school. We will call this the First-Place condition. The referent of the subject NP came second in the other two contexts, so we will call this the Second-Place condition. If children know that the polarity sensitive expression *renhe* 'any' can be licensed in all downward entailing contexts including *dou*, then they were expected to judge (55) to be a true description of the story in the First-Place condition, but a false description of the story in the Second-Place condition.

If children know that the quantificational expression *dou* is stronger than the comparative operator *bi*$_{[-AA]}$...*xian* 'earlier than', and they know the licensing conditions on *wh*-words, then they were expected to interpret the *wh*-word *shenme* 'what' in (54) in the scope of *dou*, and assign the *wh*-word *shenme* a non-interrogative existential meaning. Therefore, they should judge (54) to be a statement in both conditions, and provide an appropriate true or false judgment. On the other hand, if children analysed the *wh*-word *shenme* as licensed by a covert *wh*-operator, rather than *dou*, then they would be expected to judge (54) to be a question. In the Second-Place condition, the child was expected to refer to the third-place character, in answering the test sentence. In the First-Place condition, the child was expected to refer to both of the other characters. An example of a typical trial is as follows.

There are three students in the animal school, the panda, the rabbit and the cat. They all love milk very much. Mr. Owl, the headmaster of the school, puts two bottles of milk at the school gate every morning. One is large, for the first student who gets to school; the other is small, for the student who arrives second. Today, mother panda is going to the doctor; she has to leave in the very early morning. When she is leaving, mother panda wakes the panda up and tells the panda that she could sleep for at most another hour. Since she is already awake, the panda gets up, has a quick breakfast, and then rushes to school. Could she get a bottle of milk this time? The panda is the earliest one! Mr. Owl gives her the large bottle of milk! She is so happy! After a while, the rabbit reached school as well. Mr. Owl gives her the small bottle of milk. Finally, the cat arrives, but there is no milk left (Fig. 1 illustrates the scene at the conclusion of the story).

Fig. 2. The last scene of the sample story

In Experiment 1, twenty-three child participants and fifteen adults were presented with the 4 different stories of sentences like (54). In Experiment 2, fourteen child participants and fifteen

adults were presented with 4 stories of sentences like (55). To control for prosody, the test sentences were pre-recorded. The recording was conducted in a sound-attenuated laboratory at Beijing Language and Culture University. The test sentences were produced by a female native speaker of Beijing Mandarin, who was asked to produce the test sentences using level intonation. In addition, the speaker was asked to produce the characters *shen* and *me* separately. Then, the two characters spliced together, to eliminate potential biases based on prosodic cues.

In addition to the test trials, each subject witnessed four filler trials. On two of these filler trials, the puppet produced simple *wh*-questions. For example, in a long jump competition, the puppet produced the sentence *Shenme dongwu tiao de zui yuan?* 'Which animal jumped furthest?'. On the other two filler trials, the puppet produced simple statements. For instance, in a car race, the puppet produced the sentence *huangqiche pao de zui kuai.* 'The yellow car went fastest'. In total, the child subjects responded to eight items. The fillers were included to ensure that children were paying attention, to provide an equal number of questions and statements, and to provide an equal number of true and false statements. The experimental session took about 20 minutes, and was audio-recorded. The subjects' responses to the test sentences were recorded for subsequent analysis.

6.4 Results and discussion

The test sentences for Experiment 1, shown in (54), contained the *wh*-word *shenme* 'what,' and in adult Mandarin, such sentences are interpreted as statements. The experimental finding was that children judged them to be statements 97% of the time (88/91 trials) [16], and, as anticipated, adult subjects judged the test sentences to be statements 100% of the time. There was no significant difference between the child group and the adult group (Mann-Whitney

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[16] One child was presented only 3 test sentences because of time limitations in that particular testing session.

test, Z =0.947, p =.344). In Experiment 2, the test sentences contained the polarity sensitive expression *renhe* 'any', as in (55), and both children and adults judged the test sentences as statements 100% of the time.The fillers were interpreted correctly on all trials by both children and adults.

In both experiments, children and adults consistently judged the test sentences to be true descriptions of stories in the First-Place condition, but false descriptions of stories in the Second-Place condition. In addition to overtly rejecting the test sentences in the Second-Place condition (saying *Cuo le.* 'Wrong.'), both children and adults pointed out that another character had come in first place. If we refer to the example story, then children and adults would have rejected the puppet's statement in the Second-Place condition by referring to the fact that the rabbit had arrived first. The results of the two experiments are summarized in Table 3.

Table 3. Proportion of the two types of responses to the test sentences in Experiment 1 and Experiment 2

Test sentence	Response type			
	Statement		Question	
	Children (%)	Adults (%)	Children (%)	Adults (%)
bi shenme dou xian	97	100	3	0
bi renhe dou xian	100	100	0	0

The results show that Mandarin-speaking children and adults, interpreted both the *wh*-word *shenme* 'what' and the NPI *renhe* 'any' universally in sentences with the quantificational expression *dou* and the comparative operator $bi_{[-AA]}...xian$ 'earlier than'. We can compare these results with Experiment 2 in Chapter 2. In that experiment, children and adults

interpreted *renhe* 'any' as an NPI. In brief, the finding is that with or without *dou*, the polarity sensitive expression *renhe* is always licensed and has an existential indefinite reading, as graphically depicted in Figure 3.
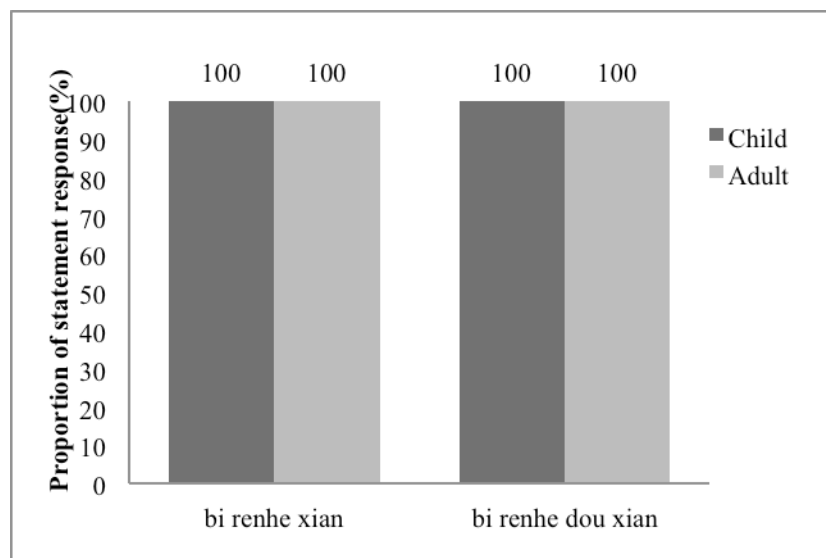

Fig. 3: Proportion of statement responses to *renhe* 'any' in sentences with or without *dou*

On the other hand, if the *wh*-word *shenme* 'what' is in sentences with only $bi_{[-AA]}...xian$ 'earlier than', then both children and adults interpreted *shenme* as a question marker; if *dou* is added to the same $bi_{[-AA]}...xian$ 'earlier than' sentence, then both children and adults interpreted *shenme* as a non-interrogative existential, as graphically depicted in Figure 4.
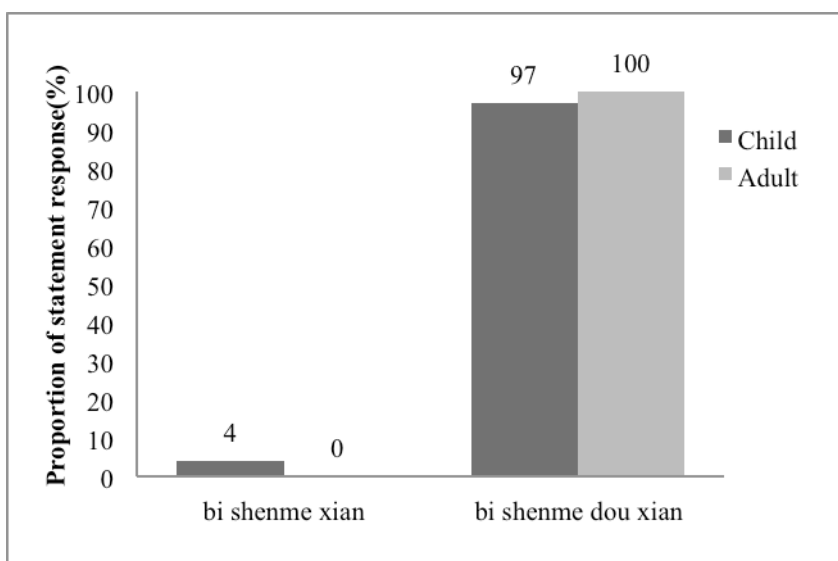
Figure 4: Proportion of statement responses to *shenme* 'what' in sentences with or without

dou

This is compelling evidence that Mandarin-speaking children exhibit adult-like sensitivity to the different interpretations of the *wh*-word *shenme* 'what' in different downward entailing contexts. When the *wh*-word *shenme* appears in the scope of a downward entailing but not anti-additive operator, it is interpreted as a question marker; however, when *shenme* appears in the scope of *dou*, which is stronger than a merely downward entailing operator, it is assigned a universal reading, similar to *renhe* 'any'. Children know that the quantificational expression *dou* behaves like an anti-additive operator, and that *dou* takes the *wh*-word *shenme* and causes it to be interpreted as a non-interrogative existential. Children also demontrate knowledge that the addition of *dou* into the sentence has no effect with *renhe* 'any' in downward entailing contexts.

7. Conclusion

In Mandarin, asking questions and making statements can be conveyed using the same *wh*-words, albeit in different linguistic contexts. The distributional pattern of the alternative interpretations of *wh*-words in Mandarin can be used to evaluate the influence of different

126

linguistic contexts on semantic interpretation. In upward entailing contexts, the *wh*-word *shenme* 'what' is only licensed as a question marker, and the NPI *renhe* 'any' is not licensed. In downward entailing but not anti-additive ([-AA]) contexts, *shenme* and *renhe* are both permitted, but *shenme* is a question marker, whereas *renhe* is analysed as a Negative Polarity Item (NPI). In contexts that are both downward entailing and anti-additive ([+AA]), *shenme* and *renhe* are both licensed and generate same existential indefinite readings.

In previous research, Mandarin-speaking children (and adults) have been found to interpret *wh*-words such as *shenme* 'what' as being equivalent in meaning to the NPI *renhe* 'any' in both downward entailing and anti-additive contexts, and they interpret the same *wh*-words as question markers in upward entailing contexts (Su, Zhou and Crain 2011; Zhou and Crain 2011). Since *renhe* 'any' is always interpreted as an existential indefinite in the linguistic contexts we have discussed, while the *wh*-word *shenme* 'what' can be interpreted as a question marker or as an non-interrogative existential, we have drawn on this distinction to test between downward entailing but not anti-additive contexts on the one hand, and both downward entailing and anti-additive contexts, on the other. The study presented in Chapter 2 of this thesis compared three-to-five-year-old Mandarin-speaking children's interpretation of *shenme* 'what' and *renhe* 'any' in these two linguistic contexts. In the experiment, *shenme* and *renhe* were introduced in sentences with the comparative operator *bi…xian* 'earlier than', which is downward entailing but not anti-additive, as shown in (56) and (57).

(56) Xiongmao bi$_{[-AA]}$ shenme dongwu xian laidao xuexiao?

    panda   than   what animal early arrive school

   'Which animal did the panda arrived at school earlier than?'

(57) Xiongmao bi$_{[-AA]}$ renhe dongwu xian laidao xuexiao.

　　panda　　than　　any　animal　early arrive　school

　　'The panda arrived at school earlier than any other animals.'

The experiment clearly demonstrated that both children and adults know that in sentences with the comparative operator *bi*$_{[-AA]}$...*xian* 'earlier than', the *wh*-word *shenme* is interpreted as a *wh*-question marker, whereas the NPI *renhe* 'any' is interpreted as an NPI, and as a consequence, as a statement.

　　　　The study reported in the present chapter tested a second condition, in which the quantificational adverb *dou* was introduced into sentences like (58) or (59) with either the *wh*-word *shenme* or the polarity sensitive expression *renhe*. As we have seen, the adverb *dou* behaves like the class of expressions that are both downward entailing and anti-additive.

(58) Xiongmao bi$_{[-AA]}$ shenme dongwu dou xian laidao xuexiao.

　　panda　　than　　what　animal　all　　early arrive　school

　　'The panda arrived at school earlier than every animal.'

(59) Xiongmao bi$_{[-AA]}$ renhe dongwu dou xian laidao xuexiao.

　　panda　　than　　any animal　all　　early arrive　school

　　'The panda arrived at school earlier than every animal.'

We found that children interpreted *shenme* 'what' and *renhe* 'any' within the scope of *dou*, and judged them both as universals. The same pattern was found for adults.

　　　　The results of these experiments show that both children and adults were sensitive to the different interpretations of *renhe* and *shenme* across the various experimental conditions. In sentences with *dou*, children assigned the non-interrogative meaning to the wh-word

shenme. By contrast, in sentences with the comparative expression *bi…xian* 'earlier than' alone, children interpreted *shenme* as a question marker. In both conditions, *renhe* 'any' was licensed.

These findings demonstrate that, by age 4, Mandarin-speaking children demonstrate extremely complex semantic knowledge. Experiments with children reveal that at this age, they know that the quantificational expression *dou* behaves like downward entailing and anti-additive operators ($O_{[+AA]}$),whereas the comparative operator *bi…xian* 'earlier than' without *dou* is downward entailing, but not anti-additive ($O_{[-AA]}$). They know that *dou* is stronger than *bi…xian* 'earlier than', and *bi…xian* 'earlier than' and that *dou* licenses a different interpretation of the *wh*-word *shenme* 'what'.

These results attest to the early mastery of adult-like linguistic knowledge of *dou* in child Mandarin. Now the questions become, where and how do young children make the connection between the semantic interpretations of different ∃-items (the *wh*-word *shenme* and *renhe* 'any') and linguistic contexts of different strengths (*dou* and *bi…xian* 'earlier than') in which they occur? As we have noted, the differences across the sentence types are subtle and complex, and it is likely that it would be difficult to learn such fine-grained differences by attending to distributional facts in the input from parents and caretakers. Another question is whether there is sufficient evidence for this complex pattern of facts in the positive input. Are there relevant triggering data in the adult input that enable children to distinguish different types of linguistic contexts incorporating the polarity sensitive expression *renhe* 'any' and the alternative interpretations of the *wh*-word *shenme* 'what'? In order to test this possibility, we did a corpus analysis of three Mandarin corpora on the Child Language Data Exchange System (CHILDES) database (the Beijing 2 corpus, the Zhou 1 and Zhou 2 corpora) (MacWhinney 2000). In a survey of 52, 554 parental utterances, only 20 instances of constructions in which *shenme* 'what' occurs in the scope of *dou* were found (e.g., *Baba shenme dou bu zhidao.* 'Papa knows nothing.'), and no occurrence of *renhe* 'any' was found

in sentences that contained *dou*. In addition, no exact matches were found in which *shenme* 'what' and *renhe* 'any' appeared with the comparative operator $bi_{[-AA]}$ 'than' in the same sentence. Such low frequencies of relevant input make it unlikely that children learn different types of linguistic contexts and the interpretations of *wh*-words and *renhe* 'any' by merely relying on the input data.

Given the difficulty that children are likely to encounter if they rely on the input data to learn the difference between how these terms are used in different linguistic contexts, we propose that the early emergence of the distinction between different Ǝ-items the *wh*-words and *renhe* 'any' in different types of linguistic contexts is based on innate knowledge of the licensing mechanisms for different Ǝ-items.

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Appendix 1

Test sentences used in Experiment 1

(1) Xiongmao bi shenme dongwu dou xian laidao xuexiao.

    panda   than what animal all early arrive school

    'The panda arrived at school earlier than all the other animals.'

(2) Zi-huoche   bi shenme huoche dou xian yun-wan   shitou.

    purple-train   than what   train   all   early carry-finish stone

    'The purple train finished carrying stones earlier than all the other trains.'

(3) Xiaoma bi shenme dongwu dou xian chi-wan   xiangchang.

    horse   than what   animal   all early eat-finish sausage

    'The horse finished eating the sausage earlier than all the other animals.'

(4) Xiaoxiong bi shenme dongwu dou xian zhuodao yu.

    bear   than what   animal   all   early catch   fish

    'The bear caught the fish earlier than all the other animals.'

Appendix 2

Test sentences used in Experiment 2

(1) Xiongmao bi renhe dongwu dou xian laidao xuexiao.

    panda   than any   animal   all early arrive school

    'The panda arrived at school earlier than any other animals.'

(2) Zi-huoche   bi renhe huoche dou xian yun-wan   shitou.

    purple-train than any   train   all early carry-finish stone

    'The purple train finished carrying stones earlier than any other trains.'

(3) Xiaoma bi renhe dongwu dou xian chi-wan xiangchang.

    horse   than any   animal   all early eat-finish sausage

    'The horse finished eating the sausage earlier than any other animals.'

(4) Xiaoxiong bi renhe dongwu dou xian zhuodao yu.

    bear   than any   animal all early catch   fish

    'The bear caught the fish earlier than any other animals.'

Appendix 3

Children's responses on the first and the fourth trials, Experiment 1

Subject	Age	*Bi shenme dou xian* 'earlier than what all'	
		Responses	
		First-Place condition	**Second-Place condition**
Girl	4;02	Right.	Wrong, the pig caught first, not the bear.
Girl	4;05	Right.	Wrong, he caught first (pointing to the pig).
Girl	4;06	Right.	Wrong, the pig is the first.
Boy	3;11	Right.	Wrong, the pig caught first, not the bear.
Boy	4;00	The rabbit and the cat.	Wrong, the pig is the first.
Boy	4;05	Right.	Wrong, the pig caught first.
Boy	4;05	Right.	Wrong, the pig caught first.
Girl	4;09	Right.	Wrong, he is the first (pointing to the pig), and he is the second (pointing to the bear).
Girl	3;11	Right.	Wrong, the pig caught first.
Girl	4;03	Right.	Wrong, the pig caught first, not the bear.
Girl	5;01	Right.	Wrong, he is the first (pointing to the pig).
Boy	4;08	Right.	Wrong, the pig caught first.
Girl	4;06	Right.	Wrong, the pig caught first, not the bear.
Girl	4;02	Right.	Wrong, the pig caught first.
Boy	4;00	Right.	Wrong, the pig is the first, not the bear.
Boy	3;09	Right.	Wrong, the pig caught first.
Boy	4;02	The rabbit and the cat.	

Girl	4;04	Right.	Wrong, the pig caught first, not the bear.
Boy	4;07	Right.	Wrong, the pig caught first.
Girl	4;03	Right.	Wrong, he caught first (pointing to the pig).
Girl	4;03	Right.	Wrong, the pig is the first, not the bear.
Girl	4;09	Right.	Wrong, the pig caught first.
Girl	4;06	Right.	Wrong, the pig caught first, not the bear.

Appendix 4

Children's responses on the first and the fourth trials, Experiment 2

Subject	Age	*Bi renhe dou xian* 'earlier than any all'	
		Responses	
		First-Place condition	**Second-Place condition**
Girl	4;2	Right.	Wrong, the pig caught first.
Girl	4;4	Right.	Wrong, the bear is the second.
Boy	4;7	Right.	Wrong, the pig caught first.
Girl	4;9	Right.	Wrong, he is the first (pointing to the pig), and he is the second (pointing to the bear).
Boy	4;5	Right.	Wrong, the pig caught first.
Boy	4;8	Right.	Wrong, the bear caught second.
Girl	4;3	Right.	Wrong, the pig caught first.
Boy	4;9	Right.	Wrong, the pig is the first.
Boy	4;8	Right.	Wrong, the pig caught first, not the bear.
Girl	4;4	Right.	Wrong, the bear is the second.
Girl	4;5	Right.	Wrong, the pig caught first, not the bear.
Boy	4;7	Right.	Wrong, the pig caught first.
Boy	4;6	Right.	Wrong, the pig caught first.
Girl	4;8	Right.	Wrong, the pig caught first.

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

(1) Dui   le.

   right SFP

  'Right.'

(2) Xiaotu he xiaomao.

   rabbit and cat

   'The rabbit and the cat.'

(3) Xiaozhu zui xian zhuodao, bu-shi xiaoxiong.

    pig   most early catch   not-is bear

   'The pig caught first, not the bear.'

(4) Xiaozhu di-yi.

    pig   first

   'The pig is the first.'

(5) Ta di-yi, ta di er.

   he first   he second

    'He is the first, and he is the second. '

(6) Xiaoxiong di-er.

    bear   second

   'The bear is the second.'

(7) Xiaoxiong di-er-ge zhuodao.

  bear   second-CL catch

  'The bear caught second.'

CHAPTER 4

On the acquisition of existential quantified

items in Mandarin

Abstract

Mandarin *wh*-words can be used to ask questions and to make statements. In statements, the *wh*-word *shenme* 'what' is similar in meaning to *renhe* (English 'any'), and it is semantically related to the disjunction word *huozhe* 'English or'. The present study explained the distribution and interpretive patterns of these three existential quantified items. To meet this goal, a distinction is drawn between 'weak' Downward Entailing (DE) operators and 'strong' downward entailing operators. In sentences with weak DE operators, the disjunction word *huozhe* is assigned disjunctive truth conditions, the *wh*-word *shenme* is a question marker, and the polarity sensitive item *renhe* is analysed as an Negative Polarity Item. In strong DE contexts, the disjunction word *huozhe*, the wh-word *shenme* and the polarity sensitive item *renhe* all generate a 'conjunctive' (universal) meaning. Finally, in upward entailing linguistic contexts, the disjunction word *huozhe* has disjunctive truth conditions, *shenme* functions as a question marker, and *renhe* is not tolerated.

This study also investigated how three-to-five-year-old Mandarin-speaking children interpret disjunction *huozhe* in sentences with weak Downward Entailing (DE) operators and in sentences with strong ones. This is tested by truth value judgment tasks that compare the responses by both children and adults to sentences with the Downward Entailing (but not anti-additive) comparative expression *bi…xian*. We presented subjects with test sentences that contained the adverbial quantifier *dou* (*bi…dou xian*) (a strong DE context) and we presented them with sentences that did not contain *dou* (*bi…xian*) (a weak DE context). The main findings were that adults interpreted the disjunction word *huozhe* differently in these two linguistic contexts. In sentences with *dou*, adults assigned a conjunctive interpretation of disjunction, whereas in sentences without *dou*, adults generated a disjunctive interpretation. In contrast to adults, Mandarin-speaking children assigned a conjunctive interpretation interpreted to the disjunction word *huozhe* in both kinds of sentences. The findings support the conclusion that the strength of DE operators is a relevant factor in determining logical

scope in sentences with multiple logical operators for adults, and support the growing body of evidence that children strongly favour scope assignments that generate strong readings, even in cases where adults favour weak scope assignments.

1. Introduction

In Mandarin, the *wh*-word *shenme* (English 'what'), the polarity sensitive expression *renhe* (English 'any') and the disjunction operator *huozhe* (English 'or') are all logically equivalent existential items in certain contexts. Consider a finite domain with two individuals, John and Mary. The meaning of the *wh*-question *Who laughed*? is traditionally rendered as the set of its (true) answers, so in this limited domain its meaning consists of the propositions taken from the following set of answers {John laughed (but not Mary), Mary laughed (but not John), John and Mary laughed}. Notice that these possible answers are also the truth conditions associated with the disjunctive statement *John or Mary laughed*, with the disjunction word 'or' being assigned the truth conditions associated with inclusive disjunction, as in classical logic. Similarly, the existential statement *Someone laughed* conveys the same information as the disjunctive statement *John or Mary laughed* in this limited domain. Based on this logical equivalence, *wh*-phrases, indefinite (polarity) expressions, and disjunction phrases are referred to as ∃-items, adopting the logical symbol for the existential quantifier (cf. Karttunen 1977; Jackendoff 1972; Jayaseelan 2001; Rooth and Partee 1982; Chierchia 2006, 2010; Liao 2011). Recently, the distribution and interpretation of sentences with existential items (∃-items) has received considerable attention, both in the theoretical literature, and in the literature on language development, including the acquisition of Mandarin Chinese.

As a *wh*-in-situ language, Mandarin *wh*-words are not 'fronted' as in English (Huang, 1982a, 1982b; Cheng 1991; Aoun and Li 1993; Huang, Li, & Li, 2009). Moreover, Mandarin *wh*-words have both an interrogative meaning and a non-interrogative meaning. We will distinguish these meanings by the feature [+/-WH]. The interrogative meaning is illustrated in (1).

(1) Yuehan chi-le   **shenme**?

   John   eat-ASP what

  'What did John eat?'

In (1), the *wh*-word *shenme* 'what' has the [+WH] value. We will assume that *wh*-words in *wh*-questions such as (1) are licensed by a covert *wh*-operator $Q_{[+WH]}$ (Liao 2011; cf. Chierchia 2006; Fox 2007; Chierchia 2010). Although there is no movement of *wh*-phrases in the surface syntax of Mandarin sentences, the *wh*-phrase is hypothesized to undergo movement at the level of Logical Form (LF), as in the diagram in (2). This yields the quantifier-variable representation in (3) (Huang 1982a).

(2) <u>$Q_{[+WH]}$ Shenme$_{[+WH]}$</u> Yuehan chi-le ~~shenme~~$_{[+WH]}$?

      <u>what</u>   John   eat-ASP ~~what~~

(3) $Q_{[+WH]}$ [shenme$_i$ [Yuehan chi-le t$_i$]]?

      What   John   eat-le

The Mandarin polarity sensitive expression *renhe* 'any' is not tolerated in this linguistic environment, as shown by the ungrammaticality of (4). In contrast to (4), example (5) shows that *renhe* 'any' is licensed by the negative existential *mei-you* 'not-have'. As this example indicates, polarity sensitive expressions such as Mandarin *renhe* require an overt linguistic licensing operator.

(4) * Yuehan chi-le **renhe** shuiguo.

   John   eat-ASP any   fruit

   'John ate any fruit.'

(5) Mei-you xuesheng mai **renhe** shu.

  not-have student buy any book

  'No student bought any book.'

As noted earlier, Mandarin *wh*-words also have non-interrogative interpretations in certain linguistic contexts (cf. Cheng 1991, 1994; Huang 1982a; Li 1992; Lin 1996, 1998; Liao 2011). Interestingly, the non-interrogative meanings of Mandarin *wh*-words are licensed by the same linguistic expressions that license the polarity sensitive expression *renhe*. Consider the Mandarin statement in (6)[17]. Here, the *wh*-word *shenme* 'what' is licensed by the negative existential quantificational expression *mei-you* 'not-have.' In this case, *shenme* 'what' doesn't 'raise' at the level of semantic interpretation (LF). Instead, it sits in the surface syntax position (*in situ*) at LF. [18]

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[17] Sentences like (6) may have an interrogative interpretation in echo questions. For example, if someone says *Mei-you xuesheng mai lishi-shu* 'No student bought history books,' the listener could respond by asking *Mei-you xuesheng mai shenme shu?* 'What books did no student buy?' to show that the listener didn't understand the kind of books the speaker had mentioned.

[18] I wish to thank one of the examiners for proposing an alternative analysis of the negative expression *meiyou*. On this account, *meiyou* resides outside the clause that contains the [+PPI] disjunctive phrase. Therefore, the [+PPI] expression cannot take scope over *meiyou*, because the polarity sensitivity of disjunction phrases is clause bound.

(6) Mei-you xuesheng mai **shenme**[-WH] shu.

    not-have student   buy   what   book

    'No student bought any book.'

A comparison of examples (5) and (6) indicates that the *wh*-word *shenme* and the polarity sensitive expression *renhe* 'any' make similar semantic contributions to the sentence meaning in certain linguistic contexts. That is, the non-interrogative interpretation of *shenme* in (6) is close to that of *renhe* 'any' in (5).

      There is a class of linguistic operators that license both *renhe* 'any' and the non-interrogative interpretation of *wh*-words, as we will see. There is another class of linguistic operators that licenses *renhe*, but do not tolerate the non-interrogative interpretation of *wh*-words. The comparative operator *bi…xian* 'earlier than' is in this class. So, both the *wh*-word *shenme* and the NPI *renhe* are permitted in sentences with *bi…xian* 'earlier than', but *shenme* receives a [+WH] interrogative interpretation. This is illustrated in (7).

(7) a. Yuehan bi **shenme** xuesheng xian dao?

     John   than what   student   early arrive

    'Which student did John arrive earlier than?'

  b. Yuehan bi **renhe** xuesheng xian dao.

    John   than any   student   early arrive

    'John arrived earlier than any other student.'

In (7a), the *wh*-word *shenme* must 'raise' at the level of semantic interpretation (LF), take scope over the comparative operator *bi…xian* 'earlier than', as shown in the diagram in (8).

(8) Q[+WH] Shenme[+WH] xuesheng Yuehan bi ~~shenme[+WH] xuesheng~~ xian dao?

      what   student   John than ~~what~~   ~~student~~   early arrive

Up to this point, we have observed that in the surface syntax, Mandarin *wh*-words like *shenme* 'what' appear *in situ*, but they are assigned different interpretations depending on the linguistic operators contained elsewhere in the sentence. In sentences with a covert *wh*-operator Q[+WH] (as in (1)) (regardless of the presence or absence of the comparative *bi…xian* 'earlier than' as in (7a)), *shenme* is attracted by the covert operator Q[+WH], such that it raises at the level of semantic interpretation (LF) and is assigned an interrogative interpretation. In sentences with other 'strong' logical expressions like the negative existential *mei-you* 'not-have' (as in (5)), *shenme* is [-WH], such that it is assigned a non-interrogative interpretation. The Mandarin NPI *renhe* 'any' has no alternative interpretation, so it is always interpreted in its original position in the surface syntax.

In this paper, we focus on another existential quantified item (∃-items), the Mandarin disjunction word *huozhe* (English 'or'). Languages differ in the ways in which words for disjunction are interpreted in sentences with predicate negation. Consider the English statement in (9) *John didn't drink beer or wine*. The negated disjunction generates a 'conjunctive' entailment, so the statement entails both that *John did not drink beer* and that *John did not drink wine*. This is the 'surface scope' reading (NEG > OR), because the scope bearing elements *not* and *or* are interpreted in the same order in which they appear in the overt syntax. Other languages that assign the (NEG > OR) reading in simple negative sentences with disjunction include German, French, Greek, Romanian, Turkish, Bulgarian, and Korean (cf. Chierchia et al. 2001; Lee 2010; Crain 2012).

(9) John didn't drink beer or wine.

Mandarin Chinese has the same surface word order as English, However, when the English example in (9) is translated into Mandarin, as in (10), adult speakers of Mandarin judge the sentence to mean that John didn't drink beer OR didn't drink wine.

(10) Yuehan mei-you he   pijiu **huozhe** hongjiu.

    John   not-have drink beer or   wine

  'It is beer or wine (and possibly both) that John didn't drink.'

Example (10) is true in three circumstances, in which (i) John didn't drink beer but drank wine, or (ii) John didn't drink wine but drank beer, or (iii) John drank neither beer nor wine. We can see that, adult Mandarin-speakers assign the 'inverse scope' reading, with disjunction taking scope over negation. We will render this scope assignment as (OR > NEG). This scope assignment contrasts with the surface scope reading (NEG > OR) assigned by English-speakers.[19] Other languages that assign the (OR > NEG) reading in simple negative sentences with disjunction include Japanese, Russian, Portuguese, Hungarian, Serbo-Croatian, Slovak, and Polish (Goro and Akiba 2004a, b; Szabolcsi 2002; Verbuk 2007).

    To explain the differences that the interpretation of disjunction words in sentences with predicate negation across languages, Goro (2004) proposed a lexical parameter, which has come to be known as the Disjunction Parameter (c.f. Szabolcsi 2002; Goro 2004; Crain and Khlentzos 2008; Crain, Goro and Minai 2007; Crain, Goro and Thornton 2006). This parameter establishes two classes of languages. In one class of languages, the disjunction word is a Positive Polarity Item, whereas it is not a Positive Polarity Item in the other. By definition, a Positive Polarity Item (PPI) must take scope over negation. On this analysis, the

disjunction operator OR ('∨' in logic) in Universal Grammar has the truth condition associated with inclusive-OR. Nevertheless, as we have seen, negative sentences with disjunction are assigned different interpretations across languages. These differences in interpretation are due to the different scope relations associated with the alternative values of the Disjunction parameter {+PPI, -PPI}. If an expression has the [+PPI] value, it must 'raise' at the level of semantic interpretation to take scope over negation. On the other value, [-PPI], the expression is interpreted in its position in the surface syntax (i.e., *in situ*).

As we have seen, disjunction takes scope over negation in Mandarin, so the disjunction word *huozhe* is assigned the positive value of the parameter, i.e., [+PPI]. As the diagram in (11) indicates, when disjunction is [+PPI], it 'raises' at the level of semantic interpretation (LF) to take scope over negation.

(11) Yuehan <u>pijiu huozhe</u>[+PPI] <u>hongjiu</u> mei-you he   ~~pijiu huozhe~~[+PPI] ~~hongjiu.~~

John   <u>beer   or   wine</u>   not-have drink ~~beer or   wine~~

By contrast, the English disjunction word *or* is assigned the parameter value [-PPI], so disjunction phrases are interpreted *in situ* in negative sentences. Because negation takes scope over disjunction, negated disjunctions generate a conjunctive entailment, as in one of de Morgan's laws: ¬ (A ∨ B) ⇒ ¬A ∧ ¬B.

Predicate negation belongs to a set of logical expressions called downward entailing (DE) operators. By definition, downward entailing operators license inferences from general terms (terms referring to sets) to specific terms (terms referring to subsets of those sets) (Ladusaw 1979, 1980). For example, the statement *John does not eat fish* contains the general term *fish*, and we can replace this general term with a specific term *salmon, salva veritate*. So,

if the statement *John does not eat fish* is true, it follows that the statement *John does not eat salmon.* is also true. Other downward entailing (DE) linguistic operators include the comparative *bi…xian* 'earlier than', the temporal conjunction *zai…zhiqian* 'before', negative existential *mei-you* 'not-have', the antecedent of conditionals, and many other linguistic constructions (see Hsiao 2002; Kuo 2003; Wang and Hsieh 1996).

To verify that the comparative *bi…xian* 'earlier than' is also downward entailing, we will apply two diagnostic tests. The first test is to show that sentences with *bi…xian* 'earlier than' validate inferences from set-referring terms (e.g. *nvhai* 'girl') to sentences in which the set-referring term is replace by a a subset-referring terms (e.g. *Mali* 'Mary'). This is demonstrated in example (12). As expected, if (12a) is true, then so is (12b).

(12) a. Yuehan bi   nvhai xian dao.

   John   than   girl early arrive

   'John arrived earlier than girls.'

   b. Yuehan bi   Mali xian   dao.

   John   than   Mary early arrive

   'John arrived earlier than Mary.'

The second diagnostic test is to show that sentences with the comparative operator *bi…xian* 'earlier than' license Negative Polarity Items, as downward entailing operators are known to do (Ladusaw 1979, 1980). This is demonstrated in sentence (13). The acceptability of (13) for most Mandarin speakers indicates that *bi…xian* 'earlier than' licenses the typical Mandarin NPI renhe 'any.'

(13) Yuehan bi **renhe** xuesheng xian dao.

John   than any   student   early arrive

'John arrived earlier than any other students.'

A third diagnostic test for downward entailment does not apply in Mandarin, although it does apply in languages such as English (also German, Korean, among others). In English, downward entailing operators (symbolized as Δ) license an entailment from a disjunctive statement Δ(A ∨ B) to a conjunctive statement (ΔA ∧ ΔB) in which the downward entailing operator takes scope over each of the disjuncts (cf. Chierchia 2004; Crain, Gualmini, &Pietroski 2005; Crain 2008). For instance, English comparatives are downward entailing. Since English disjunction *or* is [-PPI], disjunction phrases are interpreted *in situ* in sentences with the comparative expression 'earlier than,' as illustrated by the English statement in (14). Notice that (14) yields a conjunctive interpretation, that is, that John arrived earlier than Mary AND that John arrived earlier than Tom.

(14) John arrived earlier than Mary or[-PPI] Tom.

The Mandarin translation of the same sentence is given in (15). This sentence generates a disjunctive interpretation, so the sentence can be paraphrased as *John arrived earlier than Mary OR John arrived earlier than Tom*. This is because Mandarin disjunction *huozhe* 'or' is [+PPI], it is forced to 'raise' at the level of semantic interpretation (LF) to take scope over *earlier than*, as shown in the diagram in (16).

(15) Yuehan bi   Mali **huozhe**[+PPI] Tangmu xian dao.

John   than Mary or   Tom   early arrive

'It is Mary or Tom (and possibly both) that John arrived earlier than.'

(16) Yuehan <u>Mali huozhe_[+PPI] Tangmu</u> bi ~~Mali huozhe_[+PPI] Tangmu~~ xian dao.

    John   Mary or   Tom   than ~~Mary or   Tom~~   early arrive

To summarize, English *or* is [-PPI] whereas Mandarin *huozhe* 'or' is [+PPI]. Therefore, in sentences with a downward entailing operator, English disjunction is interpreted *in situ*, whereas Mandarin disjunction raises at the level of semantic interpretation, taking scope over the downward entailing operator.

The generalization that Mandarin disjunction *huozhe* 'or' is [+PPI] has exceptions. In a certain class of downward entailing contexts, the polarity sensitivity of *huozhe* 'or' is cancelled; disjunction cannot take scope over downward entailing operators in this class. One such operator is the adverbial quantifier *dou* 'all'.

One aim of the present paper is to explain the distribution and interpretation of the ∃-items that we have reviewed. To achieve this aim, the class of downward entailing operators needs to be partitioned into two subclasses, according to the number of entailments they generate, with 'stronger' operators generating more entailments than 'weaker' ones. We draw upon distinctions in the literature on formal semantics as the means of meeting this goal. Once we have partitioned the class of downward entailing operators into 'strong' and 'weak' operators, we can turn to the second aim of the chapter, which is to investigate how young Mandarin-speaking children interpret the disjunction word *huozhe* 'or' in sentences with 'strong' and 'weak' downward entailing operators.

The remainder of the paper is organized as follows. First we introduce some basic facts about the scope relations that Mandarin-speaking adults assign to sentences with ∃-items. We will examine sentences with two kinds of downward entailing operators. We draw a distinction between 'weak' downward entailing operators and 'strong' downward entailing

operators. The 'weak' operators are 'merely' downward entailing, whereas the 'strong' ones are both downward entailing and anti-additive.

Based on a recent proposal, we anticipated that children's initial interpretation of the disjunction *huozhe* would differ from that of adults in certain contexts but would be the same as that of adults in some other contexts. We then review previous research on children's comprehension of disjunctions. This is followed by a presentation of two experiments that were designed to assess Mandarin-speaking children's comprehension of the disjunction *huozhe* 'or'. We compare children's interpretation of the disjunction word *huozhe* 'or' in sentences with the downward entailing (but not anti-additive) comparative expression *bi..xian* 'earlier than', both with *dou* (*bi…dou xian*) and without *dou* (*bi…xian*). The findings of these experiments support the distinction between weak ('merely') downward entailing operators and the strong downward entailing operator (anti-additive-like operator) the quantificational expression *dou* for adults, and support the growing body of evidence that children strongly favour the scope assignment that generates strong readings, even in cases where adults strongly favour the weak scope assignment.

2. The interpretation of the disjunction word *huozhe* 'or'

We already witnessed Mandarin disjunction word *huozhe* 'or' is [+PPI] while English disjunction *or* is [-PPI] in cases when they are licensed by downward entailing operators such as predicate negation and comparatives. As illustrated in (17b) and (18b), in the scope of these downward entailing operators, the Mandarin disjunction word *huozhe* 'or' raises from its position in the surface syntax to take scope over these operators at the level of semantic interpretation. Adult Mandarin-speakers, therefore, assign the inverse scope (OR > Δ) reading rather than the surface scope (Δ > OR) reading assigned by adult English-speakers. In logic, the corresponding form for the interpretations of (17b) and (18b) is (ΔA ∨ ΔB), which does not entail (ΔA ∧ ΔB) as English counterparts (17a) and (18a).

(17) a. English: John didn't drink beer or[-PPI] wine.

⇒ John didn't drink beer **and** John didn't drink wine.

b. Mandarin: Yuehan mei-you he pijiu **huozhe**[+PPI] hongjiu.

John   not-have drink beer or   wine

'It is beer **or** wine (and possibly both) that John didn't drink.'

(18) a. English: John arrived earlier than Mary or[-PPI] Tom.

⇒ John arrived earlier than Mary **and** John arrived earlier than Tom.

b. Mandarin: Yuehan bi Mali huozhe[+PPI] Tangmu xian dao.

John than Mary or   Tom   early arrive

'It is Mary **or** Tom (and possibly both) that John arrived earlier than.'

As we saw, an expression is downward entailing if it guarantees the validity of an inference from general terms to more specific terms. The examples in (19) and (20) illustrate another two expressions that have this defining property of downward entailment, since it is valid to substitute claims about sets (*eating fish*) with claims about subsets of the original set (*eating salmon*). Example (19) shows that the negative quantificational expression *no* is downward entailing. Similarly, the antecedent of a conditional statement is downward entailing, as shown in (20).

(19) a. No student eats fish.

b. ⇒ No student eats salmon.

158

(20) a. If John eats fish, he will be ill.

b. ⇒ If John eats salmon, he will be ill.

The Mandarin examples (21) and (22) correspond to (19) and (20) respectively. Example (21) and (22) show that it valid to replace the set-referring term *yu* 'fish' by the subset-referring term *sanwenyu* 'salmon' in the negative quantificational expression *mei-you* 'not have' in (21) and in the antecedent of a *ruoguo*-conditional ('if'-conditional) in (22).

(21) a. Mei-you xuesheng chi yu.

  not-have student   eat fish

 'No student eats fish.'

b. ⇒ Mei-you xuesheng chi sanwenyu.

  not-have student   eat salmon

 'No student eats salmon.'

(22) a. Ruguo Yuehan chi yu, ta jiu   hui shengbing.

 if   John   eat fish he then will ill

 'If John eats fish, he will be ill'

b. ⇒Ruguo Yuehan chi sanwenyu, ta jiu hui shengbing.

  if   John   eat salmon   he then will ill

 'If John eats salmon, he will be ill.'

In English, the disjunction word *or* is [-PPI], so disjunction phrases are interpreted *in situ* in every downward entailing context, that is, the disjunction should generate a conjunctive entailment when it appears in the scope of any downward entailing expression. This is confirmed, as the examples in (23) and (24) illustrate. Disjunction *or* generates a conjunctive entailment in both the negative quantificational expression *no* in (23) and in the antecedent of a conditional in (24), the same as disjunction *or* in the scope of the predicate negations and the comparatives.

(23) a. No student drank beer or wine.

b. ⇒ No student drank beer **and** no student drank wine.

(24) a. If John eats peanuts or fish, he will be ill.

b. ⇒ If John eats peanuts, he will be ill; **and** if John eats fish, he will be will.

If we translate the English examples (23) and (24) into Mandarin, the same interpretation is manifested. That is, in the negative existential expression *mei-you* 'not-have', as shown in (25a), the disjunction *huozhe* 'or' generates a conjunctive entailment in (25b) (where conjunction *bingqie* 'and' takes scope over both of the negative sentences *Mei-you xuesheng he pijiu* 'No student drank beer.' and *Mei-you xuesheng he hongjiu* 'No student drank wine.'). Similarly, in the antecedent of conditional statements, as illustrated in (26a), the disjunction *huozhe* 'or' entails the conjunctive statement in (26b). In example (26b), the conjunction operator *bingqie* 'and' takes scope over both of the conditionals *Ruguo Yuehan chi huasheng, ta jiu hui shengbing* 'If John eats peanuts, he will be ill' and *Ruguo Yuehan chi yu, ta jiu hui shengbing.* 'If John eats fish, he will be ill.'

(25) a. Mei-you xuesheng he   pijiu **huozhe** hongjiu.

    not-have student   drink beer or   wine

      'No student drank beer or wine.'

    b. ⇒ Mei-you xuesheng he   pijiu bingqie mei-you xuesheng   he hongjiu.

      not-have student   drink beer and   not-have student   drink wine

      'No student drank beer **and** no student drank wine.'

(26) a. Ruguo Yuehan chi huasheng **huozhe** yu, ta jiu   hui shengbing.

    if   John   eat peanut   or   fish he then will ill

   'If John eats peanuts or fish, he will be ill.'

    b. ⇒ Ruguo Yuehan chi huasheng, ta jiu hui shengbing; bingqie ruguo yuehan chi yu, ta

       if   John   eat peanut   he then will ill   and   if   John   eat fish he

   jiu   hui shengbing.

   then will ill

   'If John eats peanuts, he will be ill **and** if John eats fish, he will be ill.'

In sentences (25a) and (26a), the polarity sensitivity of the Mandarin *huozhe* 'or' is cancelled. The disjunction word *huozhe* 'or' doesn't 'move' to take scope over both of the downward entailing operators: the negative existential expression *mei-you* 'not-have' and the antecedent of conditionals; instead, *huozhe* 'or' is interpreted in position, yielding a conjunctive entailment. When Mandarin disjunction word *huozhe* is no longer [+PPI], it patterns like the English disjunction word *or*, which is [-PPI]. So in these two downward entailing contexts, Mandarin *huozhe* and English *or* yield the same conjunctive interpretations.

    It is worth pointing out why the Mandarin disjunction word *huozhe* 'or' loses its

polarity sensitivity when it appears in certain downward entailing contexts such as with the negative existential expression *mei-you* 'not-have' and the antecedent of conditionals, but not in other downward entailing contexts like predicate negation and comparatives. The reason is that they are different kinds of downward entailing contexts. Predicate negation and comparatives are downward entailing but not anti-additive operators whereas the negative existential expression *mei-you* 'not-have' and the antecedent of conditionals are both downward entailing and anti-additive operators.

Formally, a function f is anti-additive if it generates the following logical equivalence: $f(A \vee B) \Leftrightarrow f(A)$ & $f(B)$. Anti-additivity is a logical equivalence. In one member of the equivalence, conjunction takes scope over both occurrences of some relevant logical operator, Op. We can render this symbolically as $Op(A)$ & $Op(B)$. In the other member of the equivalence, the operator, Op, takes scope over disjunction: $Op(A \vee B)$. Anti-additive operators and downward entailing operators stand in a subset-superset relation (Zwarts 1981; van der Wouden 1997; Blaszczak 2001).

We saw that when the Mandarin disjunction operator *huozhe* 'or' appears in the scope of the negative existential *mei-you* 'not-have,' as in (27a), *huozhe* is prohibited from taking scope over *mei-you* 'not-have.' Therefore, disjunction is interpreted where it is positioned in the surface syntax and, therefore, generating the conjunctive entailment, as shown in (27b). Notice also that example (27b) entails (27a). The logical equivalence of (27a) and (27b) indicates that the negative existential expression *mei-you* 'not-have' is anti-additive.

(27) a. Mei-you xuesheng he   pijiu **huozhe** hongjiu.

     not-have student   drink beer or   wine

     'No student drank beer or wine.'

b. Mei-you xuesheng he   pijiu bingqie mei-you xuesheng he hongjiu.

   not-have student   drink beer and   not-have student   drink wine

   'No student drank beer and no student drank wine.'

Similarly, we can ascertain whether or not the antecedent of a conditional statement is anti-additive. Evidence that it is is found in (28). When the disjunction operator *huozhe* 'or' appears in the antecedent of a *ruguo*-conditional ('if'-conditional), as in (28a), it entails the conjunctive statement in (28b). Example (28b) also entails (28a). Therefore, the antecedent of a conditional statement is anti-additive.

(28) a. Ruguo Yuehan chi huasheng **huozhe** yu, ta jiu   hui shengbing.

        if   John   eat peanut   or   fish he then will ill

      'If John eats peanuts or fish, he will be ill.'

   b. Ruguo Yuehan chi huasheng, ta jiu hui shengbing; bingqie ruguo yuehan chi yu, ta

      if   John   eat peanut   he then will ill   and   if   John   eat fish he

      jiu   hui shengbing.

      then will ill

      'If John eats peanuts, he will be ill and if John eats fish, he will be ill.'

On the other hand, when the Mandarin disjunction operator *huozhe* 'or' appears in the scope of comparatives as in (29a), *huozhe* 'or' raises at the level of semantic interpretation to take scope over the comparative operator *bi…xian* 'earlier than'. Therefore, Mandarin adults judge (29a) to mean that John arrived earlier than Mary **or** John arrived earlier than Tom. So (29a) is true in three circumstances, where (i) John arrived earlier than Mary but not Tom, or (ii) John arrived earlier than Tom but not Mary, or (iii) John arrived earlier than both Mary and

Tom. This means that (29a) can be true in two of the circumstances that falsify (29b). Therefore, the comparative *bi* 'than' is not anti-additive.

(29) a. Yuehan bi Mali **huozhe** Tangmu xian   dao.

John   than Mary or   Tom   early arrive

'It's Mary or Tom (and possibly both) that John arrived earlier than.'

  b. Yuehan bi Mali xian   dao bingqie Yuehan bi Tangmu xian   dao.

John than Mary earlier arrive and   John   than Tom   early arrive

'John arrived earlier than Mary and John arrived earlier than Tom.'

Similarly, predicate negation is not anti-additive in Mandarin. This is shown in example (30). When the disjunction word *huozhe* 'or' appears in the scope of the negation marker *mei-you* 'not', *huozhe* takes scope over negation for adult speakers of Mandarin. This is why adults judge (30a) to mean that John didn't drink beer **or** John didn't drink wine. In short, example (30b) entails (30a), but (30a) does not entail (30b). So, the predicate negation *mei-you* is not anti-additive.

(30) a. Yuehan mei-you he   pijiu **huozhe** hongjiu.

John   not-have drink beer   or   wine

'It is beer or wine (and possibly both) that John didn't drink.'

  b. Yuehan mei-you he   pijiu bingqie yuehan mei-you he   hongjiu.

John   not-have drink beer and   John   not-have drink wine

'John didn't drink beer and John didn't drink wine.'

We can see that anti-additive contexts are strong, whereas merely downward entailing contexts are weak. Downward entailing contexts have the property of either (31a) or (31b), but not both; while anti-additive contexts satisfy both (31a) and (31b) (Van der Wouden 1997; Zwarts 1998).

(31) a. $f(X \vee Y) \Rightarrow f(X) \wedge f(Y)$

    b. $f(X) \wedge f(Y) \Rightarrow f(X \vee Y)$

We have made several observations. First, the Mandarin disjunction word *huozhe* 'or' is [+PPI]. It 'raises' at LF when it appears in the scope of 'weak' downward entailing operators ($O_{[-AA]}$) such as predicate negation and comparatives. Disjunction yields a disjunctive interpretation in these sentences. By contrast, the polarity sensitivity of the disjunction word *huozhe* 'or' is cancelled when it appears in the scope of 'strong' downward entailing operators which are also anti-additive operators ($O_{[+AA]}$). This includes the negative existential *mei-you* 'not-have' and the antecedent of conditionals. In these contexts, the disjunction *huozhe* 'or' is no longer [+PPI], so it is interpreted *in situ* and generates a conjunctive interpretation.

3. ∃-items with *dou* 'all'

In Mandarin, the quantifier *dou* (roughly corresponding to English 'all') has been the topic of much discussion in the literature on theoretical linguistics. Setting aside the ongoing controversy about the syntax and semantics of *dou*, there are some generally acknowledged properties concerning *dou*. One observation is that *dou* is a distributive universal quantifier that quantifies over plural expressions that precede it (Huang 1982b; Cheng 1995; Lee 1986; Yeh 1986; Pan 2006). Consider the sentences (32) and (33). In (32), without *dou*, the sentence means that 'they', as a group, collectively bought a house. The sentence could be true even if

one or two members in the group did not contribute to the purchase. In (33), by contrast, *dou* quantifies over the entire set of individuals, giving the sentence a distributive reading. Thus sentence (33) means that each of the relevant individuals bought their own house.[20] The sentence is false if even a single individual failed to purchase a house.

(32) Tamen mai-le   yi-dong   fangzi.

    they   buy-ASP one-CL   house

    'They bought a house (collectively).'

(33) Tamen dou mai-le   yi-dong   fangzi.

    they   all   buy-ASP one-CL   house

    'They bought a house (individually).'

The second observation is that the quantifier *dou* is downward entailing. This is because it is valid to infer from the truth of sentence (34a), with the general term *yu* 'fish', to the truth of sentence (34b), with the specific term *sanwenyu* 'salmon'.

(34) a. Yuehan yu dou maiwan-le.

    John   fish all   sell.out-ASP

    'John sold out all the fish.'

   b. Yuehan sanwenyu dou maiwan-le.

    John   salmon   all   sell.out-ASP

    'John sold out all the salmon.'

---

[20] *Dou* behaves somewhat differently form English *each*. But the differences are not critical to our study. For a useful discussion of the differences between *dou* and *each*, see Xiang (2008).

The third property of *dou* is that it can quantify over the ∃-items *wh*-words such as *shei* 'who' and *shenme* 'what' and generate a universal reading (Huang 1982b; Cheng 1991; Li 1992). An example is shown in (35). In (35), the *wh*-word *shenme* 'what' has the [-WH] value, it is interpreted in the scope of *dou* and receives a non-interrogative universal reading. Example (36) shows that the other ∃-item *renhe* 'any' can also be licensed by *dou* and has a same universal meaning. [21]

(35) Yuehan **shenme**[-WH] shu dou kan.

    John   what   book all read

    'John reads every book.'

(36) Yuehan **renhe** shu dou kan.

    John   any   book all read

    'John reads every book.'

---

[21] If the modal *keyi* 'can' is introduced in sentences like (35) and (36), the *wh*-word *shenme* and renhe 'any' resemble Free Choice Items, as shown in (i) and (ii).

(i) Yuehan **shenme** shu dou keyi kan.

    John   what book all can read

    'John can read any book.'

(ii) Yuehan **renhe** shu dou keyi kan.

    John   any   book all can eat

    'John can read any book.'

Another constraint on *dou* is that, when it quantifies over a disjunctive phrase, a conjunctive interpretation is generated, as illustrated in (37). In (37), the polarity sensitivity of *huozhe* 'or' is cancelled. The disjunction word *huozhe* 'or' is [-PPI] and is interpreted in the scope of the quantifier *dou*. The sentence is true in only one circumstance, where John sold out of both the apples and the pears.

(37) Yuehan pingguo **huozhe** li dou maiwan-le.

    John   apple   or   pear all sell.out-ASP

    'John sold out of both the apples and the pears.'

Examples (35)-(37) indicate that the quantificational expression *dou* behaves like the type of linguistic expressions that is both downward entailing and anti-additive ($O_{[+AA]}$). For example, the *wh*-word *shenme* 'what' is [+WH] and receives a non-interrogative interpretation when it appears in the scope of $O_{[+AA]}$ expressions. This is shown for the $O_{[+AA]}$ negative existential quantificational expression *mei-you* 'not-have' in (38a), and for the $O_{[+AA]}$ antecedent of conditionals in (39a). In both cases, the wh-word *shenme* 'what' has the same meaning as the polarity sensitive expression *renhe* 'any,' as shown in (38b) and (39b).

(38) a. Mei-you xuesheng mai **shenme**$_{[-WH]}$ shu.

    not-have student buy what   book

    'No student bought any book.'

  b. Mei-you xuesheng mai **renhe** shu.

    not-have student buy any book

    'No student bought any book.'

(39) a. Ruguo you **shenme**[-WH] shengyin chaodao ni, qing gaosu wo.

    if   have what   noise   bother you please tell me

    'If any noise bothers you, please tell me.'

    b. Ruguo you **renhe** shengyin chaodao ni, qing gaosu wo.

    if   have any   noise   bother you please tell me

    'If any noise bothers you, please tell me.'

As we saw, when the disjunction *huozhe* 'or' is licensed by a $O_{[+AA]}$ lingusitic expression, the Mandarin disjunction word *huozhe* 'or' is [-PPI]. In such cases *huozhe* 'or' is interpreted *in situ* and generates a conjunctive interpretation. We have provided examples of this linguistic behavior using the negative existential quantificational expression *mei-you*[+AA] 'not-have' as in (40), and using the antecedent of *if*[+AA]-conditionals as in (41).

(40) Mei-you xuesheng he   pijiu **huozhe** hongjiu.

    not-have student   drink beer or   wine

    'No student drank beer **and** no student drank wine.'

(41) Ruguo Yuehan chi huasheng **huozhe** yu, ta jiu   hui shengbing.

    if   John   eat peanut   or   fish he then will   ill

    'If John eats peanuts, he will be ill **and** if John eats fish, he will be ill.'

So, just like the anti-additive operators ($O_{[+AA]}$), *dou* can license all the three ∃-items: the [-WH] *shenme* 'what', the polarity sensitive expression *renhe* 'any' and the [-PPI] *huozhe* 'or'. But when licensed by *dou*, these ∃-items are no longer Negative Polarity Items (NPIs).

Because they are licensed by $O_{[+AA]}$, they are converted into expressions with a conjunctive (universal) meaning.

The disjunction word *huozhe* 'or' and the polarity sensitive expression *renhe* 'any' are assigned a different interpretation in sentences that contain modal verbs. Consider sentence (42a), in which the disjunction word *huozhe* 'or' is in the scope of the modal verb *keyi* 'can'. This sentence generates a 'free choice inference', such that it can be paraphrased as in (42b), with the meaning that John is free to choose between beer and wine.

(42) a. Yuehan keyi he   pijiu **huozhe** hongjiu.

   John   can drink beer   or   wine

   'John can drink beer or wine.'

   b. Yuehan keyi he   pijiu bingqie yuehan keyi he hongjiu.

   John   can drink beer   and   John   can drink wine

   'John can drink beer and John can drink wine.'

If the modal *keyi* 'can' is removed from (42a), we are left with a plain disjunction word *huozhe* 'or' as in (43). The sentence is true in three circumstances, (i) if John drinks beer but not wine, (ii) if John drinks wine but not beer, or (iii) if John drinks both beer and wine. The third set of circumstances, in which John drinks both beer and wine is difficult to access for most people, due to a scalar implicature of 'exclusivity' (Grice 1975; Horn, 1996).

(43) Yuehan he   pijiu **huozhe** hongjiu.

   John   drink beer   or   wine

   'John drinks beer or wine.'

Next consider sentence (44), in which the polarity sensitive expression *renhe* 'any' is licensed by the modal *keyi* 'can'. The speaker of (44) is asserting that John has been given permission to drink all kinds of alcohol. In this context, *renhe* 'any' has universal force, and does not, at first glance, appear to be a ∃-item. This interpretation of *renhe* 'any' is a free choice inference, meaning that John is free to choose what alcohol to drink. If the modal *keyi* 'can' is removed, as in (45), the sentence becomes ungrammatical, because there is no licensor.

(44) Yuehan keyi he **renhe** jiu.

　　　John　can　drink any　alcohol

　　　'John can drink any alcohol.'

(45) *Yuehan he **renhe** jiu.

　　　 John　drink any　alcohol

　　　'John drinks any alcohol.'

When the *wh*-word *shenme* 'what' appears in sentences with the modal *keyi* 'can', it is a question marker, as illustrated in (46). If *keyi* 'can' is removed, as in (47), the sentence is upward entailing, and the *wh*-word *shenme* is still a question marker.

(46) Yuehan keyi he **shenme** jiu?

　　　John　can　drink what　alcohol

　　'Which alcohol can John drink?'

(47) Yuehan he　**shenme** jiu?

　　　John　drink　what　alcohol

　　'Which alcohol does John drink?'

We can see that the three ∃-items under discussion, the disjunction word *huozhe* 'or', the polarity expression *renhe* 'any' and the interrogative [+WH] interpretation of *shenme* are all licensed in sentences with the modal verb *keyi* 'can.' In this linguistic context, however, *renhe* 'any' and the disjunction word *huozhe* have a free choice reading, whereas the *wh*-word *shenme* 'what' functions as a question marker.

In contrast to the quantifier *dou* and anti-additive operators (O$_{[+AA]}$) like the negative existential *mei-you* 'not have' and the antecedent of conditionals, the 'weak' downward entailing operators (O$_{[-AA]}$) license *renhe* 'any', but these linguistic contexts only facilitate the interrogative [+WH] interpretation of *shenme* 'what.' As illustrated in (48) (repeated from (7)), when it appears in the scope of the comparative *bi*$_{[-AA]}$ ...*xian* 'earlier than', the *wh*-word *shenme* is [+WH]. It raises to tke scope over *bi*...*xian* 'earlier than' and is interpreted as a question marker, whereas *renhe* 'any' is analysed as an Negative Polarity Item.

(48) a. Yuehan bi **shenme** xuesheng xian dao?

    John   than what   student early arrive

   'Which student did John arrive earlier than?'

  b. Yuehan bi **renhe** xuesheng xian dao.

    John   than any student   early arrive

   'John arrived earlier than any other students.'

Notice what happens however, if the quantifier *dou* is added to (48) as shown in (49). In this case, the *wh*-word *shenme* 'what' becomes [-WH], and both *shenme* 'what' and *renhe* 'any' generate the same negative polarity readings.

(49) a. Yuehan bi **shenme** xuesheng dou xian dao.

     John   than what   student all early arrive

  'John arrived earlier than every student.'

    b. Yuehan bi **renhe** xuesheng dou xian dao.

     John   than any student   all early arrive

  'John arrived earlier than every student.'

Example (50) (repeated from example (29a)) shows that in the scope of the comparative operator *bi…xian* 'earlier than', which is $O_{[-AA]}$, *huozhe* 'or' is [+PPI], it raises to take scope over *bi…xian* 'earlier than' and generates a disjunctive interpretation.

(50) Yuehan bi Mali **huozhe** Tangmu xian   dao.

    John than Mary or   Tom   early arrive

    'It's Mary or Tom (and possibly both) that John arrived earlier than.'

Notice what happened, however, if the quantifier *dou* is added to (50) as shown in (51). In this case, the disjunction *huozhe* 'or' is no longer [+PPI], it is [-PPI], interpreted *in situ* and generates a conjunctive interpretation.

(51) Yuehan bi Mali **huozhe** Tangmu dou   xian   dao.

    John than Mary or   Tom   all early arrive

    'John arrived earlier than both Mary and Tom.'

Now we can see that in the scope of merely downward entailing operators ($O_{[-AA]}$) like the comparative operator *bi…xian* 'earlier than', the *wh*-word *shenme* is [+WH], and raises at the

level of semantic interpretation to yield an interrogative interpretation. In this linguistic context, the disjunction *huozhe* 'or' is [+PPI], and it also raises to take scope over $O_{[-AA]}$, generating a disjunctive reading. By contrast, the quantifier *dou* behaves like anti-additive operators ($O_{[+AA]}$). When it appears in the scope of *dou*, the *wh*-word *shenme* 'what' is [-WH] and the disjunction word *huozhe* 'or' is [-PPI], Both of them have to be interpreted in position. The *wh*-word *shenme* 'what' is assigned a non-interrogative universal reading and the disjunction word *huozhe* 'or' is assigned a conjunctive interpretation. On the other hand, *renhe* 'any', is always interpreted in position, no matter whether it is licensed by $O_{[-AA]}$ or by $O_{[+AA]}$-like *dou*.

A comparison of Examples (48) and (49) reveals that in merely downward entailing contexts, *dou* won't make a difference to the interpretation of *renhe* 'any', but will make a difference with the *wh*-word *shenme* 'what'. *Dou* turns the [+WH] *shenme* 'what' into [-WH]. A comparison of Examples (50) and (51) reveals that in merely downward entailing contexts, *dou* turns the [+PPI] *huozhe* 'or' into [-PPI], namely it turns the disjunctive interpretation of the disjunction *huozhe* 'or' into an existential quantifier with a conjunctive interpretation. Children's knowledge of the disjunction word *huozhe* 'or' in these two contexts is investigated in the study presented in this chapter.

4. The Semantic Subset Principle

A learnability problem arises whenever an expression has two possible values, one generating an interpretation that makes a sentence true in a superset of circumstances that correspond to the other interpretation. If the learner initially guesses the superset language, the evidence they encounter will always be consistent with this guess if the local language is actually the subset language. This is labelled the Subset Problem (Angluin 1980, Baker 1979).

The alternative values of the lexical parameter of disjunction stand in a subset/superset relation. The [+PPI] value of Disjunction Parameter makes sentences true in a superset of the

circumstances that correspond to the [–PPI] value. For example, English *or* exemplifies the subset value of the parameter, and Mandarin *huozhe* 'or' exemplifies the superset value although the polarity effect is cancelled when Mandarin disjunction *huozhe* 'or' is in strong linguistic environments as it is in sentences with anti-additive operators ($O_{[+AA]}$) and $O_{[+AA]}$-like *dou*. If children adopted the superset value, i.e., [+PPI], they would generate sentence meanings that are not licensed in the local language, in addition to ones that are licensed. This raises a learnability problem: in the absence of negative evidence, children would be unable to purge their grammars of the unacceptable meanings.

To avoid this subset problem, it has been proposed that children's hypotheses are constrained by a learning principle called the Semantic Subset Principle (SSP) (Crain, Ni, and Conway 1994). The SSP compels children to adopt the subset value of the parameter as their initial setting. The subset value for disjunction corresponds to the [-PPI] setting of the Disjunction Parameter. According to the SSP, children acquiring Mandarin initially select the parameter value corresponding to English; hence, child speakers of Mandarin would license conjunctive entailments in sentences with disjunction in any downward entailing contexts, whereas Mandarin adults only license such entailments in strong downward entailing contexts (sentences with $O_{[+AA]}$), but not in weak downward entailing contexts (sentences with $O_{[-AA]}$).

If we have a lexical parameter, whatever the surface syntax, the strong item moves out over $O_{[-AA]}$. A subset problem arises only when an asymmetric entailment occurs. For example, in English, disjunction is [-PPI], and when it is in the scope of $O_{[-AA]}$, it generates a conjunctive ($\Delta A \wedge \Delta B$) interpretation. In Mandarin, disjunction is [+PPI], and it generates a disjunctive ($\Delta A \vee \Delta B$) interpretation in the same linguistic environment. $\Delta A \wedge \Delta B$ (the subset reading) is stronger than $\Delta A \vee \Delta B$ (the superset reading), therefore $\Delta A \wedge \Delta B$ entails $\Delta A \vee \Delta B$, but the reverse does not hold.

Although the Mandarin *wh*-word *sheme* 'what' is associated with one of two values of a parameter {+WH, -WH}, the subset problem does not arise. This is because there is no

asymmetric entailment relation between the question and the statement. When there is no semantic subset problem, there is no requirement for children to take a particular reading as their initial hypothesis.

Now consider the polarity sensitive expression *renhe* 'any'. Because it has no alternative interpretation, there's no lexical parameter associated with it. *Renhe* 'any' is weak. When it appears with $O_{[+AA]}$, it is analysed as an NPI, with $O_{[+AA]}$-like *dou*, it is converted into an expression with a conjunctive (universal) meaning, and without $O_{[+AA]}$ or *dou*, it is ungrammatical.

5. Children's comprehension of disjunction in downward entailing contexts

Regardless of the different scope preferences exhibited by adult speakers of typologically distinct languages (e.g., English, Japanese, Mandarin), young children acquiring these languages initially assign the same scope preferences to disjunction in downward entailing contexts.

The earliest tests of this prediction were conducted by Goro and Akiba (2004a,b), with Japanese-speaking children and adults. They investigated children's interpretation of negated disjunctions in sentences like (52). For adult speakers, (52) means that the pig didn't eat the pepper OR the pig didn't eat the carrot. Despite the disjunction word *ka* appearing within the scope of negation, *nakat*, in the surface syntax, *ka* is interpreted by adults as having scope over negation.

(52) Butasan-wa ninjin ka pi'iman-wo tabe-nakat-ta

　　pig-TOP　pepper or carrot-ACC eat-NEG-PAST

　　'The pig didn't eat the pepper or the carrot.'

The Goro and Akiba study used a version of the Truth Value Judgment Task (Crain and Thornton 1998). The task was conducted by two experimenters. One experimenter acted out short vignettes in front of the child, and the other played a puppet, who watched the vignettes along with the child subject. The vignettes were about 12 different animals, who were presented with a pepper, a carrot and a cake to eat. If an animal ate both of the vegetables, the child was instructed to give it a gold medal; if an animal ate only one of the vegetables, then it received a blue medal, and if an animal did not eat either vegetable, then it received a black cross.

As anticipated, Japanese-speaking children (n=30; mean age 5;3) rejected the target statements 75% of the time. To justify their rejections, children pointed out that in sentences like (52), the pig had, as a matter of fact, eaten one of the vegetables. This response indicates that Japanese-speaking children assigned the NEG>OR reading. This reading is preferred by English-speaking children and adults, but not by adult speakers of Japanese; Japanese-speaking adults accepted the same sentences in the same circumstances 100% of the time. A replication of the Goro and Akiba study was conducted in Mandarin by Jing, Crain and Hsu (2005) with the same result.

Following Goro and Akiba (2004a, b), one other cross-linguistic study (Notley, Zhou, Jensen and Crain 2011) tested children's interpretation of disjunction in sentences with the temporal conjunction (English *before*, Mandarin *zai…zhiqian*). These temporal conjunctions are weak (merely) downward entailing operators, for both child and adult speakers of Mandarin and English. The Notley et al. study used a Truth Value Judgment Task. The task involved two experimenters. One acted out stories using toy characters and props, and the other played the role of a puppet who watched the stories alongside the child subject. On a typical trial, there was a running race between three animals, a dog, a turtle and a bunny. At the conclusion of the race, the bunny was first, the dog came in second, and the turtle finished last. When the story concluded, the puppet produced test sentence (53).

(53) English: The dog reached the finish line before the turtle or the bunny.

Mandarin: Xiaogou zai wugui huozhe tuzi zhiqian paodao-le zhongdian.

dog   at turtle or   rabbit before   reach-ASP finish line

'The dog reached the finish line before the turtle or the bunny'

The child's task was to decide whether the puppet's statement was an accurate description of the story. Here are the main findings. Mandarin-speaking adults rejected the test sentences 75% of the time, whereas Mandarin-speaking children rejected them 100% of the time. The English-speaking children rejected the test sentences 93% of the time, and English-speaking adults rejected them 98% of the time.

The results of this experiment show that Mandarin-speaking children behave more like English-speaking children and adults than like Mandarin-speaking adults. The findings are evidence that Mandarin-speaking children are guided by the semantic subset principle in acquiring the meaning of disjunction. That is, children initially analyse the disjunction *huozhe* in the scope of the (weak) downward entailing operator *zai...zhiqian* 'before', because this generates the truth conditions associated with the subset reading of the Disjunction Parameter in Mandarin. These findings also provide evidence against an experience-based account of language development, since Mandarin-speaking children are clearly not using adult input as the basis for their interpretation of disjunction *huozhe*.

Children's interpretation of disjunction in downward entailing and non-downward entailing contexts has been the subject of cross-linguistic investigations. One representative example is a study by Su, Zhou & Crain (2011) who investigated Mandarin-speaking children's interpretation of the disjunction word *huozhe* 'or' in the predicate phrase of *meiyou* 'not-have' versus *mei* 'every'. The study adopted a Truth Value Judgment Task, and the main finding was that both children and adults have a conjunctive interpretation of *huozhe* in the predicate phrases of *meiyou* 'not-have', whereas both children and adults assigned a

disjunctive interpretation to *huozhe* when it appeared in the predicate phrases of *mei* 'every'. The test sentences included (54) and (55).

(54) Meiyou xiaoche juqi daishu huozhe xiaogou.

    not-have car   lift kangaroo or   dog

   'No car lifted a kangaroo or a dog.'

(55) Mei-liang xiaoche dou juqi-le   daishu huozhe xiaomao.

    every-CL car   all lift-ASP kangaroo or   cat

   'Every car lifted a kangaroo or a cat. '

In (54), the disjunction word *huozhe* 'or' is in the predicate phrase of *meiyou* 'not-have'. Since this is a strong downward entailing context (with the negative existential *meiyou*, which is anti-additive), the polarity sensitivity of the disjunction *huozhe* is cancelled and, consequently, *huozhe* generates a conjunctive entailment. However, when the disjunction word *huozhe* appears in the predicate phrase of *mei* 'every,' as in (55), it does not generate a conjunctive entailment, because the predicate phrase of *mei* 'every' is a non-downward entailing linguistic environment.

     The results revealed that both children (n=26, mean age 4;9) and adults rejected the test sentences with disjunction in the predicate phrase of *meiyou* 'not-have' (children: 94% of the time, adults: 98% of the time). By contrast, both children and adults accepted the test sentences when *huozhe* 'or' was in the predicate phrase of *mei* 'every' (children: 90% of the time, adults: 95% of the time). This study provided evidence that Mandarin-speaking adults assign a conjunctive interpretation of disjunction in strong downward entailing linguistic contexts. In such contexts, children also initially favour the conjunctive interpretation of disjunction. However, children and adults differed in the interpretation of disjunction in the

predicate phrase of *mei* 'every'. In such non-downward entailing context, adults computed an implicature of exclusivity, but children failed to compute this implicature, as has been found in much previous work.

In a similar study, Su (2011) tested three-to-five-year-old Mandarin-speaking children's interpretation of disjunction word *huozhe* 'or' in *ruoguo*-conditional (*if*-conditional) sentences. The test sentences are shown in (56) and (57). In (56), *huozhe* is in the antecedent clause. It is a strong downward entailing (anti-additive) context, therefore the polarity sensitivity of the disjunction *huozhe* is cancelled and *huozhe* is assigned a conjunctive entailment. By contrast, in (57), *huozhe* is in the consequent clause. Since it is a non-downward entailing context, adult speakers are expected to assign disjunctive truth conditions to *huozhe*.

(56) Ruguo xiaoma yunzou yumi huozhe huotuichang, ta jiu   hui dedao jinbi.

     if   pony   move corn or   sausage   he then will get   gold.coin

     'If a pony moves a corn or a sausage, then he will get a gold coin.'

(57) Ruguo xiaotuzi zhaodao baoshi, ta   jiu hui dedao xiaoqiu huozhe xingxing

     if   rabbit   find   jewel she then will get   ball   or   star

     'If a rabbit finds a jewel, then she will get a ball or a star.'

The results show that, along with the rules of first order logic, Mandarin-speaking children (n=30, mean age 4;11) assigned a conjunctive entailment when disjunction appears in the antecedent clause as in (56) (97% of the time), and they assigned a disjunctive entailment when it appeared in the consequent clause as in (57) (91% of the time), showing an adult-like mastery of disjunction when it appeared in conditional sentences.

Using a truth-value judgment task, Jing, Crain and Hsu (2005) investigated Mandarin-speaking children's interpretation of sentences with the quantificational expression *dou* 'all' and the disjunction word *huozhe* 'or' as in (58). On a typical trial, three workers were wearing hats and one was not wearing a hat. The workers with hats either had a hammer or a pair of pliers (and one also had a wrench), whereas the worker without a hat had a hammer. The sentence (58) was therefore, false for adults, because one worker with a hammer was not wearing a hat.

(58) Na-le   chuizi   huozhe qianzi de gongren dou dai-zhe   maozi.

     take-ASP hammer or   pliers DE worker all wear-ASP hat

     'Workers that took a hammer or a pair of pliers are all wearing a hat.'

It was found that 23 out of the 30 children rejected the sentence (58), and justified their rejections by pointing out that the worker without a hat had a hammer. In other words, children interpreted sentence (58) as meaning "workers with a hammer are wearing hats AND workers with a pair of pliers are wearing hats". This was taken to be evidence that children know that *dou* quantifies over disjunction in its scope, thereby generating a conjunctive interpretation of disjunction.

Based on previous findings, it appears that Mandarin-speaking adults generate a disjunctive interpretation of disjunction in weak (merely) downward entailing contexts (Jing, Crain and Hsu 2005; Notley, Zhou, Jenson and Crain 2011), and they assign a conjunctive interpretation of disjunction in strong downward entailing (anti-additive) contexts (Su 2011; Su, Zhou, and Crain 2011) and sentences with the anti-additive-like operator *dou* (Jing 2005). However, across languages, young children initially favour the similar interpretive pattern of assigning the conjunctive entailment to disjunction when it appears in the scope of a

downward entailing operator, no matter how complicated the corresponding interpretations might be (Crain, 2008).

6. Experiments

We designed two experiments to investigate whether or not Mandarin-speaking children have the adult setting of the lexical semantics parameter, and assign the same scope values when interpreting the disjunction word huozhe 'or.' Children's knowledge of these properties was investigated in two different linguistic contexts. In the first context, tested in Experiment 1, Mandarin-speaking children's interpretation of the disjunction word huozhe 'or' in sentences with the comparative operator bi…xian 'earlier than' alone was tested, in sentences like (59).

(59) Xiaoyang bi[-AA] xiaogou huozhe shizi *xian* padao   shuding.

    sheep   than   dog   or   lion early climb   tree.top

  'The sheep will reach the top of the tree earlier than the dog or the lion.'

In (59), the Mandarin disjunction word *huozhe* 'or' appears in the scope of the comparative operator *bi…xian* 'earlier than'. Since *bi…xian* 'earlier than' is [-AA], for Mandarin adults, the disjunction *huozhe* is [+PPI], so we anticipated that adult participants would assign the inverse scope reading. Consequently, the disjunction word *huozhe* 'or' should have a disjunctive interpretation as in 'The sheep will reach the top of the tree earlier than the dog OR the sheep will reach the top of the tree earlier than the lion.' If Mandarin-speaking children adopt the non-adult subset value of the disjunction parameter, as dictated by Semantic Subset Principle, then they are expected to assign the surface scope reading. On this reading, sentence (59) generates a conjunctive interpretation, which can be paraphrased as 'The sheep will reach the top of the tree earlier than the dog AND the sheep will reach the top of the tree earlier than the lion.'

Experiment 2 was designed to assess how Mandarin-speaking children interpret the disjunction *huozhe* 'or' in sentences with the comparative operator $bi_{[-AA]}...xian$ 'earlier than' and the quantificational adverb *dou* 'all', as illustrated in (60).

(60) Xiaoyang $bi_{[-AA]}$ xiaogou huozhe shizi dou xian padao shuding.

  sheep than   dog or   lion all early climb tree.top

 'The sheep will reach the top of the tree earlier than both the dog and the lion.'

In (60), the disjunction word *huozhe* 'or' appears in the sentence with two operators. One is the quantificational expression *dou*, which behaves like anti-additive operators, and is a strong downward entailing operator; the other is the comparative operator *bi...xian* 'earlier than', which is a weak (merely) downward entailing operator. Since *dou* is stronger than $bi_{[-AA]}...xian$, *huozhe* 'or' is in a strong environment; therefore, the polarity sensitivity of *huozhe* is cancelled and *huozhe* has to be interpreted in position. For this reason, we anticipated that both adult and child participants would assign a conjunctive interpretation to the test sentences.

6.1 Participants

In Experiment 1, we tested thirty Mandarin-speaking children between the ages of 3;10 and 5;2, with a mean age of 4;2.

In Experiment 2, twenty Mandarin-speaking children were tested. The children ranged in age between 3;9 and 4;10, with a mean age of 4;3. All of the children were recruited from the kindergarten affiliated with Beijing Language and Culture University (BLCU), Beijing. They had no reported history of speech, hearing or language disorders. In addition, twenty-nine monolingual Mandarin-speaking adults (age range 36 to 50 years) served as a control group. The adults were from the suburbs of Beijing, and did not speak English.

6.2 Procedures

To administer this experiment, we adopted the prediction mode of the truth value judgment task (Chierchia et al., 1998). The prediction mode is an alternative to the usual description mode variant of the truth value judgment task. In general, this experimental technique is designed to investigate which meanings children can and cannot assign to sentences (Crain & Thornton, 1998). The prediction mode introduces uncertainty about how events will transpire in the story that is acted out for children. Specifically, the test sentences are presented to the child subjects as predictions about what will happen in the remainder of the story, rather than as descriptions of events that have already taken place. The prediction mode is appropriate when testing disjunction.

The task involved two experimenters – one acting out stories with toy characters and props, and the other playing the role of a puppet who watched the stories alongside the child. In the middle of the story, the puppet produced a sentence which purported to predict what would happen next. Then, the story continued and the puppet repeated his prediction after the outcome was revealed. The child's task was to tell the puppet whether his prediction was right or not. If the child informed the puppet that his prediction was wrong, then the child was asked to explain to the puppet what really happened in the story. The explanation children produced was used in the subsequent data analysis, to ensure that the child understood the story and produced a legitimate reason for rejecting the puppet's statement. Whenever the child subject judged that the puppet predicted the 'right thing', the child fed the puppet his favourite food, say, a cookie. But if the child judged the puppet predicted the 'wrong thing', the child gave him a bite of something he doesn't like as well, say a pepper. These procedures made it fun for children to play the game, and they encouraged children to attend to the test sentences.

The participants were introduced to the task individually and were tested individually. They were given four practice trials before the formal test session. On two of these practice

trials, the puppet predicted the simple sentences with the comparative operator *bi* ('than')

alone, as *Xiongmao bi xiaogou chi-de duo.* 'The panda will eat more than the dog.' One was

obviously true, and the other was obviously false. On the other two practice trials, the puppet

predicted the simple sentences with *dou*, as *Xiaoma he xiaoyang dou shuaidao le*. 'Both the

horse and the sheep will fall over.' One was true, the other was false. These practice trials

were included to verify that the child subjects could understand *bi* 'than' and *dou* 'all' in very

simple sentences, and help the children to understand that the puppet could predict something

right or wrong, thus familiarising them with the task. These practice trials were presented in a

pseudo-random order. Only those child subjects who correctly judged the truth and falsity of

the practice trials were permitted to proceed to the actual test session. Adult controls were

tested individually using the same task.

6.3 Materials

Each experiment consisted of four test stories. Each story was about a competition among

three characters. In each competition, one character came in first place, one came in second

and one was last. At the end of the competition, the characters were rewarded according to

their place in the competition (first, second or third). For each story, the test sentence in

Experiment 1 contained the disjunction *huozhe* 'or' with the comparative operator *bi…xian*

'earlier than' alone, as illustrated in (61); the test sentence in Experiment 2 contained *huozhe*

with *bi…xian* 'earlier than' and the quantificational expression *dou*, as shown in (62). (61)

and (62) are repeated from (59) and (60).

(61) Xiaoyang bi$_{[-AA]}$ xiaogou huozhe shizi *xian* padao   shuding.

     sheep   than   dog   or   lion early climb   tree.top

   'The sheep will reach the top of the tree earlier than the dog or the lion.'

(62) Xiaoyang bi[-AA] xiaogou huozhe shizi dou xian padao shuding.

    sheep   than   dog   or   lion all early climb tree.top

   'The sheep will reach the top of the tree earlier than both the dog and the lion.'

In the contexts associated with two of the four test sentences, the referent of the subject NP (e.g. the sheep) came first, so this is called the First-Place condition. For the other two sentences, the referent of the subject NP came second, so this is the Second-Place condition. We controlled the order of the disjunct in each condition. For the two First-Place condition sentences, the character on the first disjunct reached second in one, and reached third in the other. For the two sentences in the Second-Place condition, the character mentioned in the first disjunct came in first place in one trial, and came in third place in the other trial.

We expected that if children initially assume that disjunction is [-PPI], they would compute conjunctive interpretations of disjunctions in both (61) and (62). In this case, they would be expected to judge both (61) and (62) to be true in the First-Place condition, but false in the Second-Place condition. On the other hand, if children adopt adult values of the Disjunction Parameter, then they would assign the disjunctive interpretation of disjunction in (61), but the conjunctive interpretation of disjunction in (62). In this case, children would be expected to judge (61) to be a true description of the stories in both conditions (i.e. when the sheep reached the top of the tree first, earlier than both other participants, as well as when the sheep reached the top of the tree second, earlier than only one other participant), and they would be expected to judge (62) to be true in the First-Place condition, but false in the Second-Place condition. An example of a typical context is as follows.

A lion, a sheep and a dog are learning tree climbing with Master Raccoon. The day of the final exam had arrived. The one who reaches the top of the tree first will get the award of excellence. The exam is about to begin! (as illustrated in Fig. 1)

Fig.1. The first half of the sample story in the experiment

At this point, the puppet made a prediction about the outcome of the exam, using a test sentence as *wo cai xiaoyang bi*[-AA] *xiaogou huozhe shizi xian padao shuding.* 'I guess the sheep will reach the top of the tree earlier than the dog or the lion.' (in Experiment 1) or as *wo cai xiaoyang bi*[-AA] *xiaogou huozhe shizi dou xian padao shuding.* 'I guess the sheep will reach the top of the tree earlier than both the dog and the lion.'(in Experiment 2). After that, the experimenter continued the story saying to the puppet 'All right, let's continue this story to see whether your guess is right or not.'

Now Master Raccoon says: 'Get ready! Go!' The lion is really a good climber. He reaches the top of the tree easily. The sheep climbs halfway up the tree but hasn't enough puff in him to last out till the top of the tree. The dog has trouble, each time he lifts up his front paws, his back paws slide off the branches. No luck, he cannot climb the tree at all. (Fig. 2 illustrates the scene at the conclusion of the story).

Fig.2. The second half of the sample story in the experiment

After the story, the experimenter asked the puppet what he had just guessed. Then the puppet repeated the test sentence to remind the subjects about his prediction as *wo cai-de shi xiaoyang bi*[-AA] *xiaogou huozhe shizi xian padao shuding.* 'What I guessed was the sheep would reach the top of the tree earlier than the dog or the lion.'(in Experiment 1); or as *wo cai-de shi xiaoyang bi*[-AA] *xiaogou huozhe shizi dou*[+AA] *xian padao shuding.* 'What I guessed was the sheep would reach the top of the tree earlier than both the dog and the lion.' (in Experiment 2).

Each test trial was followed by a filler trial in which the puppet predicted sentence contained neither comparatives nor *dou,* nor disjunction. For example in a long jump competition, the puppet made a prediction as *Houzi tiao de zui yuan.* 'The monkey will jump farthest.' So, in total, the children responded to eight items in this task. The fillers allowed us to balance the total number of true and false statements, and check whether the children had been paying attention to the stories. The experimental session took about 20 minutes, and was

audio-recorded. The subjects' responses to the test sentences were recorded for subsequent analysis.

6.4 Results and discussion

All the subjects responded correctly to the filler trials. Consider first the results from Experiment 1, where the disjunction *huozhe* is in sentences with the comparative operator *bi*[-AA]...*xian* 'earlier than'. In this context, thirty Mandarin-speaking children accepted the test sentences 98% of the time in the First-Place condition (57/58 trials[22]), but rejected them 93% of the time in the Second-Place condition (55/59 trials). The overall pattern of results across children clearly shows that Mandarin-speaking children have a preference to assign a conjunctive interpretation to the disjunction *huozhe* 'or' in sentences with the comparative operator *bi*[-AA]...*xian* 'earlier than'.

A Wilcoxon signed rank test revealed a significant difference between the children's responses in the two conditions (Z=3.74, p<0.001). The children's justifications for their rejections typically showed they understood the test sentences to mean that the referent of the subject NP had come in first place. For example, the response of one child aged 4;2 to the Second-Place condition sentence *Xiaoyang bi xiaogou huozhe shizi xian padao shuding.* '[The sheep]2nd place will reach the top of the tree earlier than [the dog]3rd place or [the lion]1st place.' is given in (63):

(63) PUPPET: Wo cai dui-le hai shi cai cuo-le?

'Did I guess right or wrong? '

---

[22] The response to one test sentence of one child (which is First-Place condition) was excluded from the analysis, because he said *Wo mei tingdong shi shenme yisi*. 'I didn't catch the meaning of what he said.' One child wasn't presented last 2 test stories for lack of time. One is First-Place condition, the other is Second-Place condition.

CHILD: Cuo-le.

    'Wrong'

PUPPET: Weishenme?

    'Why? '

CHILD: Yinwei shizi xian dao.

    'Because the lion reached first.'

A group of 14 monolingual Mandarin-speaking adults accepted the test sentences 96% of the time in the First-Place condition (27/28 trials), and 96% of the time in the Second-Place condition (27/28 trials). In adult Mandarin, the conjunctive interpretation of disjunction is not the only available reading in sentences with *bi...xian* 'earlier than'. Disjunction takes scope over *bi...xian* 'earlier than' for adult speakers, making the Second-Place condition sentence true. A Mann–Whitney test comparing the children's responses with adult responses in this task showed no significant difference in the First-Place condition (Z=3.06, p<0.05), but a significant difference in the Second-Place condition (Z=3.06, p<0.05). The comparison of the child and adult acceptance rates to the two test sentence conditions is given in Figure 3.
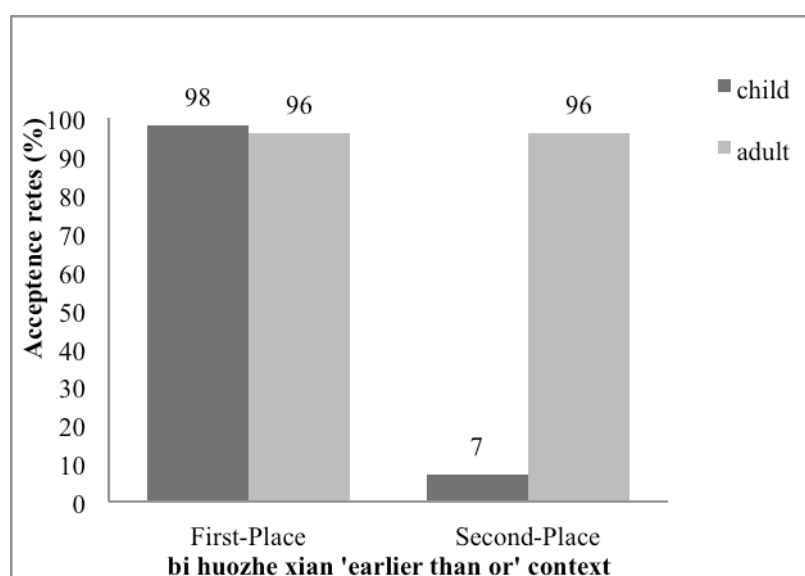

Figure 3. Child and adult acceptance rates in Experiment 1

The findings from Experiment 1 indicate that disjunction is permitted to take scope over the comparative operator $bi_{[-AA]}...xian$ 'earlier than' for adults, but children consistently generate a conjunctive interpretation of disjunction in the scope of the comparative $bi...xian$ 'earlier than,' so children require that the referent of the subject NP arrive first, not just before one of the others.

This brings us to the findings from Experiment 2, where the disjunction *huozhe* appeared in sentences that contained the quantificational adverb *dou* and the comparative operator $bi_{[-AA]}...xian$ 'earlier than'. In this context, twenty Mandarin-speaking children accepted the test sentences 83% of the time in the First-Place condition (33/40 trials), but children rejected the sentences 78% of the time in the Second-Place condition (31/40 trials). The results show that children compute the conjunctive interpretation of disjunction when disjunction *huozhe* 'or' appears in sentences with *dou*. A Wilcoxon signed rank test revealed a significant difference between the children's responses in the two conditions (Z=3.49, p<.001). Children's justifications for their rejections showed they understood the test sentences to mean that the referent of the subject NP had come in first.

The fifteen adult participants accepted the First-Place test sentences 100% of the time (30/30 trials) and rejected their Second-place test sentences 100% of the time (30/30 trials). A Mann–Whitney test comparing child and adult responses in this task showed no significant differences in either the First-Place condition (Z=1.66, p=0.521) or the Second-Place condition (Z=0.859, p=0.681). The comparison of English-speaking child and adult acceptance rates to the two test sentence conditions is given in Figure 4.
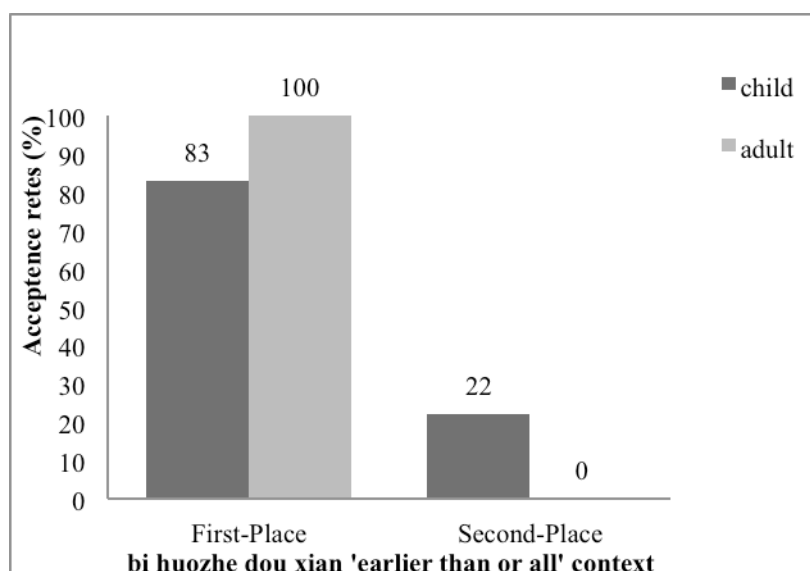
Figure 4. Child and adult acceptance rates in Experiment 2

The findings in Experiment 2 show that both children and adults generate a conjunctive interpretation of disjunction in the scope of the quantificational adverb *dou*. So both groups required the referent of the subject NP to arrive before one of the others, but not before both.

7. General discussion

The present study investigated Mandarin-speaking children's comprehension of the disjunction word *huozhe* 'or'. We compared children's interpretation of *huozhe* in sentences with the downward entailing (but not anti-additive) comparative expression *bi..xian* 'earlier than', both with *dou* (*bi…dou xian*) as shown in (65) (Experiment 2) and without *dou* (*bi…xian*) as shown in (64) (Experiment 1) ((64) and (65) are repeated from (59) and (60)).

(64) Xiaoyang bi$_{[-AA]}$ xiaogou huozhe shizi *xian*   padao   shuding.

    sheep   than   dog   or   lion early climb   tree.top

  'The sheep will reach the top of the tree earlier than the dog or the lion.'

(65) Xiaoyang bi$_{[-AA]}$ xiaogou huozhe shizi dou xian padao shuding.

     sheep   than   dog   or   lion   all   early   climb   tree.top

   'The sheep will reach the top of the tree earlier than both the dog and the lion.'

The results show that Mandarin-speaking adults assign a disjunctive interpretation of *huozhe* in (64), is a weak DE context; but a conjunctive interpretation of *huozhe* in (65), a strong DE context. However, Mandarin-speaking children assign a conjunctive interpretation of the disjunction *huozhe* in both linguistic environments. This finding is analogous to some of the results reported in previous studies using different DE operators. For example, the sentences with the predicate negation *meiyou* 'not' (Jing, Crain and Hsu 2005) and the sentences with the temporal conjunction *zai...zhiqian* 'before' (Notley, Zhou, Jensen and Crain 2011) are both weak DE contexts, and it has been found that children do not assign *huozhe* the disjunctive reading in these contexts as adults do; rather, children assign a conjunctive meaning. On the other hand, in the sentences with the antecedent of a conditional (Su 2011) and the sentences with the negative existential *mei-you* 'not-have' (Su, Zhou, and Crain 2011), both strong DE contexts, both children and adults generate the same conjunctive interpretation of *huozhe*.

    The findings of these experiments support the distinction between weak DE operators and strong DE operators, For adults, in weak DE contexts, the polarity restriction is associated with the value [+PPI], *huozhe* is interpreted as taking scope over weak DE operators (OR > Δ), generating a weak (superset) reading; whereas when *huozhe* appears in strong DE contexts, its polarity sensitivity is cancelled. In this case, strong DE operators take scope over *huozhe* (Δ > OR), yielding a strong (subset) reading.

    The findings of these experiments also support the hypothesis that children adhere to the Semantic Subset Principle (SSP) and are guided by universal logical principles governing the interpretation of disjunction. The SSP is viewed as a learning mechanism that dictates

how children initially set certain lexical parameters. For these parameters, the alternative values generate readings that stand in a subset/ superset relation. In such cases the SSP entreats children to initially adopt the parameter value that is associated with the strong (subset) reading, even if this requires the child to enforce polarity restrictions that are not enforced by adults. The SSP ensures that language learners avoid adopting the superset value of lexical parameters in cases where these values would lead to a subset problem. To avoid subset problems, the SSP requires children to initially adopt the [-PPI] value of the lexical parameter, so the lexical *huozhe* is not raised but rather interpreted in its surface syntactic position in any kind of DE context. This is the only way for children to add a weaker reading on the basis of truth-conditional evidence. Children receive evidence from the input informing them that the strong reading is not operative in certain circumstances. Based on positive evidence, therefore, children can realign their intpertations to make them consistent with those of adult speakers in the local linguistic community. For example, adults will provide evidence that they assign a disjunctive interpretation of *huozhe* in the sentence in (65), because adults will use this sentence in circumstances in which the sheep reaches the top before the dog but not before the lion.

The strength of DE contexts is relevant in adults' interpretation of sentences with scope ambiguities not only in the cases of the disjunction word *huozhe* 'or'. For example, we observed that in weak DE contexts like sentences with the comparative operator *bi...xian* 'earlier than' as in (66), the *wh*-word *shenme* 'what' has the [+WH] value. This means that it raises at the level of semantic interpretation, to generate an interrogative interpretation. However, when *shenme* appears in strong DE contexts like sentences with *dou* as in (67), the *wh*-word *shenme* has the [-WH] value, and it sits in the surface syntax position (*in situ*) at LF.

(66) Xiongmao bi   shenme dongwu xian   laidao xuexiao?

    panda   than what   animal early arrive school

   'Which animal did the panda arrived at school earlier than?'

(67) Xiongmao bi   shenme dongwu dou xian laidao xuexiao.

    panda   than what   animal all early arrive school

   'The panda arrived at school earlier than every animal.'

Since there is no asymmetric entailment relation between the question and the statement as illustrated in (66) and (67), though *sheme* is associated with [+/-WH], children don't have the subset problem. Therefore, children do not have to start up with a particular reading. This is confirmed by the experiments we conducted in Chapter 2 and Chapter 3. It was found that children exhibit adult-like sensitivity to the different interpretations of the *wh*-word *shenme* in (66) and (67).

In the case of the polarity sensitive expression *renhe* 'any', there is no lexical parameter to be set. The consequence is that there is no need to invoke the SSP. This is also confirmed by the experiments we conducted in Chapter 2 and Chapter 3 using the test sentences as in (68) and (69).

(68) Xiongmao bi   renhe dongwu xian laidao xuexiao.

    panda   than any   animal early arrive school

   'The panda arrived at school earlier than any other animals.'

(69) Xiongmao bi   renhe dongwu dou xian laidao xuexiao.

    panda   than any   animal   all   early arrive school

   'The panda arrived at school earlier than every animal.'

8. Conclusion

The present study was designed to validate a theoretically motivated account of the distribution and interpretation of three ∃-items: the disjunction word *huozhe* 'or', the *wh*-word *shenme* 'what' and the polarity sensitive expression *renhe* 'any.' The analysis we proposed drew on a distinction between 'weak' Downward Entailing (DE) operators and 'strong' ones. Based on this distinction, we have established the following: In sentences with weak DE operators, *huozhe* is assigned disjunctive truth conditions, the wh-word *shenme* is interpreted as a question marker, and *renhe* is analysed as an NPI. In strong DE contexts, *huozhe, shenme* and *renhe* all yield a 'conjunctive' (universal) meaning. Finally, in upward entailing contexts, the disjunction word *huozhe* has disjunctive truth conditions, the *wh*-word *shenme* functions as a question marker, and the polarity sensitive items *renhe* is not tolerated.

This study also investigated how young Mandarin-speaking children interpret the disjunction word *huozhe* 'or' in sentences with strong Downward Entailing (DE) operators and in ones with weak DE operators. The results support the conclusion that the strength of DE operators plays an important role in determining how logical scope is assigned in sentences with multiple logical expressions. The results lend additional weight to the growing body of evidence that children initially favour scope assignment that generates strong readings, even in cases where adults strongly favour the weak scope assignment. Therefore, the findings add new evidence for the Semantic Subset Principle.

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Appendix 1

Test sentences used in Experiment 1

(1) Xiaoyang bi xiaogou huozhe shizi xian padao   shuding.

   sheep   than dog   or   lion early climb   tree.top

  'The sheep will reach the top of the tree earlier than the dog or the lion.'

(2) Zi-huoche   bi huang-huoche huoche lan-huoche xian yun-wan   shitou.

   purple-train   than yellow-train   or   blue-train early carry-finish stone

   'The purple train will finish carrying stones earlier than the yellow train or the blue train.'

(3) Xiaozhu bi xiaolaohu huozhe xiaoxiong xian likai shamo.

    pig   than tiger   or   bear   early leave desert

   'The pig will leave the desert earlier than the tiger or the bear.'

(4) Xiongmao bi xiaotu huozhe xiaomao xian laidao xuexiao.

    panda   than rabbit or   cat   early arrive   school

   'The panda will arrive at school earlier than the rabbit or the cat.'

Appendix 2

Test sentences used in Experiment 2

(1) Xiaoyang bi xiaogou huozhe shizi dou xian padao   shuding.

    sheep   than dog   or   lion all early climb   tree.top

    'The sheep will reach the top of the tree earlier than both the dog and the lion.'

(2) Zi-huoche   bi   huang-huoche huoche lan-huoche dou xian yun-wan   shitou.

    purple-train than yellow-train   or   blue-train   all early carry-finish stone

    'The purple train will finish carrying stones earlier than both the yellow train and the blue

    train.'

(3) Xiaozhu bi xiaolaohu huozhe xiaoxiong dou xian likai shamo.

    pig   than tiger   or   bear   all early leave desert

    'The pig will leave the desert earlier than both the tiger and the bear.'

(4) Xiongmao bi xiaotu huozhe xiaomao dou xian laidao xuexiao.

    panda   than rabbit or   cat   all early arrive school

    'The panda will arrive at school earlier than both the rabbit and the cat.'

Appendix 3

Children's responses on each condition of the example trials, Experiment 1

Subject	Age	Bi *huozhe xian* 'earlier than or' sentence	
		Responses	
		First-Place condition	**Second-Place condition**
Girl	5;2	Right.	Wrong, the lion reached first.
Girl	5;0	Right.	Wrong, the lion is the first; he (pointing to the sheep) is the second.
Boy	4;6	Right.	Wrong, the lion reached first.
Girl	5;2	Right.	Wrong, he reached first (pointing to the lion).
Boy	4;9	Right.	Wrong, the lion reached first.
Girl	4;10	Right.	Wrong, the lion is the first.
Girl	4;11	Right.	Wrong, the lion reached first.
Boy	5;0	Right.	Wrong, the lion reached first.
Boy	4;9	Right.	Wrong, the lion is the first.
Boy	5;0	Right.	Wrong, he is the first (pointing to the lion).
Girl	4;11	Right.	Wrong, the lion reached first.
Boy	4;10	I didn't catch the meaning of what he said.	Wrong, the lion reached first.
Girl	4;9	Right	Wrong, the lion reached first.
Boy	4;4	Right	Wrong, the lion is the first.
Boy	4;5	Right	Wrong, the lion reached first, he (pointing to the sheep) is the second.
Boy	4;9	Right	Wrong, the lion reached first.
Boy	3;10	Right	Wrong, he is the first (pointing to the lion).

Boy	4;2	Right	Wrong, the lion reached first.
Boy	4;5	Right	Wrong, the lion reached first.
Girl	4;4	Right	Wrong, he reached first (pointing to the lion).
Girl	4;3	Right	Wrong, the lion reached first.
Boy	4;10	Right	Wrong, the lion is the first.
Boy	4;9	Right	Wrong, the lion reached first.
Boy	4;7	Right	Wrong, the lion reached first.
Boy	4;6	Right	Wrong, the lion reached first.
Boy	4;10	Right	Wrong, he is the first (pointing to the lion).
Boy	4;5	Right	Wrong, the lion is the first.
Girl	4;3	Right	Wrong, the lion reached first.
Girl	4;7	Right	Wrong, the lion reached first
Girl	4;5	Right	Wrong, the lion reached first.

Appendix 4

Children's responses on each condition of the example trials, Experiment 2

Subject	Age	*Bi huozhe dou xian* 'earlier than or all' sentence	
		Responses	
		First-Place condition	**Second-Place condition**
Girl	4;2	Right.	Wrong, the lion reached first.
Boy	4;5	Right.	Wrong, the lion reached first.
Girl	4;3	Wrong, the panda arrived earlier than the rabbit and the cat.	Wrong, the lion is the first, the sheep is the second.
Girl	4;5	Right.	Right.
Boy	4;1	Right.	Wrong, the lion reached first.
Boy	4;0	Right.	Wrong, the lion is the first, not the sheep.
Boy	4;5	Right.	Wrong, the lion reached first.
Boy	4;10	Right.	Wrong, he is the first (pointing to the lion).
Girl	3;10	Wrong, the rabbit arrived first.	Right.
Girl	4;9	Right.	Wrong, the lion reached first.
Girl	4;3	Right.	Wrong, the lion is the first.
Girl	4;6	Right.	Wrong, the lion reached first, not the sheep.
Boy	4;5	Right.	Wrong, the lion is the first.
Girl	4;1	Right	Right.
Boy	4;6		Wrong, the lion reached first.
Boy	4;6	Right.	Wrong, the lion is the first.

Girl	4;2	Right.	Wrong, the lion reached first.
Girl	3;9	Wrong, the rabbit arrived first.	Wrong, he is the first (pointing to the lion), he is the second (pointing to the sheep).
Girl	4;1	Right.	Right.
Girl	4;7	Right.	Wrong, the lion reached first.

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

(1) Dui   le.

   right SFP

   'Right.'

(2) Wo mei ting-dong shi shenme yisi.

   I   not hear-understand is what meaning

   'I didn't catch the meaning of what he said.'

(3) Cuo   le.

   wrong SFP

   'Wrong.'

(4) Shizi xian dao.

   lion   early arrive

   'The lion reached first.'

(5) Ta di-er.

   he second

 'He is the second.'

(6) Shizi di-yi.

   lion   first

 'The lion is the first.'

CHAPTER 5

Conclusion

Conclusion

This thesis explores Mandarin-speaking children's interpretations of the *wh*-word *shenme* 'what' by comparing the interpretation of *shenme* to that of the polarity sensitive expression *renhe* 'any' and the disjunction operator *huozhe* 'or.' These three kinds of Mandarin expressions make similar semantic contributions to conversational contexts where the individuals under discussion have been identified or are salient. Therefore, they form a class which we will call ∃-items. In the present study, all three of these ∃-items have been investigated in three formally distinct linguistic environments. The distributional and interpretive patterns of these expressions were assessed in these environments in a series of experimental investigations of children's developing semantic knowledge. This chapter summarizes the major findings and discusses the relevance of these findings for some of the key issues in language development.

As a *wh*-in-situ language, Mandarin *wh*-words can be used to ask questions and they can be used to make statements. In statements, the *wh*-word *shenme* 'what' is similar in meaning to the existential expression *renhe* (English 'any'). It is also semantically related to the disjunction word *huozhe* (English 'or'). In a domain with a finite number of individuals, i.e., {Jon, Mary, Bill} a statement with an existential expression (e.g., *someone, anyone…*), such as *Someone laughed*, is logically equivalent to a disjunctive statement *Jon, Mary, or Bill laughed.* Similarly, the statement *It is not the case that anyone laughed* is logically equivalent to the disjunctive statement *It is not the case that Jon or Mary or Bill laughed.* This is true in Mandarin, just as in English. Therefore, the *wh*-word *shenme*, the polarity expression *renhe* and the disjunction operator *huozhe* are all properly classified as existential expressions, i.e., ∃-items (cf. Karttunen 1977; Jackendoff 1972; Jayaseelan 2001; Rooth and Partee 1982; Jayaseelan 2001; Chierchia 2006, 2010; Liao 2011). One of the main goals of this thesis was to examine the semantics of *shenme* 'what,' as distinguished from that of *renhe* 'any' and

huozhe 'or'. Based on the semantic analysis of these three ∃-items, we validated a theoretically motivated account of the distribution and interpretation of these three ∃-items.

Still, ∃-items are not all the same. Chapters 2-4 explored the different distributional and interpretive patterns that characterize ∃-items. Our investigations examined three linguistic contexts. One of these linguistic contexts generates upward entailing (monotonic increasing) inferences. Upward entailing contexts validate inferences from subsets to supersets. For example whenever the sentence *John bought a Toyota* is true, so is the sentence *John bought a car*. This shows that simple affirmative sentences are often upward entailing. In Mandarin, the *wh*-word *shenme* 'what' is a question marker in upward entailing linguistic contexts, as example (1) shows. The *wh*-word *shenme* 'what' cannot be used to make a statement, as shown by the unacceptability of (1a). Another property of upward entailing contexts is illustrated in (1b). As the example shows, the polarity sensitive expression *renhe* 'any' is unacceptable in simple affirmative sentences, just as English 'any' is unacceptable in such contexts. Finally, the disjunction word *huozhe* 'or' has disjunctive truth conditions in upward entailing contexts, as shown in (1c).

(1) a. Yuehan mai-le **shenme** che?

　　　 John　 buy-ASP what　 car

　　　 'What car did John buy?'

　 b. *Yuehan mai-le **renhe** che.

　　　 John　 buy-ASP any　 car

　　　 'John bought any car.'

c. Yuehan mai-le   Falali **huozhe** Baoshijie.

   John   buy-ASP Ferrari or   Porsche

   'It's a Ferrari or a Porsche (and possibly both) that John bought.'

Upward entailing linguistic contexts can be distinguished from downward entailing contexts. Sentences with downward entailing operators validate inferences in the opposite direction. In downward entailing contexts, inferences are licensed from supersets to subsets. Negation is a downward entailing operator, such that whenever the sentence *John didn't buy a car.* is true, so is the sentence *John didn't buy a Toyota*.

Based on work on formal semantics, downward entailing linguistic contexts can be partitioned into two classes. One class contains 'weak' downward entailing operators. The other class contains 'strong' downward entailing operators. More specifically, the class of weak downward entailing operators contain linguistic expressions that are downward entailing, but ones that are not anti-additive. One example of a weak downward entailing contexts in Mandarin is the comparative operator *bi…xian* 'earlier than.' Notice that the *wh-*word *shenme* remains a question marker in sentences with this weak downward entailing operator. This is shown in (2a). The second observation is that the disjunction word *huozhe* continues to be assigned disjunctive truth conditions in such contexts, as shown in (2c). The final observation is that the polarity sensitive expression *renhe* is permitted in weak downward entailing contexts, as shown in (2b).

(2) a. Yuehan bi **shenme** xuesheng xian dao?

   John   than what   student   early arrive

   'Which student did John arrive earlier than?'

b. Yuehan bi **renhe** xuesheng xian dao.

   John   than any student   early arrive

   'John arrived earlier than any other students.'

c. Yuehan bi Mali **huozhe** Tangmu xian   dao.

   John   than Mary or   Tom   early arrive

   'It's Mary or Tom (and possibly both) that John arrived earlier than.'

The second class of downward entailing contexts are labelled 'strong.' The class of strong downward entailing operators contain linguistic expressions that are both downward entailing, and anti-additive. By definition, a function f is anti-additive if it generates the following logical equivalence: $f(A \lor B) \Leftrightarrow f(A) \,\&\, f(B)$. Notice that anti-additivity is an equivalence between logical expressions. In one member of the equivalence, conjunction takes scope over both occurrences of some relevant logical operator, Op. We can render this symbolically as Op(A) & Op (B). In the other member of the equivalence, the operator Op takes scope over a disjunction: Op(A v B). In human languages like English and Mandarin, there are expressions that generate this kind of logical equivalence. The negative determiner *no* is a candidate for being strong. This is based on the following observation: whenever the sentence *No professor bought a Ferrari or a Porsche* is true, so is the sentence *No professor bought a Ferrari and No professor bought a Porsche.,* and vice versa. This shows that the negative determine *no* is anti-additive.

In the present study, we suggest that the Mandarin adverbial quantifier *dou* 'all' is a plausible candidate to be considered a strong downward entailing operator. We noted that the distributional facts supported this conclusion. We observed that the *wh*-word *shenme,* the polarity expression *renhe* and the disjunction operator *huozhe* are all licensed in the scope of the adverbial quantifier *dou*. This is similar to other strong expressions, such as the negative

existential *meiyou* 'not-have' and the antecedent of a conditional statement. A second fact is also important, namely that all three of these expressions generate a conjunctive (universal) meaning in sentences with *dou*. Examples are shown in (3).

(3) a. Yuehan **shenme** shu dou kan.

     John   what   book all read

    'John reads every book.'

  b. Yuehan **renhe** shu dou kan.

    John   any   book all read

    'John reads every book.'

  c. Yuehan pingguo **huozhe** li dou maiwan-le.

    John   apple   or   pear all sell.out-ASP

   'John sold out of both the apples and the pears.'

Let us summarize what we have covered so far. We began this study by establishing three distributional and interpretive patterns for the ∃-items *shenme* 'what', *renhe* 'any' and *huozhe* 'or' In one set of linguistic contexts (upward entailing), *shenme* 'what' is a question marker, *renhe* 'any' is prohibited, and the disjunction word *huozhe* 'or' has disjunctive truth conditions. In the second set of contexts (downward entailing, but not anti-additive), *shenme* remains a question marker, and *huozhe* continues to be assigned disjunctive truth conditions; however, *renhe* is permitted in these contexts. The third set of (downward entailing, anti-additive) contexts includes the Mandarin adverbial quantifier *dou* 'all.' In such contexts, *shenme, renhe, and huozhe* are all licensed, but they yield a 'conjunctive' meaning that is different in character from the meanings of these expressions in the other linguistic contexts.

The compatibility of the three ∃-items with the three different types of linguistic contexts is illustrated in Table (1)

Table 1. *Shenme* 'what', *renhe* 'any' and *huozhe* 'or' in different linguistic contexts

Linguistic contexts	*Shenme* 'what'	*Renhe* 'any'	*Huozhe 'or'*
Upward entailing	Question	*	Disjunctive
Weak downward entailing	Question	NPI	Disjunctive
Strong downward entailing (*dou*)	Conjunctive	Conjunctive	Conjunctive

Based on the patterns indicated in Table 1, we proceeded to conduct experimental research investigating children's comprehension of the ∃-items *shenme*, *renhe* and *huozhe* in the different linguistic contexts indicated in the table.

Chapter 2 used Question Statement Tasks to investigate Mandarin-speaking children's comprehension of the *wh*-word *shenme* 'what' and the negative sensitive expression *renhe* 'any' in two weak downward entailing contexts. One of these contexts was incorporated in Experiment 1. The test sentences in Experiment 1 contained the temporal operator *zai...zhiqian* 'before', as shown in (4) and (5). Another set of test sentences was used in Experiment 2. These sentences contained the comparative operator *bi...xian* 'earlier than', as shown in (6) and (7).

(4) Yazi zai **shenme** dongwu zhiqian youdao zhongdian?

   duck at   what   animal before swim finishing.line

   'Which animal did the duck reach the finishing line before?'

(5) Yazi zai **renhe** dongwu zhiqian youdao zhongdian.

duck at any animal before swim finishing.line

'The duck reached the finishing line before any other animals.'

(6) Zi-huoche   bi **shenme** huoche xian yun-wan   shitou?

purple- train than what   train   early carry-finish stone

'Which train did the purple train finish carrying stones earlier than?'

(7) Zi-huoche   bi **renhe** huoche xian yun-wan   shitou.

purple- train than any   train   early carry-finish stone

'The purple train finished carrying stones earlier than any other trains.'

In the surface syntax of example (4), the *wh*-word *shenme* 'what' appears in the scope of the temporal operator *zai…zhiqian* 'before'. In example (6), *shenme* appears in the scope of the comparative operator *bi…xian* 'earlier than'. Since *zai…zhiqian* 'before' and *bi…xian* 'earlier than' are weak downward entailing operators, the *wh*-word *shenme* is assumed to 'raise' at the level of semantic interpretation (Logical Form) to take scope over these operators. Having raised, the *wh*-word *shenme* receives a [+WH] interrogative interpretation, despite the fact that NPI *renhe* was licensed in the same sentences, as indicated in (5) and (7).

Intuitively, the analysis we propose is the following. The *wh*-word *shenme* must be licensed. There are kinds of two licensing operators. One is a covert operator, Q, with a [+WH] feature, so this operator can be rendered symbolically as $Q_{[+WH]}$. Whenever a *wh*-word is interpreted as a question marker, we suppose that it is licensed by $Q_{[+WH]}$. In contrast, whenever the *wh*-word *shenme* is assigned a non-interrogative meaning, we suppose that it is licensed by a different linguistic operator, and one that is overt. This operator can either be a strong downward entailing linguistic environment, such as in sentences with the negative

existential *mei-you* 'not have' or in the antecedent clause of a *ruguo*-conditional. In these contexts, *wh*-words are NPIs. Finally, *wh*-words can be licensed by the adverbial quantifier *dou*. Whenever *wh*-words such as *shenme* are licensed by *dou*, they receive a conjunctive (universal) interpretation through a process called recursive exhaustification. One of the main goals of the present study was to determine whether young Mandarin-speaking children know that the *wh*-word *shenme* can be licensed in these different ways. It is worth noting that the adverbial quantifier *dou* also licenses the polarity sensitive expression *renhe*, as well as the disjunction word *houzhe*. In sentences with *dou*, *renhe* generates free choice inferences, and *houzhe* generates a conjunctive (universal) meaning.

We conducted a series of experiments to assess children's linguistic knowledge of the *wh*-word *shenme*. To determine the meaning children assigned, we also included sentences with the polarity sensitive expression *renhe* 'any' in the experiments in Chapter 2. The results indicated that three-to-five-year-old Mandarin-speaking children interpreted *shenme* 'what' as a *wh*-question marker in both weak downward entailing contexts, whereas they interpreted the sentences with *renhe* 'any' as statements. The same pattern was found for adults. Some of the results reported in previous studies using strong downward entailing operators like the negative existential *mei-you* 'not have' (Su, Zhou and Crain 2011) and the antecedent of a conditional (Zhou and Crain 2011) show that Mandarin-speaking children (and adults) interpret *wh*-words as being equivalent in meaning to the NPI *renhe* 'any' in strong downward entailing contexts. We interpreted these findings as evidence for a distinction made in the theoretical literature between strong and weak Negative Polarity Items (NPIs). On this analysis, children know that *shenme* 'what' is a strong NPI and that *renhe* 'any' is a weak NPI. Both the strong NPI *shenme* and the weak NPI *renhe* are licensed in strong downward entailing contexts, *salva veritate*. However, *shenme* can only function as a question marker in weak downward entailing contexts. Previous research also show that children understand that in upward entailing contexts like sentences with the predicate phrase of *mei* 'every' (Su, Zhou

and Crain 2011) and in the consequent of a conditional (Zhou and Crain 2011), *wh*-words are interpreted as question markers. These results attested to the early mastery of adult-like linguistic knowledge of *wh*-words in child Mandarin.

Chapter 3 investigated the semantic properties of the Mandarin quantificational expression *dou* 'all'. Two experiments were conducted to assess whether or not children know that *dou* is a strong downward entailing operator, such that it behaves like other anti-additive operators, licensing both the non-interrogative meaning of the *wh*-word *shenme* 'what' and the polarity sensitive expression *renhe* 'any'. This was demonstrated using a Question Statement Task. This task was employed to compare children's comprehension of *shenme* and *renhe* in sentences with the weak downward entailing operator *bi..xian* 'earlier than' and the strong downward entailing operator *dou*. Examples of the test sentences are given in (8) and (9).

(8) Xiongmao bi   **shenme** dongwu dou xian laidao xuexiao.

    panda   than what   animal   all   early arrive school

    'The panda arrived at school earlier than every animal.'

(9) Xiongmao bi **renhe** dongwu dou xian laidao xuexiao.

     panda   than any   animal   all   early arrive school

    'The panda arrived at school earlier than every animal.'

In (8), the quantificational expression *dou* is anti-additive-like operator whereas the comparative operator *bi…xian* 'earlier than' is downward entailing but not anti-additive. Since *dou* is stronger than *bi…xian* 'earlier than', *shenme* has the [-WH] value, it is interpreted in the scope of *dou* and receives a non-interrogative universal force. *Renhe* 'any' can also be licensed by *dou* and has a same universal meaning as in (9).

We found that children (and adults) assigned the non-interrogative universal meaning to the *wh*-word *shenme* in (8), and they assigned the same universal meaning to *renhe* 'any' in (9). Some of the results reported in Chapter 2 show that in sentences with the comparative expression *bi…xian* 'earlier than' alone, children interpreted *shenme* as a question marker whereas they interpreted *renhe* as an NPI in the same weak downward entailing context. These findings demonstrate that, by age 4, Mandarin-speaking children know that *dou* licenses the non-interrogative meaning of *shenme*, similar in meaning to *renhe* 'any', whereas in sentences with *bi…xian* in which *dou* is not present in the structure, *shenme* is analysed as a question marker. These results also indicate that children are sensitive to the strength of different downward entailing operators.

The strength of downward entailing operators played an important role in determining how logical scope was assigned by children and adults in sentences with multiple logical expressions. We observed that in weak downward entailing contexts like sentences with the comparative operator *bi…xian* 'earlier than' as in (10) (a test sentence from Chapter 2), the *wh*-word *shenme* 'what' has the [+WH] value. This means that it 'raises' at Logical Form to generate an interrogative interpretation, as a question marker. However, when the *wh*-word *shenme* appears in sentences with *dou* as in (11) (repeated form (8)), *shenme* has a [-WH] value. This means that it sits *in situ* at the level of semantic interpretation (Logical Form), and thus generates a non-interrogative interpretation.

(10) Xiongmao bi **shenme** dongwu xian laidao xuexiao?

    panda   than what animal early arrive school

  'Which animal did the panda arrived at school earlier than?'

(11) Xiongmao bi   **shenme** dongwu dou xian laidao xuexiao.

   panda   than what   animal   all   early arrive school

'The panda arrived at school earlier than every animal.'

Although the Mandarin *wh*-word *sheme* 'what' is associated with one of two values of a parameter {+WH, -WH}, children don't experience a subset problem in this case. This is because there is no asymmetric entailment relation between the question meaning and the statement meaning of *shenme* (cf. Angluin 1980, Baker 1979). Therefore, children are not compelled by the Semantic Subset Principle to take one particular meaning of *shenme* as their initial hypothesis. This is confirmed by the findings that children exhibit adult-like sensitivity to the different interpretations of the *wh*-word *shenme* in (10) and (11).

      Consider next the polarity sensitive expression *renhe* 'any.' Since this expression has no alternative interpretation, there is no lexical parameter to be set. As a consequence, the Semantic Subset Principle (SSP) is not operative (Crain, Ni, and Conway 1994). This is confirmed by the findings of the experiment reported in Chapter 2 and Chapter 3, using the test sentences in (12) and (13) ((13) is repeated from (9)).

(12) Xiongmao bi **renhe** dongwu xian laidao xuexiao.

   panda   than any   animal early arrive school

'The panda arrived at school earlier than any other animals.'

(13) Xiongmao bi **renhe** dongwu dou xian laidao xuexiao.

   panda   than any   animal   all early arrive school

'The panda arrived at school earlier than every animal.'

Chapter 4 used the prediction mode of the Truth Value Judgment Tasks to investigate Mandarin-speaking children's comprehension of the disjunction word *huozhe* 'or'. Two experiments were conducted comparing children's interpretation of *huozhe* in sentences with the downward entailing (but not anti-additive) comparative expression *bi…xian* 'earlier than.' Experiment 1 used sentences without *dou* (*bi…xian*) as shown in (14). Experiment 2 used sentences with *dou* (*bi…dou xian*) as in (15).

(14) Xiaoyang bi xiaogou **huozhe** shizi xian padao shuding.

    sheep   than   dog   or   lion early climb   tree.top

  'The sheep will reach the top of the tree earlier than the dog or the lion.'

(15) Xiaoyang bi xiaogou **huozhe** shizi dou xian padao shuding.

    sheep   than   dog   or   lion all early climb tree.top

  'The sheep will reach the top of the tree earlier than both the dog and the lion.'

In example (14), without *dou*, the Mandarin disjunction word *huozhe* 'or' appears in the scope of the comparative operator *bi…xian* 'earlier than'. Since *bi…xian* 'earlier than' is a merely (weak) downward entailing operator, for Mandarin adults, the disjunction *huozhe* is [+PPI], adults assign the inverse scope reading. Consequently, the disjunction word *huozhe* 'or' has a disjunctive interpretation as 'The sheep will reach the top of the tree earlier than the dog OR the sheep will reach the top of the tree earlier than the lion.' In addition to sentences like (14), without *dou*, we also presented children with sentences like (15), where the disjunction word *huozhe* 'or' appears in the sentence with two operators, the comparative operator *bi…xian* 'earlier than' and the quantificational expression *dou*. We found that *dou* behaves like an anti-additive operator. The Disjunction Parameter was cancelled and *huozhe* was interpreted in its surface position, and generated a conjunctive interpretation. So, the meaning of (15) can be

paraphrased as 'The sheep will reach the top of the tree earlier than the dog AND the sheep will reach the top of the tree earlier than the lion.'

The results were exactly as predicted. We found that Mandarin-speaking adults assigned a disjunctive interpretation of *huozhe* in (14), a weak downward entailing context; but they assigned a conjunctive interpretation to *huozhe* in (15), a strong downward entailing context. Like adults, Mandarin-speaking children assigned a conjunctive interpretation to *huozhe* in (15), as expected. However, children assigned the same conjunctive interpretation to *huozhe* in (14), in contrast to adults. A similar result has been observed in several previous studies, as will discuss momentarily. In any event, the finding was that Mandarin-speaking children assigned a conjunctive interpretation to the disjunction word *huozhe* in both the weak downward entailing context in (14) and in the strong downward entailing context in (15).

The finding that children and adults interpret the disjunction word *huozhe* differently replicates findings reported in previous studies using different downward entailing operators. For example, the sentences with the predicate negation *meiyou* 'not' (Jing 2005) and the sentences with the temporal conjunction *zai…zhiqian* 'before' (Notley 2011) are both weak downward entailing contexts, and it has been found that children assigned a conjunctive interpretation of *huozhe* in both of these contexts, whereas adults speakers of Mandarin assigned disjunctive truth conditions to *huozhe* in these contexts. On the other hand, in the sentences with the antecedent of a conditional (Su 2011) and the sentences with the negative existential *mei-you* 'not-have' (Su, Zhou, and Crain 2011), both strong downward entailing contexts, it has been found in previous research that both children and adults generate the same conjunctive interpretation of *huozhe*.

These findings of the present study support the theoretical distinction between weak downward entailing operators and strong downward entailing operators. As far as we know, this is the first time that evidence in favour of this distinction has been forthcoming from experimental studies of child and adult language. Let us briefly review the relevant findings.

For adults, the disjunction word *huozhe* is [+PPI]. In weak downward entailing contexts therefore, *huozhe* is interpreted as taking scope over weak downward entailing operators (OR > Δ), generating a weak (superset) reading; whereas when *huozhe* appears in strong downward entailing contexts, its polarity sensitivity is cancelled. In this case, strong downward entailing operators take scope over *huozhe* (Δ > OR), yielding a strong (subset) reading.

The findings of the series of experimental studies we have reported provided evidence that Mandarin-speaking children know that (i) the weak downward entailing contexts license the interrogative interpretation of the *wh*-word *shenme* 'what', and the strong downward entailing contexts license the non-interrogative interpretation of *shenme*; while *renhe* 'any' is licensed in any downward entailing contexts; and (ii) the quantificational expression *dou* 'all' licenses both *shenme* and *renhe*, and turns *wh*-word *shenme* into non-interrogative universal; and (iii) disjunction yields a conjunctive interpretation in any downward entailing contexts, as in classical logic. This interpretation of disjunction is the same as that of English-speaking children and adults, but different from that of Mandarin-speaking adults in which disjunction has a disjunctive interpretation in weak downward entailing contexts. The interpretations of *shenme* 'what', *renhe* 'any' and *huozhe* 'or' by Mandarin-speaking adults and children in different linguistic contexts are summarized in Table 2.

Table 2. Adults' and children's interpretations of *shenme* 'what', *renhe* 'any' and *huozhe* 'or'

in different linguistic contexts

Linguistic contexts	*Shenme* 'what'		*Renhe* 'any'		*Huozhe 'or'*	
	Adults	Children	Adults	Children	Adults	Children
Upward entailing	Question	Question	*	*	Disjunctive	Disjunctive
Weak downward entailing [-AA]	Question	Question	NPI	NPI	Disjunctive	Conjunctive
Strong downward entailing [+AA]	NPI	NPI	NPI	NPI	Conjunctive	Conjunctive

As Table 2 shows, the *wh*-word *shenme* 'what' functions as an NPI in strong downward entailing ([+AA]) contexts, and as a question marker elsewhere; the existential expression *renhe* 'any' functions as an NPI in downward entailing contexts (both [-AA] and [+AA]). Note also that the disjunction word *huozhe* 'or' takes scope over weak downward entailing ([-AA]) operators for adults, but not for children (therefore, adults generate a disjunctive interpretation whereas children assign a conjunctive interpretation of disjunction in weak downward entailing contexts). When the disjunction *huozhe* appears in strong downward entailing contexts, strong downward entailing operators take scope over *huozhe* for both children and adults; therefore, both children and adults generate a conjunctive interpretation of disjunction in strong downward entailing contexts.

Based on these findings, we conclude that, by age 4, Mandarin-speaking children master the semantics of the ∃-items *shenme, renhe* and *huozhe.* They have the knowledge of the distributional and interpretive patterns of these ∃-items. The findings are interpreted as evidence of the linguistic competence by young children to compose the complex meanings of sentences with multiple logical expressions.

These experimental findings support for the nativist approach of language acquisition (Chomsky 1965, 1975, 1980), and argue against the alternative experience-based approach (Quine 1992; Dummett 1978; Brandom 2000). Specially, we argued that Mandarin-speaking children's acquisition of ∃-items in formally distinct linguistic contexts meets three hallmarks of innateness: (i) early emergence, (ii) emergence in child language despite the absence of decisive evidence from experience, and (iii) universality.

As we saw, the *wh*-word *shenme* has a variety of interpretations. Its interpretations are sensitive to the linguistic environments in which it occurs. It would be very challenging for children to learn these different interpretations just by attending to the input, and it could be expected that children would take a long time to master the complete range of facts. However, the findings from the present study show that, by age 4, Mandarin-speaking children have mastered the complex semantics of the *wh*-word *shenme* as well as the polarity sensitive expression *renhe* 'any' and the disjunction word *huozhe* 'or'. The early emergence of this knowledge casts doubt on the learning-theoretic scenarios.

We observed that the differences in the linguistic contexts we investigated are extremely subtle, and the complex interpretations of the ∃-items in different contexts would be difficult to master if children were relying only on the positive input to figure out the solution. However, we found that Mandarin-speaking children manifest adult-like distributional and interpretive patterns in response to sentences with *shenme* and *renhe*, but it does not appear plausible that children have sufficient evidence from input to learn these patterns (cf. MacWhinney 2000).

The findings offer added evidential support for the conclusion that children adhere to the Semantic Subset Principle (SSP) and are guided by universal logical principles governing the interpretation of disjunction (Boster and Crain 1993; Crain et al. 2002; Goro and Akiba 2004; Gualmini and Crain 2002; Gualmini et al. 2003; Jing et al, 2005). The SSP is viewed as a learning mechanism that dictates how children initially set certain lexical parameters. For these parameters, the alternative values generate readings that stand in a subset/ superset

relation. In such cases the SSP entreats children to initially adopt the parameter value that is associated with the strong (subset) reading, even if this requires the child to enforce polarity restrictions that are not enforced by adults. The SSP ensures that language learners avoid adopting the superset value of lexical parameters in cases where these values would lead to a subset problem. To avoid subset problems, the SSP requires children to initially favour scope assignment that generates strong readings, even in cases where adults strongly favour the weak scope assignment. This is the only way for children to add a weaker reading on the basis of truth-conditional evidence.

Our strongest argument for the nativist approach is the mismatches between child and adult language. The findings of the present study show that Mandarin-speaking children sometimes make non-adult interpretation of disjunction. In such cases, children exhibit patterns of usage of the disjunction word *huozhe* quite different from those of adults. Moreover, we found that the children of Mandarin speakers sometimes exhibit the interpretation of disjunction that are not available in Mandarin, but ones that are available in other languages spoken by adults (e.g. Mandarin-speaking children's interpretation of disjunction is the same as that of English-speaking children and adults). This supports the continuity hypothesis (Pinker 1984, Crain 1991, Crain and Pietroski 2001). The continuity hypothesis expects that the ways children differ from adults should be limited to the ways in which adult languages differ from each other. Based on the continuity hypothesis, it is not surprised that children of monolingual Mandarin-speaking children exhibit some constructions characteristic of other typologically distinct languages (e.g., English), even in the absence of any evidence for these properties in the primary linguistic data. Again, these findings provide evidence in favour of the theory of Universal Grammar.

Future directions [23]

Future research can explore children's knowledge of ∃-items in another kind of downward entailing context, in which operators are anti-morphic.[24] Anti-morphic contexts represent the strongest kind of downward entailing linguistic environment. We would like to know, therefore, whether children and adults license the non-interrogative meaning of *wh*-words, and whether or not children assign the conjunctive interpretation of disjunction in this kind of context.

By assessing Mandarin-speakers' understanding of anti-morphic operators, we would be able to explore some other de Morgan's laws in human languages. Different de Morgan's laws can be used to define the subclasses of DE operators. Specifically, downward entailing operators like *no one* (i.e., the anti-additive operators) generate the bidirectional entailments of one de Morgan's law: $\neg (A \vee B) \Leftrightarrow \neg A \wedge \neg B$. Moreover, downward entailing operators like *not* (i.e., the anti-morphic operators) generate the bidirectional entailments of the two de Morgan's laws: $\neg (A \vee B) \Leftrightarrow \neg A \wedge \neg B$ and $\neg (A \wedge B) \Leftrightarrow \neg A \vee \neg B$ (Zwarts, 1998). If it is verified that children acquiring typologically different languages have mastered these logical entailment relationships early in their language development, then this will provide further evidence that human languages draw upon the logical concepts and combinatory laws of

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[23] As one of the external examiners notes, it would be instructive to consider combinations of the various items considered in the thesis (disjunctive subjects and *bi…xian* 'earlier than', negation and disjunction in the antecedent versus the consequent claused of a conditional) and to follow up on the conditions under which polarity sensitivity is canceled.

[24] Zwarts (1998) distinguishes three levels of NPI-licensing strength. The three levels of NPI-licensing strength stand in a subset-superset relation. From strongest (subset) to weakest are (a) anti-morphic, which is both anti-additive and downward entailing, (b) anti-additive, which is downward entailing, and (c) downward entailing. A function f is anti-morphic if it generates the following two logical equivalences: $f(X \wedge Y) \Leftrightarrow f(X) \vee f(Y)$ and $f(X \vee Y) \Leftrightarrow f(X) \wedge f(Y)$.

classical logic, therefore lending added support to the logical nativist approach (cf. Chomkey 1988; Crain and Pietroski 2002; Crain, Gualmini and Pietroski 2005; Crain, Goro and Minai 2008).

It is also worth noting that future research could extend the present studies of children with typical language development to a different population, namely children with Specific Language Impairment (SLI). We have now established when typically developing Mandarin-speaking children comprehend the semantic properties of these logical expressions. The next step is to determine when children with SLI have achieved the same knowledge. This could shed new light on the nature of their deficits.

Finally, we wish to propose that future studies should investigate *wh*-words in different downward entailing contexts using children at younger ages, perhaps adopting brain imaging technologies such as MEG. Mandarin-speaking children have been found to start using non-interrogative *wh*-words (both the NPI use and the Free Choice use) as early as 2 years old in their spontaneous speech. At this age, they have already mastered the interrogative use of *wh*-words. (Li and Tang 1991; Fan 2012) Moreover, previous studies report that, by the time Mandarin-speaking children reach age four, they use *wh*-words at a nearly adult-like level (Li & Tang, 1991). Therefore, the key developmental stage for the acquisition of Mandarin *wh*-words is between the ages of 2;0 to 3;0. We can adopt brain imaging technology to compare brain regions that active in children and adults as they process sentences with multiple logical words, in order to investigate how children understand such sentences in the early stages of language acquisition. Of course, this must include cross-linguistic research, since many of the semantic distinctions that are observed in some languages remain hidden in others. We hope to have made a case in the present study – that Mandarin is an important language to investigate if the goal is to reveal the psychological reality of theoretical distinctions proposed by semanticists using the tools of psycholinguists who are interested in the emergence of meaning.

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HS Ethics Final Approval Ref No: 5201100220D

Ethics Secretariat <ethics.secretariat@mq.edu.au>   Wed, Apr 13, 2011 at 2:41 PM
To: rosalind.thornton@mq.edu.au
Cc: Stephen Crain <stephen.crain@mq.edu.au>, min.liao@students.mq.edu.au

Dear Associate Professor Thornton

Re: Children's acquisition of 'Shenme' in Mandarin Chinese

Thank you for your recent correspondence. Your response has addressed the issues raised by the Faculty of Human Sciences Human Research Ethics Sub-Committee and you may now commence your research.

The following personnel are authorised to conduct this research:

Associate Professor Rosalind Thornton
Professor Stephen Crain
Ms Min Liao

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).

2. Approval will be for a period of five (5) years subject to the provision of annual reports. Your first progress report is due on 13 April 2012.

If you complete the work earlier than you had planned you must submit a Final Report as soon as the work is completed. If the project has been discontinued or not commenced for any reason, you are also required to submit a Final Report for the project.

Progress reports and Final Reports are available at the following website: http://www.research.mq.edu.au/ for/researchers/how_to_obtain_ethics_approval/ human_research_ethics/forms

3. If the project has run for more than five (5) years you cannot renew approval for the project. You will need to complete and submit a Final Report and submit a new application for the project. (The five year limit on renewal of approvals allows the Sub-Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).

4. All amendments to the project must be reviewed and approved by the Sub-Committee before implementation. Please complete and submit a Request for Amendment Form available at the following website: http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_ research_ethics/forms

5. Please notify the Sub-Committee immediately in the event of any adverse effects on participants or of any unforeseen events that affect the continued ethical acceptability of the project.

6. At all times you are responsible for the ethical conduct of your research in accordance with the guidelines established by the University. This information is available at the following websites:

http://www.mq.edu.au/policy

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/ human_research_ethics/policy

If you will be applying for or have applied for internal or external funding for the above project it is your responsibility to provide the Macquarie University's Research Grants Management Assistant with a copy of this email as soon as possible. Internal and External funding agencies will not be informed that you have final approval for your project and funds will not be released until the Research Grants Management Assistant has received a copy of this email.

If you need to provide a hard copy letter of Final Approval to an external organisation as evidence that you have Final Approval, please do not hesitate to contact the Ethics Secretariat at the address below.

Please retain a copy of this email as this is your official notification of final ethics approval.

Yours sincerely,

Dr Katey De Gioia
Acting Chair
Faculty of Human Sciences Ethics Review Sub-Committee
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