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

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Abstract

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

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

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1. Introduction

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

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

2. Scope Phenomena in English

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

(1) Every horse didn't jump over the fence.
(2) Not every horse jumped over the fence.

In (1), the universal quantifier *every* and negation *not* can each take scope over the other. Following standard parlance, we will use the term 'surface scope' to refer to the reading in which the syntactic and semantic representations are isomorphic: what you hear/read is what you get. The surface scope reading of (1) is the EVERY > NOT reading. This is typically

analyzed using the following logical form: $\forall$ x [horse'(x) → ¬ jumped over the fence'(x)][1]. We will use the term 'inverse scope' to refer to the reading in which there is no isomorphism between the syntactic and semantic representations. This is the NOT > EVERY reading of (1), with the associated logical form: ¬ $\forall$ x [horse'(x) → jumped over the fence'(x)][2].

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

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

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

Even if (2) were ambiguous, the (hypothetical) inverse scope reading would be difficult for language users to access, for pragmatic reasons. One of the main pragmatic principles is the Principle of Cooperation (Grice, 1989). According to the Principle of Cooperation, speakers are expected to convey as much relevant information as they can about a given topic. This has a profound effect on how certain sentences are interpreted. Its effect is particularly pronounced in the interpretation of linguistic expressions that form a natural scale with other

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

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

expressions, on the basis of the information strength they convey[3]. Familiar scales of this kind include <*or, and* > and <*some, many, most, every*>, where terms on the left of the scale are 'weaker' than terms to their right. When a speaker uses a statement that contains a 'weaker' (less informative) term from one of these scales (e.g., *or*), this invites the hearer to infer that the speaker was not in a position to use a 'stronger' (more informative) term from these scales (e.g., *and*). In order to keep the hearer's mental model of the conversation information-aligned with that of the speaker, the hearer attributes to the speaker the negation of the statement with the 'stronger' term, and the hearer augments his or her mental model of the discourse context accordingly.

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

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

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

In contrast to English, adult speakers of Mandarin find the translation of the English sequence

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

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

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

in (3) to be an overt contradiction. The offending assertion is (4).

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

One might be tempted to explain the unacceptability of (4) for Mandarin-speakers by supposing that Mandarin uniquely licenses the surface scope reading of sentences corresponding to English (2), whereas English licenses both the surface scope and the inverse scope reading. The problem with this analysis of the situation is that, even if Mandarin uniquely allowed the surface scope reading, Mandarin-speakers should still accept the assertion in (4), i.e., *Bushi mei-pi ma dou tiaoguo-le liba* 'Not every horse jumped over the fence' in circumstances in which none of the horses jumped over the fence. As long as the surface scope reading (NOT > EVERY) in Mandarin is asymmetrically entailed by the (hypothetical) inverse scope reading (EVERY > NOT), then the surface scope reading will make Mandarin sentences true in the circumstances that correspond to the inverse scope reading (EVERY > NOT). And this, in turn, suggests that Mandarin-speakers should not find (4) to be contradictory to any greater extent than English speakers find (3) contradictory. The fact that Mandarin-speakers do find (4) contradictory suggests that Mandarin imposes an additional restriction on the truth conditions of 'not…every' sentences, thereby breaking the asymmetric entailment relation with 'every…not' sentences. We will return to this issue shortly.

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

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

3. Scope Phenomena in Mandarin Chinese

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

(5) Mei-pi ma dou meiyou tiaoguo liba.
every-CL horse all not-have jump-over fence
'Every horse didn't jump over the fence.'
a. $\forall$ x [horse'(x) → ¬ jumped over the fence'(x)]
b. *¬ $\forall$ x [horse' (x) → jumped over the fence' (x)]

Next, consider example (6). In this example, a different expression for negation *bu* 'not' c-commands the universal quantifier *mei* 'every'. It is the contention of many linguists that the unique interpretation is one in which negation takes wider scope than the universal quantifier (NOT > EVERY). The EVERY > NOT reading, as represented in (6a), is judged by many linguists to be unavailable for Mandarin-speaking adults, as indicated by the asterisk. According to these linguists, (6) can be paraphrased as 'some, but not all of the horses jumped over the fence.'

(6) Bushi mei-pi ma dou tiaoguo-le liba.
not-be every-CL horse all jump-over-ASP fence
'Not every horse jumped over the fence.'
a. * $\forall$ x [horse'(x) → ¬ jumped over the fence'(x)]
b. ¬ $\forall$ x [horse' (x) → jumped over the fence' (x)]

But what is the logical form for the unique NOT > EVERY interpretation, such that it prevents Mandarin-speakers from accepting (6) in circumstances in which none of the horses

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

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

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

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

[6] We adopt this terminology for convenience only, following common practice in the literature. We do not use 'presupposition' to indicate that this proposition can be flouted any more easily than the assertion can be.

representations are given in (9) and (10), respectively.

(9) Mei-pi ma dou meiyou tiaoguo liba.
every-CL horse all not-have jump-over fence
'It was every horse that didn't jump over the fence.'
Logical form: $\exists x$ [horse' (x) $\wedge \neg$ jumped over the fence' (x)] $\wedge$
$\forall$ x [horse'(x) $\rightarrow \neg$ jumped over the fence'(x)]

(10) Bushi mei-pi ma dou tiaoguo-le liba.
not-be every-CL horse all jump-over-ASP fence
'It wasn't every horse that jumped over the fence.'
Logical form: $\exists x$ [horse' (x) $\wedge$ jumped over the fence' (x)] $\wedge$
$\neg \forall$ x [horse' (x) $\rightarrow$ jumped over the fence' (x)]

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

The scope rigidity of Mandarin contrasts with other languages, including English. Notice that the logical form in (10) is not a viable candidate to express the truth conditions associated with the English sentence corresponding to (10): *Not every horse jumped over the fence.* The reason is that the truth conditions for this sentence include circumstances in which none of the horses jumped over the fence. As we saw, the English sentence *Not every horse jumped over the fence* implies that at least one horse jumped over the fence, but it does not assert this. This makes the use of *Not every horse jumped over the fence* infelicitous, but not truth-conditionally false, in circumstances in which none of the horses jumped over the fence. The infelicity is produced by a pragmatic implicature, which is 'defeasible' (Grice, 1989). To cancel the implicature, the speaker simply insists, overtly, that none of the horses jumped over the fence, by saying for example: *Not every horse jumped over the fence. In fact none of them did*. In contrast to English, we suggest that Mandarin imposes a presupposition of existence in the logical form associated with (10). If so, then adult Mandarin-speakers should not only

reject (10) as an accurate description of circumstances in which none of the horses jumped over the fence, but they should continue to rule out this interpretation even in the face of an overt claim that none of the horses jumped over the fence. We test this prediction in the next section.

4. A comparison of English and Mandarin

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

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

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

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

There are two candidates for the language-internal properties. One possibility is that the

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

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

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

In short, the findings from interviews with native speakers of Mandarin reinforce the two-fold conclusions that, first, sentences like (10) are unambiguous in Mandarin and, second, that the lack of ambiguity is due to the occurrence of the focus expression *shi*. To sum up, Mandarin and English differ in scope interpretation in that Mandarin exhibits scope rigidity, whereas English is more flexible in scope assignment. This difference is due to language-internal properties. We turn now to children's knowledge of scope interpretation in these languages, to see whether or not they have adult-like knowledge.

5. Child Language Research

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

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

An alternative proposal has been advanced by Gualmini (e.g., 2004). According to Gualmini, children can access both readings for sentences like (13), but the pragmatic context needs to be carefully constructed to elicit the inverse scope reading from children. The prerequisite for children to access the inverse scope reading, according to Gualmini, involves the satisfaction of the felicity conditions associated with the use of negation. Negative statements are typically used to point out a discrepancy between what was expected to happen and what actually happened (see, e.g., De Villiers and Tager-Flusberg, 1975; Givon, 1978; Wason, 1965). In this regard, the inverse scope reading of (13) is felicitous in a context in which every horse was expected to jump over the fence, but in the end, some horses ran into the fence instead of jumping over it, say, thus failing to meet the expectation. By contrast, sentence (14) sounds odd as a description of the same context, even though it is true, because the context didn't establish the expectation that every horse would run into the fence.

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

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

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

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

Previous studies on Mandarin-speaking children's knowledge of scope interpretation mainly focused on their understanding of sentences with universal and existential quantifiers

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

In the present study, we sought to investigate how Mandarin-speaking children understand the scope relations between the universal quantifier and negation in sentences like (9) and (10). Two main questions were addressed. The first question is whether or not Mandarin-speaking children have adult-like knowledge of the restrictions on the interpretation of sentences like (9) and (10), which are deemed to be unambiguous for adults. As discussed earlier, we attribute the unambiguity of sentences like (9) and (10) to the focus sensitivity of *dou* in (9) and *shi* in (10). Thus, for children to have completely adult-like knowledge, this would mean that they should treat *dou* and *shi* as focus-sensitive operators and compute the relevant presuppositions and assertions that are associated with such expressions. If so, then children should be expected to interpret these sentences as being unambiguous, i.e., children should access only the surface scope reading. This brings us to the second question. What if children do not have adult-like knowledge? On this scenario, children will not be sensitive to the focus properties of *dou* and *shi*, then are therefore expected to interpret sentences like (9) and (10) in the same way as English-speaking children interpret sentences like (1) and (2).

Although no studies have investigated English-speaking children's interpretation of the kind of 'not…every' sentences under consideration, such as (2)[7], it has been found that English-speaking children younger than 5- or 6-years old typically lack sensitivity to conversational implicatures, at least in certain tasks (see, e.g., Chierchia et al., 2001; Noveck, 2001; Papafragou and Musolino, 2003). For example, Noveck (2001) found that English-speaking children treated sentences with a 'weaker' term *some* (e.g., *Some giraffes have long necks*) equally as sentences with a 'stronger' term *all* (e.g., *All giraffes have long necks*). Chierchia, et al. (2001) found that English-speaking children interpreted sentences with a 'weaker' term *or* (e.g., *John bought pizza or pasta to the party*) as having the same meaning as sentences with a 'stronger' term *and* (e.g., *John bought pizza and pasta to the*

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

party). Based on the findings of these studies, we would expect English-speaking children to accept 'not…every' sentences like (2) in a scenario in which none of the horses jumped over the fence. And, if Mandarin-speaking children interpret Mandarin sentences like (9) and (10) in the same way as English-speaking children interpret (1) and (2), then Mandarin-speaking children should permit the use of 'not…every' sentences in the 'none' contexts. The experiments that follow were designed to assess these two possibilities.

6. Experiment 1

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

6.1 Subjects

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

6.2 Method and Procedures

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

The child subjects were introduced to the task individually and then tested individually. They were given 2 practice items before the actual test, one in which the puppet's statement was obviously true and one in which it was obviously false, so that children knew that the puppet could say something wrong. These practice items were also used to familiarize children with the task. Only those children who correctly rejected the puppet's statement were included in the actual test.

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

6.3 Materials

Two kinds of scenarios were constructed, one corresponding to the EVERY > NOT reading and the other to the NOT > EVERY reading. We will refer to these scenarios as the

'none' and 'some' scenarios, respectively. Test sentences like (9) and (10) were presented following either of the scenarios. Thus subjects were tested in four conditions: (i) 'every…not' sentences like (9) in the 'none' scenario, (ii) 'every…not' sentences in the 'some' scenario, (iii) 'not…every' sentences like (10) in the 'none' scenario, and (iv) 'not…every' sentences in the 'some' scenario. There were 2 trials in each condition, yielding 8 test trials. Conditions (i) and (iv) are used to illustrate.

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

(16) Mei-ge nühai dou chi-le bingjiling, danshi mei-ge nühai dou meiyou
every-CL girl all eat-ASP ice cream but every-CL girl all not
chi yao.
eat pill
'Every girl ate an ice cream, but every girl didn't take pills.'

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

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

(17) Mei-pi ma dou tiaoguo-le liba, danshi bushi mei-pi
every-CL horse all jump-over-ASP fence, but not-be every-CL

ma dou tiaoguo-le fangzi.
horse all jump-over-ASP house
'Every horse jumped over the fence, but not every horse jumped over the house.'

Four control trials were included to investigate children's understanding of negation in simple sentences, and their understanding of universal quantification in simple sentences. These control trials were used to verify that children could answer both 'yes' and 'no' correctly and that they had no difficulty understanding negation when it appeared alone, and universal quantification when it appeared alone. If the child always said 'yes' to the puppet's statements on these control trials, this would be used as evidence that the child did not understand the task, and his or her data would be eliminated from the subsequent analysis. On two of these control trials, the puppet produced the negative statements in (18) and (19). In the relevant scenarios, the statement in (18) was true and (19) was false.

(18) Xiaotuzi zhuangdao-le juanxincai, danshi meiyou zhuangdao huluobo.
rabbit hit-ASP cabbage but not hit carrot
'The rabbit hit the cabbage, but he didn't hit the carrot.'
(19) Tiaotiaohu zhaodao-le xiaotuzi, danshi meiyou zhaodao xiaozhu.
Tigger find-ASP rabbit but not find pig
'Tigger found the rabbit, but he didn't find the pig.'

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

(20) Mei-ge ren dou nadao-le beike.
every-CL person all get-ASP shell
'Everyone got shells.'
(21) Mei-zhi xiaomao dou mai-le binggan.
every-CL cat all buy-ASP biscuit
'Every cat bought biscuits.'

6.4 Results and Discussion

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

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

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

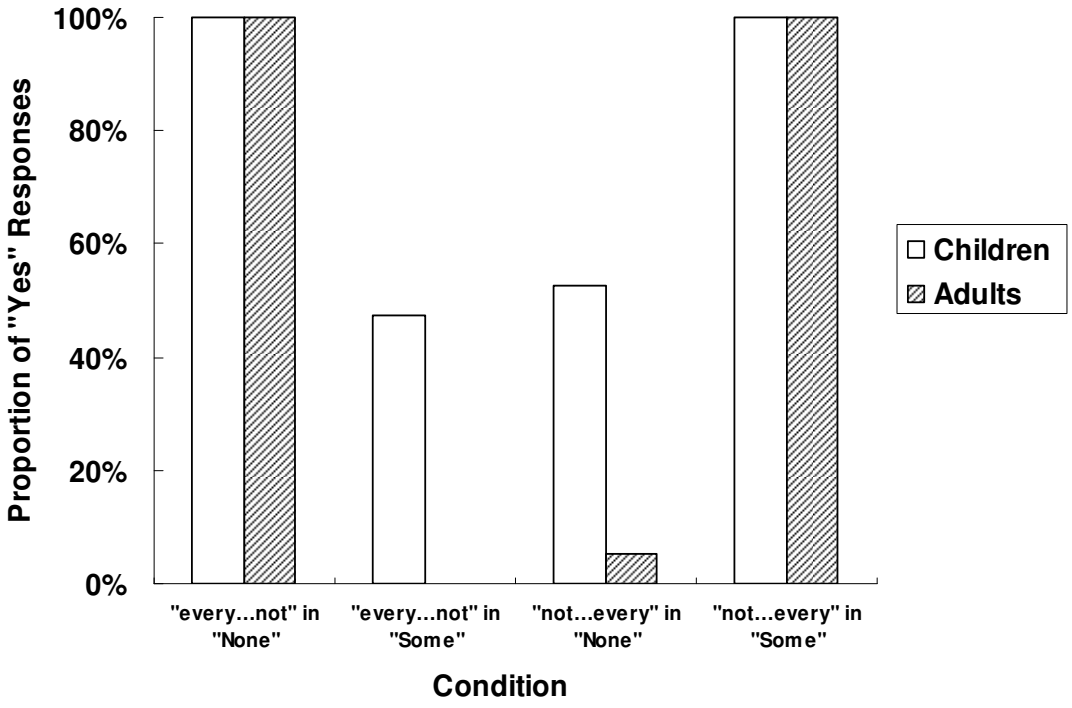

FIGURE.1. Proportion of 'Yes' Responses to the Puppet's Statements for Children and Adults in Each Condition, Experiment 1

As noted earlier, children who rejected the puppets' statements were asked why the puppet was wrong. They justified their answers in the same way as adults did. For example, in condition (ii), which corresponded to the inverse scope reading of the 'every…not' sentences, they justified their rejection of the test sentences by citing the fact that one of the characters performed the action mentioned in the test sentences. In condition (iii), corresponding to the inverse scope reading of the 'not…every' sentences, children justified their negative

responses by pointing out that none of the characters performed the action mentioned in the test sentences.

So far, the main finding is that both children and adults accepted test sentences like (9) and (10) in scenarios that match the surface scope reading. However, adults rejected these sentences in scenarios in which a 'yes' response indicated access to the inverse scope reading, whereas children accepted them almost 50% of the time in the scenarios in which a 'yes' response is indicative of the inverse scope reading.

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

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

Within each group, a Wilcoxon Signed Ranks Test was used to compare the acceptance rates of test sentences in their surface scope scenarios as compared to their inverse scope scenarios in the two sentence conditions. It was found that younger children accepted the 'every…not' sentences in the surface scope scenarios to the same extent as they did in the inverse scope scenarios (100% vs. 89%, Z = 1.41, p = .50). Similarly, the younger children accepted the 'not…every' sentences in the surface scope scenarios and in the inverse scope scenarios equally often (100% vs. 100%, Z = 0, p = 1). Older children, by contrast, accepted both sentence types significantly more often in the surface scope scenarios than in the inverse

scope scenarios (For 'every…not' sentences, Z = 3, p < .01; for 'not…every' sentences, Z = 2.97, p < .01). There was a similar finding for the adults (For 'every…not' sentences, Z = 4.47, p < .001; for 'not…every' sentences, Z = 4.30, p < .001). Figure 2 gives the proportion of 'yes' responses to the puppet's statements for the three age groups in each condition.

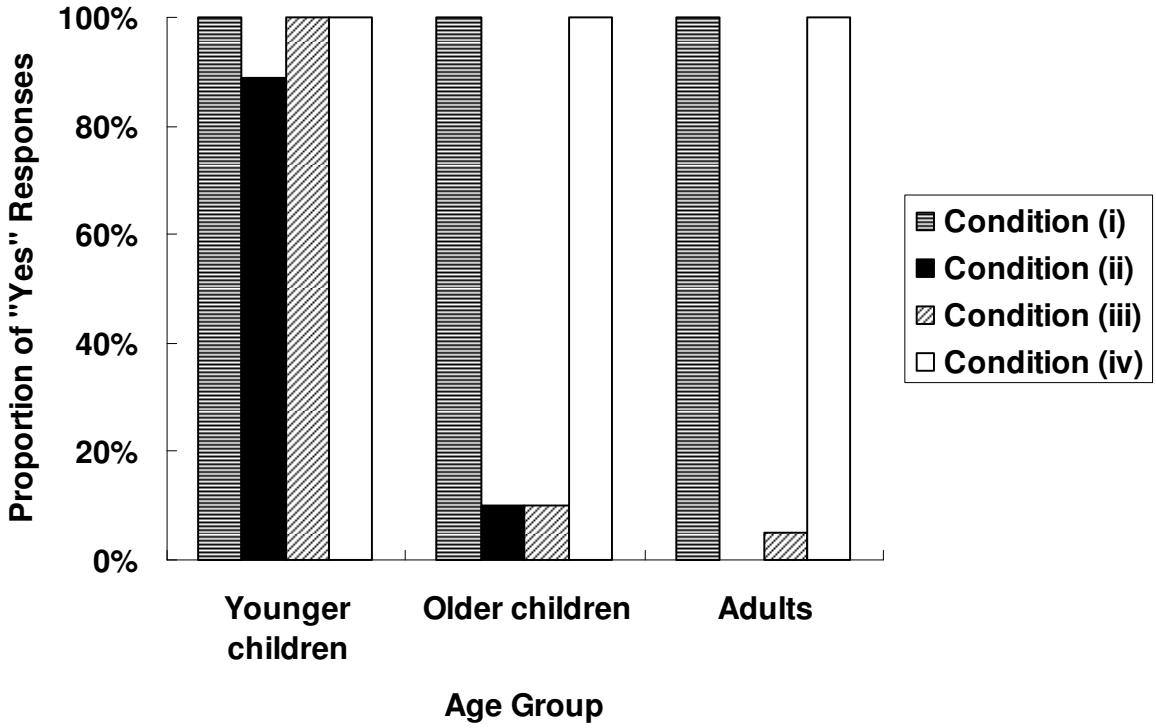

FIGURE.2. Proportion of 'Yes' Responses to the Puppet's Statements for Younger Children, Older Children and Adults in Each Condition, Experiment 1

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

then, we can answer the first question raised in section 5: Do Mandarin-speaking children have adult-like knowledge of scope phenomena? The answer is clearly negative.

This brings us to the second question put forward in section 5. We proposed there that, if Mandarin-speaking do not have adult-like knowledge of the focus-sensitive properties of *dou* and *shi*, then they should interpret sentences like (9) and (10) in the same way as English-speaking children interpret sentences like (1) and (2). But the question is although both English-speaking and Mandarin-speaking children accepted 'every…not' sentences in the felicitous 'some' contexts, the acceptance rate of the Mandarin-speaking children in our study was higher than that of the English-speaking children in Musolino and Lidz (2006) (100% vs. 60%)[8]. Then how can we interpret this difference?

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

Let us review our proposal briefly. First, we witnessed Mandarin-speaking children's acceptance of 'every…not' sentences like (9) in the 'none' contexts, as did Mandarin-speaking adults. However, in contrast to adults, Mandarin-speaking children also accepted sentences like (9) in the 'some' contexts. We attribute this difference to children's analysis of the relevant Mandarin sentences with the focus-sensitive operator *dou*, as their English counterparts with 'bare' quantificational expressions. This explains why these sentences were accepted in both contexts by children.

We explained the pattern of behavior by English-speaking adults in response to 'not…every' sentences to be a consequence of two factors: (a) a 'bare' structural analysis of

[8] We thank one of the anonymous reviewers for pointing this out to us.

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

One piece of the puzzle that remains missing is evidence that Mandarin-speaking children resemble English-speaking children in their lack of sensitivity to conversational implicatures. We discussed two examples in section 5. When children are presented with sentences with logical expressions such as *some* and *or*, these expressions appear to be interpreted using their unadorned meanings, as in classical logic. So, young English-speaking children interpret *some* to mean 'at least', rather than meaning 'some, but not all,' which is the interpretation ordinarily assigned by adults. Similarly, young English-speaking children interpret *or* as inclusive-*or*, rather than carrying an implicature of exclusivity, as it does in ordinary contexts for adult speakers. The source of the differences in interpretations of these logical words by children and adults is the subject of a great deal of controversy. According to one account, by Noveck (2001), the ability to compute implicatures becomes operative only when children reach a certain maturational stage. Another account suggests that the requisite knowledge for computing conversational implicature is in place, but young children lack the computational resources to compare the alternative representations that are required in order to license pragmatic implicatures (Reinhart, 2006). For example, in responding to statements with *or*, children must generate the alternative representation with *and*, in order to assess whether the statement with *and* would be 'stronger' (more informative) than the statement with *or*. Based on other literature, Reinhart (2006) contends that children cannot hold alternative representations in verbal working memory long enough to make the comparison, due to their limitations in computational resources as compared to older children and adults.

To evaluate this processing deficit account of pragmatic implicatures, Chierchia et al. (2001) designed an experimental technique called Felicity Judgment Task. This task was designed to see if children could compute pragmatic implicatures if the prerequisite alternative representations were made transparent to them and, hence, children were not required to compute the alternative representations themselves. To make the alternatives transparent, the task involved two puppets, each of whom produced a statement describing the experimental context, one using a statement with a 'weaker' term and the other using a statement with a 'stronger' term. For example, one puppet produced a statement with *or* and

one puppet produced a similar statement, except with *and*. The child's task was to indicate which puppet described the situation better. The findings were that children often thought that both puppets made true statements, but that the puppet who used the 'stronger' term (in the present case, *and*) said it better. Experiment 2 was designed to see if the same pattern of responses would be elicited from Mandarin-speaking children in response to 'not…every' sentences.

7. Experiment 2

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

7.1 Subjects

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

7.2 Method and Procedures

We used Felicity Judgment Task. The child subjects were introduced to the task individually and then tested individually. They were given 2 practice items before the actual test, one in which the puppet's statement was obviously true and one in which it was obviously false, so that children knew the puppet could say something wrong.

7.3 Materials

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

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

(22) Mei-zhi xiaomao dou mai-le binggan, danshi mei-zhi xiaomao dou
every-CL cat all buy-ASP biscuit but every-CL cat all
meiyou mai yu.
not buy fish
'Every cat bought biscuits, but every cat didn't buy fish.'

(23) Mei-zhi xiaomao dou mai-le binggan, danshi bushi mei-zhi xiaomao
every-CL cat all buy-ASP biscuit but not-be every-CL cat
dou mai-le yu.

all buy-ASP fish
'Every cat bought biscuits, but not every cat bought fish.'

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

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

Altogether 3 test items and 3 controls were created and they were arranged in a pseudo-random order.

7.4 Results and Discussion

In response to the control items, all 9 children judged both puppets to be right, but they indicated that the puppet who used a more specific term had better expressed what had happened. On the test items, all 9 children judged both puppets' statements to be accurate descriptions of the scenarios. When asked which one said it better, 8 children consistently favored the puppet who used the 'every…not' sentences. One child was confused, which we recorded as indicating no preference. And no child preferred the 'not…every' sentences. Friedman Test demonstrated that this difference reached significance ($\chi 2$ (2, N=9) = 14.89, $p < .001$). Figure 3 displays children's preference rates for the two types of sentences in the 'none' scenario.

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

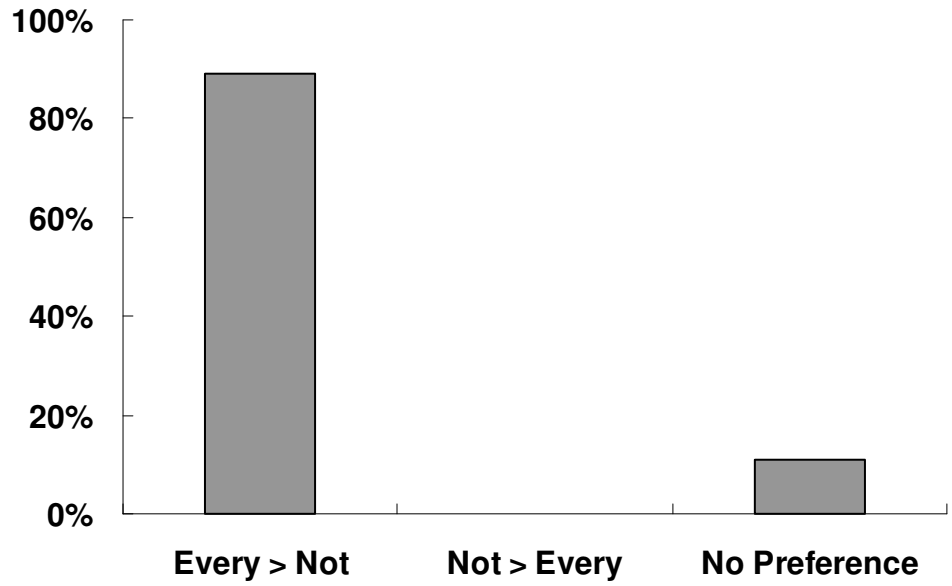

FIGURE.3. Children's Preference Rates for the Two Types of Sentences in the 'None' Scenario, Experiment 2

8. General Discussion and Conclusion

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

experiment investigated Mandarin-speaking children's sensitivity to conversational implicatures. The results showed that Mandarin-speaking children, like their English-speaking counterparts, are able to compute conversational implicatures, but only when the alternative representations are provided overtly. The second experiment also confirmed the conclusion reached in the first experiment, that Mandarin-speaking children find the relevant sentences ambiguous.

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

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

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

because *dou* and *shi* are often used as focus operators in adult language. We anticipate, therefore, that the acquisition of scope rigidity directly follows from the acquisition of the focus-sensitivity of *dou* and *shi*. We must leave this prediction for future research.

To conclude, previous research found that English-speaking children, like adults, have access to both surface scope and inverse scope relations between the universal quantifier and negation, based on which, children are claimed to have the same grammatical competence as adults do. But our study showed that Mandarin-speaking children differ from adults in scope interpretation in that they initially do not assign a unique scope reading to sentences involving the universal quantifier and negation, but rather they behave like English-speaking children, initially assigning a flexible scope relation between the universal quantifier and negation. These findings invite the conclusion that children start off with a flexible scope relation between the universal quantifier and negation. Children's grammar allows flexibility in the mappings from syntax to semantics. But they narrow down their interpretations, if need be, to those of the local language, as in Mandarin, using observable properties which give rise to the scope constraint in the local language.

Acknowledgements

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