Syntactic Constraints on Quantifier Domains: An Experimental Study of Adult Interpretation of the Mandarin Chinese Quantifier *dou*

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1 Introduction

1.1 Previous Analyses and Experimental Questions

There is an extensive body of literature on the syntax and semantics of *dou* (Cheng 1995, 2009; Chiu 1993; Feng 2014; Giannakidou and Cheng 2006; Huang 1982; Huang 1996; Lee 1986; Li 1995; Li 1997; Lin 1996, 1998; Shyu 1995; Tsai 2015a, 2015b; Tsai 2009; Wu 1999; Xiang 2008; Xu 2014; Zhang 1997; Zhou and Crain 2011; among many others); see Y.-H. A. Li (2014) for an insightful review of analyses of *dou*-quantification. The new study we report below is concerned with the syntax of *dou*, and so we motivate our specific questions by briefly reviewing here previous syntactic proposals. We consider semantic proposals regarding *dou* when they are relevant to the syntactic analysis.

Lee (1986) lays the foundation for many formal analyses of *dou*-quantification. He considers *dou* an unselective universal quantifier in the sense of Lewis (1975). According to Lewis, an unselective quantifier will bind all the (free) variables in its scope indiscriminately (but see Berman 1987 for exceptions). Nevertheless, it appears that for Lee (1986: pp. 16-17), if there are two variables in the scope of *dou*, *dou* can bind any one of them or all of them simultaneously. Although this formulation weakens the argument for unselective binding, it is motivated by the observation that sentences such as (1) seem to be *three-ways ambiguous*, as a result of *dou* quantifying over either (1a) *zheixie xuesheng* 'these students' or (1b) *women* 'we', or (1c) both. We seek to experimentally ascertain the possible adult interpretations of (1), to determine if *dou* is strictly an unselective binder that binds all free variables in its domain, that is, if *dou* quantifies over both NPs and renders meaning (1c) only.

(1)   [$_{CP}$ [zhexie xuesheng]$_i$ Top[$_{ASPP}$ [pro$_i$ [$_{ASPP}$ women *dou* xihuan t$_i$]]]
           these students   we   all   like
    a. 'For **all of these students**, we like them.'
    b. 'For the students, **all of us** like them.'
    c. 'For **all of these students, all of us** like them.'

Whether *dou* is a strict unselective quantifier also has an important implication to language acquisition studies. Previous studies use *dou* to test children's interpretation of universal quantifier and confirm that Mandarin speaking children exhibit a phenomenon very similar to unselective binding in child language, i.e., *Quantifier Spreading or Quantifier Floating* (Ke 2012; Ke and Gao 2013). Quantifier Spreading happens when a quantifier spreads to an NP that is not within its domain (Crain et al. 1996; Drozd 2001; Geurts 2003; Philip 1995; Roeper and de Villiers 1991; Roeper et al. 2011). For example, Philip (1995) found that children with an average age of 4-5 years old judged (2) to be a false statement of the scenario where each pig is eating an apple and there is an extra apple not being eaten by a pig. The acceptance of Quantifier Spreading in English remains between 60% and 28% until the age of 11-12 years old (Roeper et al. 2011). The children provided a reason

to justify their judgment: there is no pig eating the extra apple.

(2)   Every pig is eating an apple.

This is different from the adult interpretation. Adults say (2) is a correct description of the scenario because for adults the universal quantifier *all* quantifies over only the subject *pig*, and not over the object *apple*. Philip (1995) proposes that Quantifier Spreading is a result of a symmetric interpretation as shown in (3),[1] where the quantifier *every* spreads its domain over the object NP.

(3)   Every pig is eating an apple, and every apple is being eaten by a pig.

However, without a clear hypothesis regarding the adult grammar, one cannot address the question "How do children develop or acquire the adult grammar?", nor can we identify when or whether the child's grammar differs from the adult grammar. If Chinese adults exhibit the equivalent of Quantifier Spreading, i.e., unselective binding, we cannot argue that Quantifier Spreading for children is non-adult.

Following Lee (1986), Cheng (1995) assumes that *dou* is a universal quantifier. She argues that *dou* adjoins to the m-commanding NP it quantifies over at LF. Then the complex (NP + *dou*) itself undergoes quantifier raising (QR) also at LF. To explain blocking effects in *dou* quantification, Cheng (1995) applies a Principle of Economy of Derivation (PED) (Chomsky 1991), taking *dou* to make only the shortest move at LF, attaching to the closest m-commanding NP as its domain. The more distant NP is thus not available for *dou*. Cheng analyzes left dislocation sentences as in (1), where the topic *zhexie xuesheng* 'these students' is a left-dislocated NP binding a resumptive null pronoun *pro* which undergoes adjunction to AspP (p. 214). Consequently, both the *pro* (bound by the topic) and subject m-command *dou* at LF, whereas the subject is closer to *dou* than the *pro* is. Cheng's PED approach predicts that only the subject *women* 'we' can be quantified by *dou* because it is closer; thus under this analysis only meaning (1b) is possible. (Cheng seems to take (1) as ambiguous though we are not clear as to why *dou* quantification over the further *zhexie xuesheng* 'these students' does not violate PED, p. 203). Cheng's PED is interesting because it is a specific version of the locality restriction, and it has cross-linguistic significance, since it seems that English observes this locality restriction.

Zhang (1997), on the other hand, analogizes *dou* to an anaphor, and proposes that either one or all of the NPs that asymmetrically c-command *dou* can associate with *dou* by multiple linking. Zhang (1997) proposes the Linking Hypothesis (4), which builds upon Higginbotham's (1983, 1985) linking version of Binding Theory, to account for the multiple linking phenomenon when multiple NPs asymmetrically c-command *dou*.

(4)   Linking Hypothesis on *dou*-quantification (Zhang, 1997, p. 197)
        dou must be bound by linking to at least one of its licensers, which asymmetrically c-
        commands *dou* within the same clause.

Therefore, Zhang's theory predicts a three-way ambiguity for sentence (1) (meanings (1a), (1b) and (1c)), although she observes that sometimes only the first two interpretations are available—an issue to which we return below.

According to Lin (1996, 1998), however, *dou* can quantify over one and only one NP in sentences such as (1), although either one of the two NPs can be the domain of *dou*. Lin treats *dou* as a generalized distributive operator. It distributes over a particular element by binding a trace left by the element that moves to/through the Spec of a Distributive Phrase (DistP) headed by *dou*. Thus, Lin suggests that *either the trace of the topic t_k* (he assumes topicalization for topic structures in Chinese, not left dislocation), *or the trace of the subject t_j* (he adopts the VP-internal subject hypothesis), *but not both simultaneously* can be bound by *dou*, predicting either interpretation (1a) or (1b). Note that many other proposals including Li (1997), Wu (1999) and Tsai (2009) basically

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[1]Philip formalizes this interpretation in terms of event semantics. We present a plain English analysis for the sake of simplicity.

agree that *dou* heads a DistP and carries distributive force. Specifically, Li (1997) and Wu (1999) share the conclusion with Lin (1996, 1998) on the possible interpretations of sentence (1): *dou* can quantify over either one but only one NP.

There are other papers that address the question of which NP *dou* quantifies over, when multiple candidates are available, as based on the authors' semantic intuitions. For example, Lü (1980/1999) suggests a stressed NP is preferred as the domain of *dou*, and Zhan (2004) hypothesizes that the NP that is structurally closer to *dou* is more likely to be the domain of *dou*. Wen and Qiao (2002) on the other hand argue that *dou* can take multiple NPs simultaneously as its domain. In addition, Li (2013) proposes that the NP that is more salient, in terms of stress, (structural) position relative to *dou* and phrase length, will be taken as the domain.

Table 1 presents the predictions of the four theories briefly reviewed above. It shows that each theory makes distinctive predictions about the domain of *dou* sentences such as (1).

	Sub_Quantified	Top_Quantified	Both_Quantified
Strict Unselective Binding	×	×	√
Cheng's PED	√	×	×
Zhang's Multiple Linking Hypothesis	√	√	√
Lin's Distributive Operator Approach	√	√	×

Table 1: Domain of *dou* for previous theories concerning the interpretations of sentence (1).[2]

To summarize, we have shown that it remains a question whether *dou* can quantify over only one NP or can simultaneously quantify over multiple NPs as well. In addition, if *dou* turns out to quantify over only one NP, it is still unclear which NP *dou* in fact quantifies over, i.e., does a locality constraint apply? The experiment we present below will help us answer these questions.

1.2 Why Are the Judgments, and Analyses, so Disparate?

The intuitions of previous researchers concerning *dou*'s domain selection clearly differ from each other. We suggest that these disparities in the semantic interpretations by the different authors are due to the fact that most of the previous studies (including Cheng 1995; Lee 1986; Lin 1998; Lü 1980/1999; Zhang 1997) use plural nouns/phrases and demonstrative nouns/phrases, e.g., the topic and subject in (1), to examine the *dou*-induced ambiguity of the topicalized sentences. However, this is highly problematic because we usually interpret the plural or demonstrative phrases as exhaustive, no matter whether they are quantified by *dou* or not. Consequently, they are not clearly distinguishable from universal force in most cases (e.g., *those kids left* means *those kids all left*). In (1), *zhexie xuesheng* 'these students' is usually synonymous with "*all of* these students" even in the absence of the quantifier *dou*, thus masking the central question under experimental investigation, namely: whether or not a given NP is in fact quantified/quantifiable by *dou*.

To circumvent this problem, our experiment uses bare nouns rather than plurals or demonstrative phrases, because bare nouns in Mandarin are ambiguous between a singular and a plural interpretation, that is, a plural interpretation of bare nouns is not required, and can be blocked depending on the linguistic context, differently from plural nouns/phrases and demonstrative nouns/phrases. Crucially, when a bare noun is quantified by *dou*, it loses this ambiguity and must be interpreted as

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[2]Sub_Quantified, Top_Quantified and both_Quantified correspond to interpretations (1a), (1b) and (1c), respectively. Note that they are different from context types Q_Subj and Q_Top (see Figure 2), which we will introduce in the methodology section.

exhaustive (hence plural). Therefore, an obligatory plural interpretation of a certain bare nouns signals that that bare noun is quantified by *dou* under an appropriate experimental setting. We use this interpretation to test *dou* quantification over bare nouns in our experiment.

Another question needs to be addressed before we can use bare nouns as diagnosis for *dou*-quantification: Will bare nouns (e.g., *xiongmao* 'panda') lose their ambiguity and be obligatorily interpreted as exhaustive/plural when there are multiple participants/referents in the context (e.g., many pandas in the situation) that they can refer to? In our experiment, there are two participants of the kind that each bare noun can refer to. Under this situation, must the bare noun correspond to both referents? If the bare noun remains ambiguous and a singular interpretation is accepted, that is, it can apply to only one of the two referents, then we can use the bare noun as a diagnosis for *dou*-quantification. For this reason, we did a pretest to filter out participants that do not accept a singular interpretation but instead provide a plural interpretation to bare nouns in an experimental setting.

2 Experiment

We conducted an experiment to test adults' knowledge of *dou*-quantification when *dou* has two possible (c-commanding) NPs to quantify over. Which NP(s) will be taken as the domain of *dou*, the closest one to *dou*, either one of them, or both of them simultaneously?

2.1 Methodology

2.1.1 Task and Procedure

The experiment used the Truth Value Judgment Task (Crain and Thornton, 1998) and involved two experimenters. One acted out stories using toys and pictures, and the other played the role of a puppet who watched the stories alongside the participant. After each story, the puppet produced a test sentence or a filler sentence to tell the participant what he thought had happened in the story. The participant's task was to judge whether the puppet's statement was correct. The participant was then asked to provide a reason to justify her/his answer.

The test consisted of two parts, the pretest and the main test. The experiment was carried out in a quiet, empty office or lab at Beijing Language and Culture University. Participants were tested individually. Each subject experimental session typically lasted an hour.

2.1.2 Participants

50 native speakers of Mandarin Chinese were recruited through flyers distributed at Beijing Language and Culture University in Beijing, China. The results of 40 native speakers of Mandarin Chinese were included in the analysis, another set of 6 served as pilots and 4 did not pass the pretest (because they rejected 2 out of 3 pretest items). Among the 40 subjects that were included in the analysis, 8 were males and 32 females, with a mean age of 22.95 years and an age range from 19 to 39 years.

2.1.3 Materials

Pretest: The experiment includes the pretest and the main test. We have three items serving as the pretest. These three pretest items have a dual-function: they are practices for subjects to understand and be familiarized with the Truth Value Judgment Task; in addition, they are used to filter the subjects. As we have mentioned, for the purpose of the test, we want only those subjects who always accept the singular interpretation of bare nouns; therefore, in the main test if they reject the singular interpretation of a bare noun with the presence of *dou*, we take this as evidence that they assume *dou*-quantification, rather than simply interpreting bare nouns as plural. These three pretest items were structured the same as the main experiment test items in the sense that a story/context was presented first and then the experimenter who operated the puppet produced a statement. An example of the pretest follows.

The story was in accordance with the picture in Figure 1. After the story, the puppet Mr. Tiger made a statement about what happened in the story:

(5)   Penghuolong zhaodao-le feiji.
        charizard   find-ASP   plane.
        'The charizard(s) found (a) plane(s).'

Figure 1: a picture used in a pretest item.

Note that bare nouns in Chinese are ambiguous between a singular and a plural interpretation. This is why in (5) the NPs *penghuolong* 'charizard(s)' and *feiji* 'plane(s)' can either be translated as singular or plural, although there are two charizards in the story. Our prediction is that if the participants accept (5) as a true description of the story, then participants do not have difficulty to access to singular interpretation even when there are multiple referents that can satisfy the plural interpretation of the bare nouns. That is, when encountering singularity-plurality ambiguity of bare nouns, they will judge the sentence true given the bare nouns *can* be interpreted as singular, and will not judge it as false.[3] On the other hand, the rejection of sentence (5) means that the presence of two objects denoted by the bare noun leads to a plural interpretation of the bare noun.

Main test: The main test has a 3 (sentence types) × 2 (context types) factorial design. Therefore, all together we have 6 conditions, with 2 test items for each condition[4]. Three simple statements concerning the stories served as fillers to check if subjects paid attention in the experiment. Due to space limitation, we discuss only materials from two conditions. These two conditions used the same test sentence (6), i.e., a topicalized sentence, but were distinct regarding the context type, discussed below.

(6) $[_{TopP}[_{NP2}$ Tuzi$]_k$, $[[_{NP1}$xiongmao$]$ *dou* wei-le $t_k]$
                    rabbit,   panda   all   feed-ASP
(7) a.   One and only one of the two rabbits was fed by **both pandas**. (T in Q_Subj context)
      b.   One and only one of the two pandas fed **both rabbits**. (T in Q_Top context)
      c.   **Both of the two pandas** fed **both rabbits**. (F in both contexts)

(6) is possibly ambiguous in three interpretations as in (7a-c), depending on which NP(s) (either the subject NP$_1$ or the topic NP$_2$ or both) is quantified by *dou*. If (7a) is the correct interpretation, then sentence (6) would be judged as true under Q_Subj context type and as false under Q_Top type (Figure 2). (Note that the contexts are stories that were acted out for the subjects using toys, and the figures in Figure 2 simply indicate the scenarios that this story ended with.) Similarly, (6) would be true under Q_Top context type and false under Q_Subj context type if (7b) is the correct interpretation. Finally, (6) would be judged false under interpretation (7c) in both context types, because there is always one NP that is not quantified by *dou* under these two context types.

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[3]Interested readers are referred to Crain and Thornton (1998), especially chapter 6, for a comprehensive discussion on the reasons why subjects are expected to say "yes" to the pretest and test sentences in an ambiguous context, as long as one of the interpretations makes the sentences true. Subjects' explanations for their judgment in the experiment confirm that they rejected the test sentences primarily because of dou-quantification. There are only two rejections that were because the test sentences were ambiguous between a singular and a plural interpretation: the subjects complained that the assertions were not clear.

[4]The original design has 4 items for each condition. Due to time limitation, we ended up presenting only two items from each condition to the subjects.
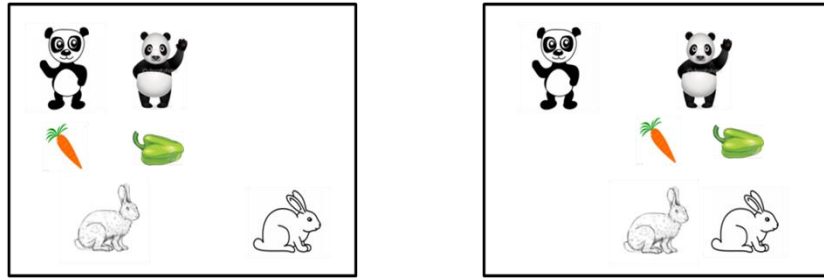
Figure 2: two context types Q_Subj (left) and Q_Top (right).

2.2 Results and Discussion

Pretests: The participants overwhelmingly accepted the pretest items. With 6 pilot subjects being excluded, only 4 of the remaining 44 participants rejected two out of the three pretest items. For the rest of the 40 participants, 39 of them said 'yes' to both of the first two pretest items, only 1 of them said 'no' to the first item while saying 'yes' to the second item. We presented the third pretest item to that participant, and this subject accepted that item. Recall that acceptance of the pretest items suggests that subjects had no difficulty imposing a singular interpretation on a bare noun. The results from the pretest thus provide us strong support for the availability of a singular interpretation of bare nouns even in a context in which there is more than one relevant referent.

Main test: Figure 3 presents the information of confidence intervals besides the percentage of acceptance answers for each condition. We used the R package *binom* to calculate the confidence intervals (Dorai-Raj 2015). According to the suggestions in Wallis (2013), Brown and Li (2005), and Newcombe (1998), we report the Wilson score intervals here.

Importantly, about 32% of the answers (25/79) are "yes" answers to the test sentence in (6) under the context type Q_Subj, and 89% of the answers are "yes" answers to the test sentence under context type Q_Top. This means that there are around 1/3 subject answers indicating that *dou* can quantify over the subject NP only, whereas about 9/10 subject answers supported the hypothesis that *dou* can quantify over the topic NP only. This is the first experimental evidence regarding adult interpretation that either the subject NP or the topic NP is acceptable as the domain of *dou*, although it is the topic that is strongly preferred.
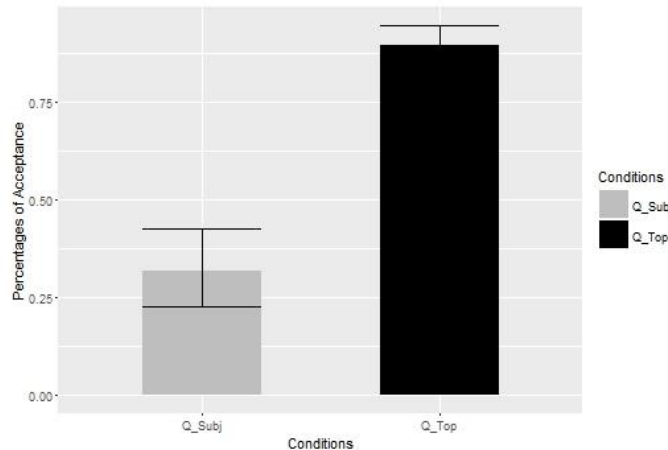

Figure 3: The percentage of acceptance over the test sentences with 95% confidence intervals.

Our results suggest that *dou* can quantify over either NP in the topic sentences, with a strong preference for the non-local domain, the topic, thus not supporting Cheng's PED account of *dou*-quantification. A version of the locality restriction such as Cheng's (1995) PED predicts that in such sentences *dou* quantifies over only the closest NP, i.e., the subject. The results also do not support

the argument that both of the NPs are quantified by *dou* at the same time, failing to corroborate the strict Unselective Binding approach and Zhang's (1997) Multiple Linking Hypothesis. This also constitutes evidence that Quantifier Spreading does not occur in adult *dou*-quantification.

Nevertheless, the last conclusion should be taken with caution, because in principle, the results do not provide evidence to refute Zhang's (1997) Multiple Linking Hypothesis. Zhang's theory predicts a three-way ambiguity, but we have seen in Figure 3 that only two interpretations show up in the results. To address this concern, we considered this question: Was there any subject that exhibited the third interpretation, in which both of the NPs are quantified by *dou* simultaneously? If this is the case, we predict that both NPs must be interpreted as exhaustive and at least some subjects would have rejected the test sentences under both Q_Subj and Q_Top context types. An examination of the individual differences enables us then to go a step further.

Table 2 presents more detailed information about the subjects' individual responses. We count the number of subjects for all response patterns, which include accepting none of the items (*None* in Table 2), accepting only one of the items (*One* in Table 2) and accepting both test items in a condition (*Two* in Table 2).

		Q_Subj		
		None	One	Two
	None	0	2	0
Q_Top	One	3	**1**	0
	Two	12	**18**	**2**

Table 2: Number of subjects accepted the test sentences.

As shown in Table 2, 18 subjects accepted both of the two items under Condition Q_Top and one of the items in Q_Subj. In addition, 21 subjects (summing the numbers in bold) accepted at least one of the items in the two conditions. This suggests that about half of the subjects considered either the topic (in Q_Top) or the subject (in Q_Subj) as the domain of *dou* across their test items, although they preferred to take the topic as the domain. Moreover, 12 subjects accepted both the items in Q_Top, but rejected both the items in Q_Subj. These participants accepted only the topic as the domain of *dou*. Most importantly, did any participants reject the test sentences under both conditions? The answer is no. We thus conclude that no evidence was observed in our experiment to support that *dou* actually quantifies over both the subject and the topic NPs simultaneously.

But notice that the results still cannot exclude the possibility that *dou* actually *can* simultaneously quantify over both NPs, although we did not observe this interpretation in our experiment. Some may argue that what happened in the experiment could be that some interpretations (i.e., one of the NPs is quantified by *dou*) masked other interpretations (i.e., both NPs are quantified by *dou*). It has been reported that participants have a bias to say 'yes' when they encounter an ambiguous sentence and one of the possible interpretations makes the speaker's statement true (Crain and Thornton 1998). However, this possibility is actually pretty low when we consider our experimental design and specially the pattern shown in the results, as in Table 2.

When we presented the stories associated with the test sentence in (8) (copied from (6)), we emphasized that both pandas needed to feed the rabbits because the pandas' mother gave both of them food and asked them to give the food to the rabbits, and both rabbits needed to be fed because both of them were very hungry. Therefore, the interpretation most compatible with this setup would be that both the pandas fed both of the rabbits, which is the interpretation where *dou* quantifies over both NPs simultaneously. This context provides a feasible reason for participants to judge the test sentence as false, but no subject rejected the test sentence under both contexts at the same time, as shown in Table 2.

(8)   [[$_{NP2}$ Tuzi]$_k$, [[$_{NP1}$ xiongmao] dou wei-le t_k].
            rabbit,   panda   all feed-ASP

Furthermore, although participants may have a bias to say 'yes' even if there is an alternative interpretation that makes a test sentence false, it is still only a bias. In other words, living with this bias we still would expect to observe that some subjects said 'no' sometimes. For example, we found 11% of rejection in the case where the subjects preferred to take the topic as the domain of *dou*; and meanwhile we found 32% of acceptance although the subjects were not completely comfortable taking the subject NP as the domain. Therefore, although it is a logically possible interpretation, it is statistically unlikely because none of the 40 participants provided even one instance of rejection for all test sentences in each of the two conditions. And remember that this interpretation is actually most compatible with the contexts. To put it another way, if such an interpretation exists, it is at best with low frequency and is rarely employed. While we cannot rule out this possibility, it appears statistically unlikely.

Suppose we are on the right track that participants preferred to take either the subject NP or the topic NP as the domain, why did they prefer the topic NP, rather than the subject NP, to be the domain? We have every reason to expect that the subject could be the preferred domain, because it is closer to *dou* both in surface structure and at LF under Cheng's (1995) assumption. For example, English seems to observe a locality constraint: in an English counterpart, the English native speakers we informally consulted confirmed that they preferred to have the subject, rather than the topic, as the domain of *all*.

One way that Mandarin Chinese is different from English is that the topic is more prominent or salient than the subject in Mandarin. Chinese is a topic prominent language where topic plays an important role (Huang et al. 2009; Li and Thompson 1981). As C. N. Li and Thompson pointed out, a topic is always in the initial position of a sentence, and it is what the whole sentence and possibly even the whole context of that sentence is about. A sentence always has a topic, but does not always have a subject. If this is on the right track, then the preference for a topic NP over a subject NP as the domain of *dou* in Mandarin can be attributed to a parsing strategy/mechanism rather than purely a syntactic principle. This is predicted if *dou*-quantification can be affected by contextual information, as assumed in Cheng (2009), where *dou* functions as a domain restrictor that can be associated with a contextually provided variable. Tsai (2015a) as well as Jiang and Pan (Jiang and Pan 2013; Jiang 1998; Pan 2006) all recognized that *dou* can take as domain an element that is implicit (at the subject or topic positions) but can be recoverable from the context. In fact, the authors have done an experiment to examine the influence of saliency effect on the selection of the domain of *dou*.

In sum, our results suggest that when there are multiple NPs available for *dou*, either one of them, but not both simultaneously, can be *dou*'s domain, compatible with Lin's (1996, 1998) theory or other theories that allow this kind of two-way ambiguity (e.g. Cheng 2009; Li 1997; Wu 1999). Note that although the results solve a puzzling problem concerning which interpretations arise from *dou*-quantification in topicalized sentences, they do not enable us to address the question whether *dou* is a distributive operator or any of its alternatives/variations. The experiment provides results that are most compatible with Lin's account, and meanwhile offer an empirical basis for future studies on the syntax of *dou*, especially when domain selection is concerned.

3 Conclusions

We can now hypothesize that if there are two NPs available for *dou*-quantification, then either one, but not both simultaneously, can be the domain of *dou*. We can also hypothesize that Quantifier Spreading does not happen in adult *dou*-quantification, which establishes the endpoint of acquisition for future investigation of children's acquisition of universal quantification. It would be interesting to see if in child Mandarin, Quantifier Spreading initially emerges as a primary interpretation, replicating the same phenomenon as has been observed in other languages (Crain et al. 1996; Drozd 2001; Drozd and van Loosbroek 2006; Geurts 2003; Philip 1995; Roeper et al. 2011).

There are limitations in this study, of course, which may be addressed in future studies. We need evidence to ascertain if the salient status of topics, compared to subjects, is indeed the primary factor that contributed to the topic-preference reported in the results from Q_Subj and Q_Top conditions. Will the results be different, if we increase the salience of the subject, or manipulate the prosodic stress positions (either on the subject or the topic or *dou*), or add another universal quantifier 'every' to the subject so that the NP in the subject position is obligatorily quantified by *dou*?

Another indeterminacy is that in principle, Zhang's (1997) Multiple Linking Hypothesis cannot be ruled out, that is, *dou* might still quantify over both NPs in principle, although we found no evidence for this interpretation. However, as we have shown, Zhang's (1997) Multiple Linking Hypothesis is not well supported either statistically or empirically. Future study will need to use testing stimuli that satisfy the following two conditions to avoid the problem caused by 'yes'-bias: (a) the test sentence is true if *dou* quantifies over both NPs simultaneously; (b) it is false if *dou* quantifies over either NP.

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