Two ways to deploy Hamblin alternatives: Mandarin questions and unconditionals

1 Introduction

According to Hamblin's (1973) semantic theory of questions, a question requires the addressee to identify a true proposition or propositions among a group of alternatives. Thus, the meaning of a question is a set of propositions that count as possible answers to it. For example, a polar question like (1-a) denotes a set containing the proposition *Jack is nice* and its negation *Jack is not nice*, as shown in (2). The alternative question in (1-b) can also be answered with these two propositions, and thus it denotes the same Hamblin-set in (2).

(1) a. Is Jack nice?
b. Is Jack nice or not nice?

(2) {Jack is nice, Jack is not nice}

In other words, Hamblin's (1973) theory predicts that there is no difference between English polar questions and English alternative questions in terms of their semantics. Many recent studies (van Rooy & Safárová, 2003; Biezma, 2009; Biezma & Rawlins, 2012, among others), however, present evidence that these two kinds of questions have different properties and are not always interchangeable.

Hamblin semantics is not robust enough to account for the contextual variation observed in the two groups of Mandarin questions that we define in this paper. We will refer to these distinct groups of questions as *ma* questions and anti-bias questions respectively. Mandarin *ma* questions, henceforth MAQs, are marked by the sentence-final particle *ma*, as shown in (3). Anti-bias questions include A-not-A questions, alternative questions, and *wh*-questions which we have grouped together because they are felicitous in the same contexts and they exhibit similar properties. Take A-not-A questions, hereafter referred to as ANAQs, as an example of anti-bias questions. ANAQs conjoin the verb and its negative counterpart, as shown in (4).

(3) Xiaoli xihuan Xiaowu ma?
Xiaoli like Xiaowu Q
'Does Xiaoli like Xiaowu?'

(4) Xiaoli xihuan bu xihuan Xiaowu (ne)?
Xiaoli like not like Xiaowu Q
'Does Xiaoli like or not like Xiaowu?'

As mentioned above, MAQs and anti-bias questions are used in different contexts. When the discourse context already contains a possible answer to the question, MAQs can be used, whereas anti-bias questions cannot, as shown in (5). Although the difference between MAQs and ANAQs has been detected very early (Li & Thompson, 1981), it is still unclear how the difference is represented in semantics. If MAQs and ANAQs both denoted a Hamblin-set, i.e., a set of propositions, (3) and (4) would denote the same set {'Xiaoli likes Xiaowu', 'Xiaoli does not like Xiaowu'}. In this way, we could not account for the distinction in (5).

(5) A: Xiaoli xihuan Xiaowu.
Xiaoli like Xiaowu
'Xiaoli likes Xiaowu.'
B: ✓MAQ #ANAQ

In this paper, we present an analysis of MAQs and anti-bias questions that accounts for their difference in (5). We show that MAQs and anti-bias questions each involve a Hamblin-set of alternatives, but that this Hamblin-set is deployed by each in different ways. We exploit this difference in order to derive the semantic distinction between these two groups of questions. The main proposals are: (i) MAQs update the Question Under Discussion (QUD; Roberts, 1996) with a Hamblin-set, and (ii) anti-bias questions similarly update the QUD with a Hamblin-set and further assert a disjunction of all the propositions in this Hamblin-set. We derive this asserted content compositionally from the syntactic structure, the sentence-final particle *ne* and the low boundary tone L% (Beckman & Pierrehumbert, 1986; Bartels, 1997) of anti-bias questions. This assertion expresses the speaker's ignorance about any possible answer and thus requires a neutral context. When a possible answer to the question has already been asserted, as in (5), the context is not neutral, and thus anti-bias questions are not felicitous here.

This paper is structured as follows: In Section 2, we present empirical observations showing that unlike MAQs, anti-bias questions can only be used in neutral contexts. Section 3 reviews the previous analyses of Mandarin questions and shows how they fail to account for the distinct behaviors of MAQs and anti-bias questions. Then, we provide our analysis for MAQs and anti-bias questions in Section 4. In Section 5, we derive the speaker's ignorance from the assertion meaning of anti-bias questions, and account for the neutrality requirement of anti-bias questions. Section 6 extends the analysis of anti-bias questions to Mandarin unconditional structures. Section 7 gives a conclusion to this study.

2 Differences between MAQs and anti-bias questions

This section provides informal characterizations of the two groups of questions. Mandarin MAQs and anti-bias questions have distinct syntactic/prosodic properties and different requirements on the context. On the basis of empirical data and a naturalness rating experiment, we show that MAQs can be used in neutral and biased contexts, whereas anti-bias questions can only be used in neutral contexts.

2.1 Syntactic and prosodic properties

MAQs are different from anti-bias questions in terms of syntactic and prosodic features. MAQs make only the positive answer p syntactically explicit with the form p-*ma*, as can be seen in (3), repeated here as (6). Syntactically, (6) consists of the positive answer *Xiaoli xihuan Xiaowu* 'Xiaoli likes Xiaowu' and the sentence-final particle *ma*.

(6) Xiaoli xihuan Xiaowu ma?
Xiaoli like Xiaowu Q
'Does Xiaoli like Xiaowu?'

In contrast, anti-bias questions make all the possible answers explicit with the surface syntactic structure. ANAQs make both the positive and negative answers explicit by conjoining the verb and its negative counterpart, as shown in (4), repeated here as (7):

(7) Xiaoli xihuan bu xihuan Xiaowu (ne)?
Xiaoli like not like Xiaowu Q
'Does Xiaoli like or not like Xiaowu?'

Alternative questions (henceforth, ALTQs) consist of two or more alternatives that are connected by *haishi* 'or', as in (8). As can be seen, ALTQs make all the possible answers explicit by conjoining the two alternatives 'Xiaoli likes Xiaowu' and 'Xiaoli likes Xiaozhang' with *haishi*.

(8) Xiaoli xihuan Xiaowu haishi xihuan Xiaozhang (ne)?
Xiaoli like Xiaowu or like Xiaozhang Q
'Does Xiaoli like Xiaowu or like Xiaozhang?'

Another kind of anti-bias question is *wh*-questions (henceforth, WHQs), which contain a *wh*-phrase, as in (9). WHQs introduce a presupposition that existentially quantifies over the disjunction of all of the question's possible answers. For example, (9) presupposes that there exists some individual x who is liked by Xiaoli. This is equivalent to the disjunction of all the propositions in the form of 'Xiaoli likes x', e.g., 'Xiaoli likes Xiaowu' or 'Xiaoli likes Xiaozhang' or 'Xiaoli likes Xiaowang'. In this sense, WHQs make all the possible answers explicit, just like ALTQs do.

(9) Xiaoli xihuan shei (ne)?
Xiaoli like who Q
'Who does Xiaoli like?'

Furthermore, anti-bias questions are optionally marked by the sentence-final particle *ne*, while MAQs are obligatorily marked by the sentence-final particle *ma*.

Prosodically, anti-bias questions obligatorily end with a final low tone, whereas MAQs lack a final low tone (see Section 4.2). The differences between MAQs and anti-bias questions are summarized as follows:

	Syntax	Prosody
MAQs	make one answer explicit; end with the particle *ma*	lack a final low tone
anti-bias questions	make all answers explicit; end with the particle *ne*	a final low tone

Table 1: Differences between MAQs and anti-bias questions

In Section 4, we will see how these syntactic and prosodic differences derive the semantic distinction between MAQs and anti-bias questions.

2.2 Requirement on the context

As pointed out in Section 1, MAQs and anti-bias questions have different requirements on the context. The empirical observation regarding the context requirement is summarized in (10).

(10) a. Both MAQs and anti-bias questions can be used in neutral contexts.
b. MAQs can be used in biased contexts, whereas anti-bias questions cannot.

The concept of 'biased context' in (10) is based on Gunlogson's (2003) proposal, given in (11). If a proposition p is publicly asserted by one discourse participant, it is possible that both participants commit themselves to p in the end. However, there is no possibility that both participants are committed to ¬p. In other words, the context is biased towards p in the sense that it is possible that p is in the Common Ground (CG, a set of propositions representing the common belief of all the participants, see Stalnaker, 1978) and it is impossible that ¬p is in the CG. Therefore, the context is neutral regarding an issue if no one publicly asserted a proposition about this issue before.

(11) If a proposition p is publicly asserted and ¬p is not publicly asserted, the context is biased towards p. (Modified from Gunlogson 2003: 47)

Let us illustrate (10) with examples. (10-a) states that both MAQs and ANAQs can be used in a neutral context, such as (12). No information about Xiaoli's feeling towards Xiaowu has ever been mentioned before, and thus the context is neutral towards the issue whether Xiaoli likes Xiaowu. The speaker can use either an ANAQ or a MAQ to seek the information.

(12) Context: Your friend arranged a blind date for Xiaoli and Xiaowu. After the date, you ask your friend:
A: Xiaoli xihuan bu xihuan Xiaowu (ne)?
Xiaoli like not like Xiaowu Q
'Does Xiaoli like or not like Xiaowu?' (ANAQ)
A′: Xiaoli xihuan Xiaowu ma?
Xiaoli like Xiaowu Q
'Does Xiaoli like Xiaowu?' (MAQ)

Let us turn to the examples of ALTQs and WHQs. Both (13) and (14) are neutral contexts in which no information about Xiaoli's favorite girl has been mentioned before. ALTQs and WHQs can be used in such neutral contexts.

(13) Context: Your friend introduced two girls, Xiaowu and Xiaozhang, to Xiaoli. You ask your friend:
A: Xiaoli xihuan Xiaowu haishi xihuan Xiaozhang (ne)?
Xiaoli like Xiaowu or like Xiaozhang Q
'Does Xiaoli like Xiaowu or like Xiaozhang?' (ALTQ)

(14) Context: Your friend introduced many girls to Xiaoli. You ask your friend:
A: Xiaoli xihuan shei (ne)?
Xiaoli like who Q
'Who does Xiaoli like?' (WHQ)

(10-b) states that MAQs can also be used in biased contexts. In (5), repeated here as (15), one discourse participant A already asserted p 'Xiaoli likes Xiaowu', thus the context is biased towards p. The MAQ used by B indicates B's doubt about the truth of p. ANAQs, ALTQs and WHQs cannot be used in such a biased context, hence they are anti-bias questions.

(15) A: Xiaoli xihuan Xiaowu.
Xiaoli like Xiaowu
'Xiaoli likes Xiaowu.'
B: ✓Xiaoli xihuan Xiaowu ma? (MAQ)
#Xiaoli xihuan bu xihuan Xiaowu? (ANAQ)
#Xiaoli xihuan Xiaowu haishi xihuan Xiaozhang? (ALTQ)
#Xiaoli xihuan shei? (WHQ)

To summarize, both MAQs and anti-bias questions can be used in a neutral context where no possible answer to the question has been asserted before. Only MAQs, but not anti-bias questions, can be used in a biased context where one possible answer has been asserted.

2.3 A naturalness rating study

Section 2.2 characterized the differences between MAQs and anti-bias questions. In order to validate these generalizations, we report a naturalness rating experiment in this section.

In Section 2.2, we made the following generalization: both MAQs and anti-bias questions can be used in neutral context, but only MAQs can be used in biased context (we will take ANAQs as a representative of anti-bias questions). Given the introspection-based generalization, we make the predictions in (16) which we test in an experiment.

(16) a. MAQs and ANAQs are all judged natural in a neutral context.
b. ANAQs are judged less natural than MAQs in a biased context.

In the experiment, each stimulus consisted of a context which established the bias, as exemplified in (17-a) and (17-b), and a target question (a MAQ or an ANAQ), as in (18-a) and (18-b). The two factors (context and question type) generate 4 fully-crossed conditions. Each condition had 10 items, for a total of 40 stimuli.

(17) a. Neutral context: John just had supper in the new canteen. You ask him:
b. Biased context: You know that the food in the canteen is very bad. However, John tells you that the food there is very delicious. You ask him:

(18) a. Shitang de fan haochi ma?
canteen GEN food good Q
'Is the food in the canteen good?'
b. Shitang de fan haochi-bu-haochi?
canteen GEN food good-not-good
'Is the food in the canteen good or not?'

The 40 stimuli and 60 fillers were written in Chinese characters and presented to the participants in a questionnaire in Qualtrics.[1] The questionnaire was organized into ten blocks, each block containing 4 stimuli and 6 fillers. The order of the 10 items within each block was randomized by Qualtrics, ensuring that no minimal pair stimuli appeared together. 16 native Mandarin speakers

[1]Qualtrics is a web-based system that conducts online surveys. Version 45634 of the Qualtrics Research Suite. Copyright©2013 Qualtrics. Qualtrics and all other Qualtrics product or service names are registered trademarks or trademarks of Qualtrics, Provo, UT, USA. http://www.qualtrics.com.

were required to judge how natural the target sentences were in the contexts by ticking the numbers on a 5-point scale: completely natural, somewhat natural, undecidable, somewhat unnatural, completely unnatural. The ratings were treated as numerical values. The t-values and p-values were calculated by the statistical software package SPSS (IBM 2011).

Figure 1 shows that MAQs and ANAQs are both judged as natural in neutral contexts. There is no significant difference between the two in neutral contexts ($p > .05$). This supports (16-a), which says that both MAQs and ANAQs are judged natural in a neutral context. Figure 2 shows that MAQs are judged more natural than ANAQs in a biased context ($t = 7.794$, $p < .001$). This supports (16-b), which says that ANAQs are judged less natural than MAQs in a biased context.

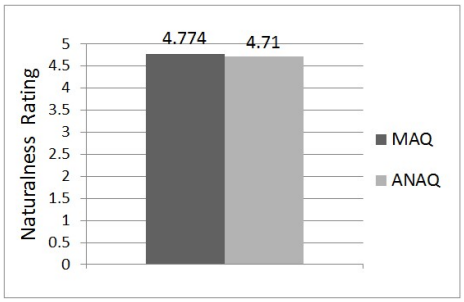


Figure 1: MAQs and ANAQs in neutral contexts

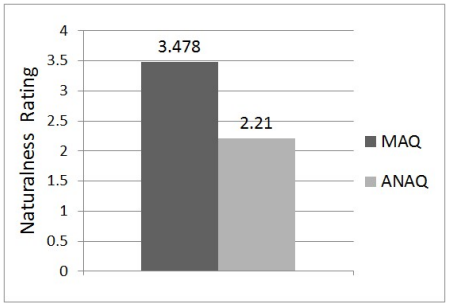


Figure 2: MAQs and ANAQs in biased contexts

Based on the introspection-based data and the experimental results, we conclude that unlike MAQs, anti-bias questions can only be used in neutral contexts.

3 Previous studies about Mandarin questions

Before presenting our semantic analysis, we will give a brief review of previous studies about Mandarin questions in this section. One of the core features of Mandarin questions is the presence of sentence-final particles, such as *ma* and *ne*. Different semantic analyses of these particles have led to different semantic analyses of Mandarin questions. Section 3.1 reviews the studies of sentence-final particles *ma* and *ne* given by Cheng (1991, 1997) and Dong (2009), and shows that both analyses are problematic. Section 3.2 reviews Dong's (2009) study on MAQs and ANAQs. In Dong's (2009) analysis, MAQs and ANAQs have identical semantics, which cannot account for the differences between these two questions that are observed in Section 2.

3.1 The studies of sentence-final particles *ma* and *ne*

As introduced in Section 2, MAQs are marked by the sentence-final particle *ma*, whereas anti-bias questions are marked by the sentence-final particle *ne*. Different accounts for these particles have been provided, but no consensus regarding the semantics or syntax of these particles has been reached. In this section, we review two representative analyses of *ma* and *ne* provided by Cheng (1991, 1997) and Dong (2009).

Cheng (1991, 1997) claims that the sentence-final particles *ne* and *ma* are both question particles. The presence of *ne* indicates that the type of the clause is *wh*-question,[2] and the particle *ma* indicates that the type of the clause is *yes/no* question. As clause-typing particles, *ma* and *ne* are generated in C position. Based on these generalizations, Cheng (1991, 1997) proposes a Clausal Typing Hypothesis as in (19). This hypothesis predicts that there is always an overt way of marking the type of a sentence. Some languages like Mandarin use question particles to mark questions, while others like English use *wh*-movement to mark questions.

(19) Every clause needs to be typed. In the case of typing a *wh*-question, either a *wh*-particle in C_0 is used or else fronting of a *wh*-word to the Spec of C_0 is used, thereby typing a clause through C_0 by Spec-head agreement. (Cheng 1997: 22)

Many researchers, like Li (2006) and Dong (2009), point out that Clausal Typing Hypothesis does not hold. There are two main arguments against the claim that *ma* and *ne* are question particles. First, WHQs, ANAQs and ALTQs are acceptable without the particle *ne*. Second, neither *ne* nor *ma* can take embedded scope. Take *ne* as an example. In (20-a), the *wh*-construction without *ne*, i.e., *shei mai le shu* 'who bought books', can be embedded under the verb *wen* 'ask', while the counterpart with *ne* cannot, as in (20-b).

(20) a. Zhangsan wen wo [shei mai le shu].
Zhangsan ask me who bought PERF books
'Zhangsan asked me who bought books.'
b. *Zhangsan wen wo [shei mai le shu ne].
Zhangsan ask me who bought PERF books ne
Intended reading: Zhangsan asked me who bought books. (Dong 2009: 32)

Therefore, Mandarin would be one of the exotic languages whose question particles only have the matrix-clause property, unlike other *wh*-in-situ languages like Navajo, Japanese and Korean where question particles can be embedded. Cheng's analysis needs to explain why Mandarin is an exception.

Next, let us have a look at Dong's (2009) study of sentence-final particles. According to Dong (2009), the particle *ne* is optional in questions and thus does not contribute to the question meaning. Dong (2009) claims that the particle *ma* is a generic form of negation, and provides evidence for this claim by introducing a subtype of ANAQs in Mandarin, which is of VO-not form. VO-not questions consist of the verb, the object and a negation word. In VO-not questions, the imperfective negation *bu* or the perfective negation *mei* appears at the end of the sentence, which looks just like a sentence-final particle, as shown in (21).

(21) a. Zhangsan xihuan Lisi bu?
Zhangsan like Lisi not
'Does Zhangsan like Lisi ?'
b. Zhangsan chi fan le mei?
Zhangsan eat meal PERF not
'Did Zhangsan eat?' (Dong 2009: 67)

[2]This generalization is not right, as ANAQs and ALTQs can also co-occur with the particle *ne* (and cannot co-occur with *ma*).

Dong (2009) claims that MAQs resemble VO-not questions in that *ma* is in the same position as the negation in VO-not questions. Therefore, *ma* is a generic form of negation in place of the perfective *mei* and the imperfective *bu*. Following this analysis, the syntactic structure of the MAQ in (22) is not (23) but (24).

(22) Zhangsan xihuan Lisi ma ?
Zhangsan like Lisi Q
Does Zhangsan like Lisi? (Dong 2009: 71)

(23) * [$_{CP}$ [$_{IP}$ Zhangsan xihuan Lisi] ma] (Dong 2009: 71)

(24) [Zhangsan [$_{VP}$ xihuan Lisi ma]] (Dong 2009: 71)

We disagree with Dong (2009) in analyzing *ma* as a form of negation, since MAQs have very different properties from VO-not questions.[3] First, VO-not questions marked by *mei* can be embedded under [+*wh*] verbs, just like other ANAQs, but MAQs cannot, as in (25).

(25) a. Wo xiang zhidao [Zhangsan chi fan le mei].
I want know Zhangsan eat meal PERF not
'I want to know whether Zhangsan had a meal or not.' (VO-not question)
b. *Wo xiang zhidao [Zhangsan chi fan le ma].
I want know Zhangsan eat meal PERF Q
Intended: 'I want to know if Zhangsan had a meal.' (MAQ)

Second, VO-not questions marked by *mei* can co-occur with the particle *ne*, just like other ANAQs, but MAQs cannot, as shown in (26).

(26) a. Zhangsan chi fan le mei ne?
Zhangsan eat meal PERF not ne
'Did Zhangsan have meal or not?' (VO-not question)
b. *Zhangsan chi fan le ma ne?
Zhangsan eat meal PERF ma ne
Intended: 'Did Zhangsan have meal or not?' (MAQ)

For these reasons, we argue that VO-not questions, as a subtype of ANAQs, are different from MAQs. The particle *ma* should not be analyzed as a form of negation.

To summarize, the previous studies on sentence-final particles *ma* and *ne* have many problems. Cheng's (1991, 1997) analysis of the particles as question particles in C position cannot explain why the particles cannot be embedded, and Dong's (2009) analysis of *ma* as a form of negation fails to distinguish between MAQs and VO-not questions.

3.2 Dong's (2009) semantic account for ANAQs and MAQs

To our knowledge, Dong (2009) is the only work that provides a formal semantic account for Mandarin questions. This section reviews Dong's (2009) semantic analysis of Mandarin ANAQs and MAQs.

[3] Dong (2009) himself also notices some potential problems caused by this analysis.

According to Dong (2009), in an ANAQ like (27), the verbal complex A-not-A creates a set of functions, as in (28).

(27) Zhangsan xihuan-bu-xihuan Lisi (ne)?
Zhangsan like-not-like Lisi ne
'Does Zhangsan like or not like Lisi?'

(28) $[\![\text{xihuan-bu-xihuan}]\!] = \{\lambda x.\lambda y.\lambda w'.\text{like}(x)(y)(w'), \lambda x.\lambda y.\lambda w'.\neg\text{like}(x)(y)(w')\}$
(Dong 2009: 60)

The two DPs *Zhangsan* and *Lisi*, each denoting a singleton set of individuals, combines with this set of functions through pointwise functional application (Hamblin, 1973) to create a set of propositions, as shown in (29). In Dong's (2009) analysis, the optional particle *ne* does not make any contribution in the semantic computation of questions. Thus, (27) denotes the set of propositions in (29).

(29) $[\![\text{Zhangsan xihuan bu xihuan Lisi}]\!] = \{\lambda w'.\text{like}(\text{l})(\text{z})(w'), \lambda w'.\neg\text{like}(\text{l})(\text{z})(w')\}$
(Dong 2009: 61)

Dong's (2009) analysis of MAQs is built upon his analysis of ANAQs. Since Dong (2009) proposes that *ma* is a generic form of negation, MAQs share the same semantic meaning as VO-not questions and other kinds of ANAQs, as shown in (30).

(30) $[\![\text{Zhangsan xihuan Lisi ma}]\!]$
$= [\![\text{Zhangsan xihuan Lisi bu}]\!]$
$= [\![\text{Zhangsan xihuan-bu-xihuan Lisi}]\!]$
$= \{\lambda w'.\text{like}(\text{l})(\text{z})(w'), \lambda w'.\neg\text{like}(\text{l})(\text{z})(w')\}$ (Modified from Dong 2009: 69)

Dong's (2009) analysis of MAQs and ANAQs fails to account for the differences between MAQs and ANAQs that are observed in Section 2.

3.3 Section summary

This section briefly reviewed the previous studies on Mandarin questions. Cheng's (1991, 1997) analysis of sentence-final particles as question particles and Dong's (2009) analysis of *ma* as form of negation both make wrong predictions. Dong's (2009) analysis of MAQs and ANAQs as sharing identical semantics fails to explain the differences between these two questions. In the next section, we present our semantic analysis which avoids the shortcomings of the previous studies and provides account for the differences between MAQs and anti-bias questions.

4 Semantics of questions

In order to explain the similarity and difference between MAQs and anti-bias questions observed in Section 2, we examine the semantics of these questions in this section. We show that both MAQs and anti-bias questions indicate an update to the Question-Under-Discussion (Roberts, 1996) stack with a Hamblin-set, but only anti-bias questions involve an assertion of the disjunction of all the propositions in the Hamblin-set.

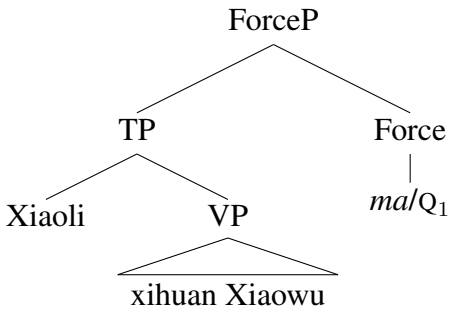
4.1 Mandarin *ma* questions (MAQs)

This section presents the analysis of the particle *ma* as a question force marker. This analysis makes correct predictions about the behaviors of *ma* and hence supports the view that sentential forces have syntactic representation. We also formalize the semantics of MAQs on the basis of Hamblin (1973) and Roberts (1996).

We propose that the *ma* particle in MAQs is a force marker, which introduces a question force head Q_1. Q_1 occupies the head position of a ForceP, so the structure of (3), repeated here as (31), is (32).

(31) Xiaoli xihuan Xiaowu ma?
Xiaoli like Xiaowu Q
'Does Xiaoli like Xiaowu?'

(32)



The analysis of *ma* as a force marker correctly predicts that MAQs cannot be embedded, since clauses indicating sentential forces cannot be embedded in Mandarin. As pointed out by Han (1998), in many languages, embedded clauses cannot express forces. This is indeed the case in Mandarin. Mandarin clauses marked as questions or commands cannot be embedded. When it appears that these clauses are embedded, they are in fact direct quotations. For example, *ni xihuan wo ma* in (33) is a direct quotation of the question 'Do you like me' uttered by Li, and *ni lai wo jia ba* in (34) is a direct quotation of the command 'Come to my home' uttered by Li.

(33) Li wen [ni xihuan wo ma]
Li ask you like me Q
✓ Li asks: 'Do you like me?' ('me' = Li)
Li asks if you like me. ('me' = the speaker of the whole sentence)

(34) Li yaoqiu [ni lai wo jia ba]
Li request you come my home BA
Li requests: '(You) come to my home!' ('my home' = Li's home)

The analysis of *ma* as a force marker also avoids the problems of the previous analyses. Cheng's (1991, 1997) analysis cannot explain why *ma* cannot be embedded. Dong's (2009) analysis fails to distinguish between MAQs and VO-not questions. These problems do not arise in our analysis. That is to say, a proper analysis of *ma* can be provided only if we assume that sentential forces are syntactically represented as force operators such as assertive operator ASSERT and question operator Q (Sadock & Zwicky, 1985; Han, 1998; König & Siemund, 2007, among others). If sentential forces like question were not represented syntactically but were just a pure pragmatic notion, the particle *ma* could only work as a set generator, which takes in a proposition p and

creates the set which contains p and ¬p. Following this analysis, the MAQ *ni xihuan wo ma* in (33) would be a set of propositions, and the verb *wen* 'ask' would take in this set of propositions and the entity Li to return a single proposition. There is nothing wrong in terms of the semantic composition. In other words, the analysis wrongly predicts that MAQs can be embedded.

Next, let us see the semantics of Q_1. In (35-a), Q_1 maps a proposition to a context change potential (CCP, of type$\langle C, C\rangle$, a function from input contexts to updated contexts, see Heim, 1982). Q_1 takes in a proposition p, and then puts the set $\{p, \neg p\}$ (Hamblin, 1973) into the QUD à la Roberts, as shown in (35-b). The '$\oplus$' is the update function which adds a set of propositions onto the top of the QUD stack. QUD(C) $\oplus$ $\{p, \neg p\}$ is a context that resembles C, except that QUD(C) now contains $\{p, \neg p\}$ at the topmost level. By using a MAQ, the speaker is showing his interest in this question and seeking the answer to this question.

(35) a. $[\![Q_1]\!] = \lambda p.\lambda C.\ [QUD(C) \oplus \{p, \neg p\}]$
b. $[\![Q_1(p)]\!] = \lambda C.\ [QUD(C) \oplus \{p, \neg p\}]$

To summarize, *ma* is a force marker. The utterance of p-*ma?* adds a Hamblin-set of propositions $\{p, \neg p\}$ onto the QUD stack as the immediate question under discussion in the stack.

4.2 Mandarin A-not-A questions (ANAQs)

This section derives the meaning of ANAQs compositionally from the meaning of a reduplication feature R, the sentence-final particle *ne* and the low boundary tone L%.

4.2.1 The feature R and the particle *ne*

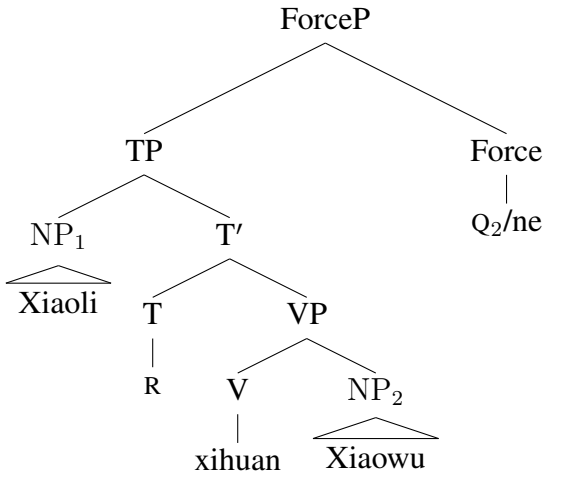
Our proposals regarding the compositional analysis of ANAQs are summarized as below:

(36) a. The feature R, located between the subject NP and the VP in the deep structure of ANAQs, is realized by a reduplication rule.
b. The feature R combines with the VP and the subject NP to create a set which contains a proposition p 'NP VP' and its negative counterpart.
c. The question operator Q_2, phonologically realized as the sentence-final particle *ne*, adds this set onto the QUD and creates a disjunction, p $\vee \neg$p.

Let us illustrate these proposals. (36-a) is based on Huang's (1991) analysis of ANAQs. The ANAQ in (4), repeated here as (37), is derived from the deep structure in (38). The feature R is realized by a reduplication rule, which copies a sequence following T and inserts *bu* 'not' between the original and its copy. Here, R copies the verb *xihuan* and gives rise to the structure in (37). The question operator Q_2, phonologically realized as the sentence-final particle *ne*, introduces the question force, and thus occupies the head position of a Force Phrase (ForceP).

(37) Xiaoli xihuan bu xihuan Xiaowu (ne)?
Xiaoli like not like Xiaowu Q?
'Does Xiaoli like or not like Xiaowu?'

(38)



The feature R derives the semantics described in (36-b). We propose that the semantics of R is as in (39). The formula $\lambda P.\lambda x.\{P(x), \neg P(x)\}$, derived from the reduplication rule, creates a Hamblin-set which contains a proposition and its negative counterpart, as shown in (40).

(39) $[\![\text{R}]\!] = \lambda P.\lambda x.\{P(x), \neg P(x)\}$

(40) $[\![\text{TP}]\!] = [\![\text{R(like.Xiaowu)(Xiaoli)}]\!] = \{\text{p}, \neg\text{p}\}$ p ='Xiaoli likes Xiaowu'

(36-c) characterizes the semantics of the question operator Q_2. We propose that Q_2 expresses two independent dimensions of meaning, an at-issue dimension and a side-issue dimension (Potts, 2005, 2007). The at-issue dimension refers to the aspect of meaning that the speaker presents as new and under discussion, while the side-issue dimension refers to the part of meaning presented as not under discussion, peripheral or backgrounded. As in (41), the denotation of Q_2 consists of two formulae: 1) an at-issue formula $\lambda Q.\lambda\text{C}.\ [\text{QUD(C)} \oplus Q]$, which takes in a Hamblin-set of propositions and then adds this set onto the QUD. 2) a side-issue formula $\lambda S.(r_1 \vee r_2 \vee ... \vee r_{|S|})$, which takes in a Hamblin-set of propositions and gives back the disjunction of all the propositions in the set. The operator '×' is defined as in (42).

(41) $[\![\text{Q}_2]\!] = \lambda Q.\lambda\text{C}.\ [\text{QUD(C)} \oplus Q]\ \times\ \lambda S.(r_1 \vee r_2 \vee ... \vee r_{|S|})$, $r_i \in S$ for all $1 < i \leqslant |S|$
(Notation: Q and S are sets of propositions of type $\langle\langle s,t\rangle,t\rangle$.)

(42) If φ and ψ are formulae, $\varphi \times \psi$ is a formula, where φ is the at-issue formula and ψ is the side-issue formula. If φ is of type $\langle a,b\rangle$, ψ is of type $\langle a,c\rangle$ and γ is of type a, $[\![(\varphi \times \psi)(\gamma)]\!]$ = $[\![\varphi(\gamma)]\!] \times [\![\psi(\gamma)]\!]$.

The interpretation of the ForceP in (38) is given in (43). The at-issue formula $\lambda Q.\lambda\text{C}.\ [\text{QUD(C)} \oplus Q]$ indicates that the speaker is interested in this question and is seeking the answer to it.

(43) $[\![\text{ForceP}]\!] = [\![\text{Q}_2]\!]([\![\text{TP}]\!])$
$= (\lambda Q.\lambda\text{C}.\ [\text{QUD(C)} \oplus Q]\ \times\ \lambda S.(r_1 \vee r_2 \vee ... \vee r_{|S|}))(\{\text{p}, \neg\text{p}\})$
$= \lambda\text{C}.\ [\text{QUD(C)} \oplus \{\text{p}, \neg\text{p}\}] \times (\text{p} \vee \neg\text{p})$ p = 'Xiaoli likes Xiaowu'

In summary, the reduplication feature R produces a Hamblin-set of propositions. The particle *ne* adds this set onto the top of the QUD, i.e., produces a question meaning, and then creates a disjunction of the propositions in the set.

4.2.2 The low boundary tone L%

The previous section derived the meaning of the ForceP. However, the semantics of ANAQs is not complete yet. There is another element in ANAQs, i.e., the final low tone, that also contributes to the semantics of the question. This section investigates the final low tone in ANAQs and compares the intonation of ANAQs with the intonations of declaratives, ALTQs and MAQs.

Shen (1999) points out that MAQs end with a final rising tone, while ANAQs end with a final falling tone, which is the characteristic of declarative intonation. This distinction is depicted in Figure 3, which is a summary of Shen (1999) given by Schack (2000). Shen (1999) also concludes that ALTQs and WHQs share the same intonation pattern with ANAQs and end with a final low tone.

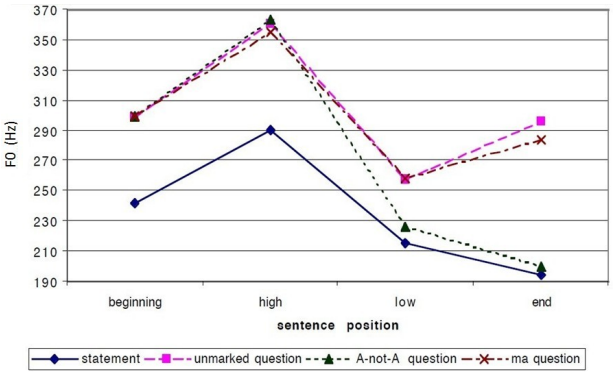


Figure 3: The average F0 in Shen's study (Schack 2000: 29)

Shen's (1990) conclusion is supported by the case study of one Mandarin speaker, who is the first author of this paper. Four utterances were recorded: a declarative, a MAQ, an ANAQ and an ALTQ, and they were analyzed in the Pan-Mandarin ToBI system (Peng et al., 2005). In the test sentence *Wulin na yinyu* 'Wulin carries silver-fish', each syllable is pronounced with tone 2 (the mid-rising tone, labeled as 35). As can be seen from Figure 4 to Figure 7,[4] ANAQs and ALTQs end with the low boundary tone L%, just like the declarative. In contrast, MAQs end with the high boundary tone H%.

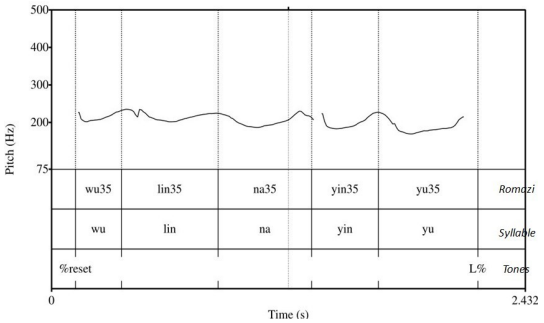


Figure 4: Declarative 'Wulin carries silver-fish.'

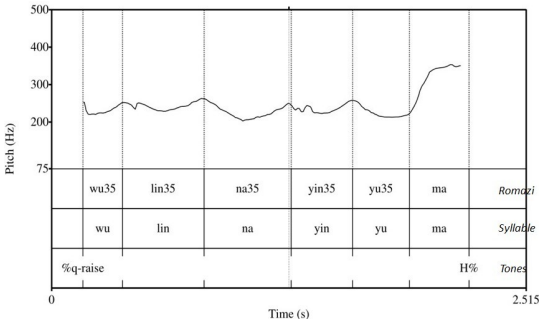


Figure 5: MAQ 'Does Wulin carry silver-fish?'

[4]Since we are only interested in boundary tones, we adopt only three tiers: Romanisation, Syllables and Tones, out of the seven tiers in the Pan-Mandarin ToBI annotation system.

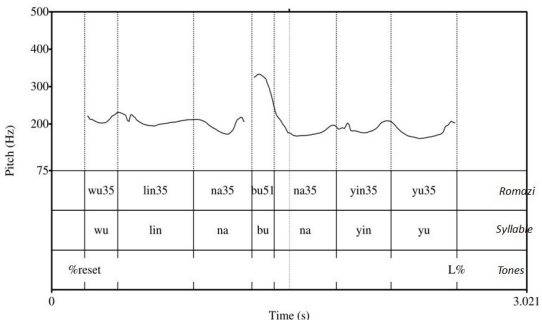


Figure 6: ANAQ 'Does Wulin carry or not carry silver-fish?'

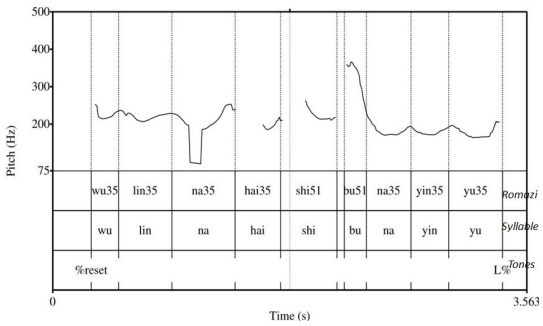


Figure 7: ALTQ 'Does Wulin carry silver-fish or not?'

In a nutshell, declaratives, ANAQs and ALTQs are marked by the low boundary tone L%, whereas MAQs are marked by the high boundary tone H%.[5]

4.2.3 L% as ASSERT and paratactic association

In this section, we propose that the low boundary tone L% provides an assertive force, and show how the paratactic association of L% to the ForceP creates an assertion 'p $\vee\neg$p'.

The proposals regarding the semantics of ANAQs are summarized as below:

(44) a. L% in ANAQs and declaratives represents the abstract ASSERT morpheme.
b. ASSERT is paratactically attached to the secondary formula 'p $\vee\neg$p' to produce an assertion 'p $\vee\neg$p'

(44-a) discusses the semantics of L% tone. It may seem unconventional to treat intonational features as lexical elements which engage in the semantic computation. Researchers like Bartels (1997), however, present convincing evidence that certain phonological features do make semantic contributions. Regarding L% tone in ANAQs, we propose the following hypothesis:

(45) a. The low boundary tone L% bears an interpretable [ASSERT] feature.
b. The question operator Q_2 bears an uninterpretable [uASSERT] feature.

(45-a) follows from the fact that the L% tone is the intonation of declaratives and thus indicates an assertive force (Bartels, 1997). (45-b) says that Q_2 also bears the [ASSERT] feature, but this feature is uninterpretable. In the framework of the Minimalist Program (Chomsky, 1995), uninterpretable φ-features must be checked against matching φ-features in order to be eliminated from the derivation. If uninterpretable features were not checked nor eliminated by LF or PF, the derivation would crash. Therefore, the [uASSERT] feature on Q_2 has to be checked against the matching [ASSERT] feature on the L% tone. As shown in Figure 8, the symbol $\otimes$ indicates that the

[5]Although ANAQs without *ne* obligatorily end with the L% tone, ANAQs containing *ne* can sometimes end with rising tone. Our intuition is that when an ANAQ containing *ne* is uttered with rising tone, the speaker is more anxious to know the answer, compared with ANAQs without *ne*. This is why Shao (1996) argues that the semantics of *ne* is to reinforce the interrogative force. We believe that this reinforcing meaning is not due to *ne*, but due to the rising tone. Following Bartels (1997) and Hara & Davis (2013), the rising tone indicates that the utterance is directed at the addressee and the speaker expects the addressee to resolve the issue. Thus, when uttering ANAQs containing *ne* with rising tone, the speaker sounds more anxious in seeking an answer. The prosody of ANAQs containing *ne* is left for future study.

L% tone is paratactically associated with the ANAQ. The [uASSERT] feature on Q_2 is checked by the [ASSERT] feature on L% and is then eliminated. Then, the structure converges.

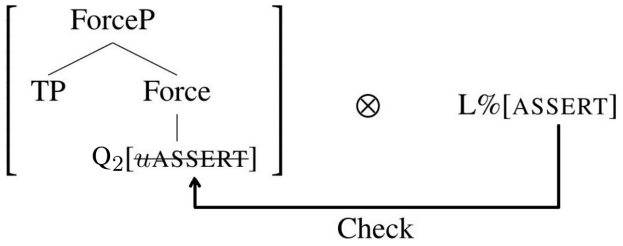


Figure 8: Feature Checking

This hypothesis correctly predicts that it is not grammatical to end an ANAQ with other tones, for example, a rising tone, as shown in (46).

(46) *Xiaoli xihuan bu xihuan Xiaowu $_{\text{H\%}}$
Xiaoli like not like Xiaowu
'Does Xiaoli like or not like Xiaowu?'

Like ANAQs, Mandarin WHQs end with the L% tone. As Mandarin WHQs also end with the question operator Q_2 (which can be phonologically realized as *ne*), our hypothesis predicts that it is not grammatical to end WHQs with other tones, e.g., a rising tone. This is a correct prediction, as shown in (47). When a WHQ ends with a rising tone, the *wh*-word can only be interpreted as an existential and the whole question is a polarity question, as shown in (48). Furthermore, (48) would be ungrammatical if *ne* is added. This verifies the hypothesis that the [uASSERT] feature on Q_2 must be checked by L%'s [ASSERT] feature.

(47) *Ni zhaodao shenme le $_{\text{H\%}}$
you find what PERF
'What did you find?'

(48) Ni zhaodao shenme le (*ne) $_{\text{H\%}}$
you find what PERF Q_2
'Did you find something?'

Going back to the semantics of the L% tone. (44-a) and (44-b) are based on Bartels (1997). Bartels (1997) proposes that English ALTQs obligatorily end with the final low phrasal tone L- (See also Pruitt & Roelofsen, 2013), and L- tone in declaratives and ALTQs represents the abstract ASSERT morpheme. ASSERT is paratactically associated with ALTQs and performs the dynamic assertive update. For example, the alternative statement in (49-b) is the presupposition of the ALTQ in (49-a). ASSERT attaches to the alternative statement to create an assertion meaning, that the speaker believes that Amy ordered one of the three drinks, mineral water, ice tea and lemonade. Anything else cannot have been ordered by Amy. In this sense, an ALTQ can be said to have an assertion component.

(49) a. Did Amy order mineral water, ice tea, or lemonade?
H* H- H* H- H* **L-**L%

b. Amy ordered mineral water, ice tea, or lemonade.

(Bartels 1997: 157)

In contrast, a *yes/no* question does not end with the final low tone L-, as shown in (50). (50) is a *yes/no* question as it has two answers, 'Yes, Amy ordered mineral water, ice tea or lemonade' and 'No, it is not the case that Amy ordered mineral water, ice tea or lemonade'. This *yes/no* question does not presuppose that Amy ordered one of the three drinks, hence does not have an assertion component.

(50) Did Amy order mineral water, ice tea, or lemonade?

(L*) (L*) L* **H-**H% (Bartels 1997: 157)

Following Bartels (1997), we propose that the low boundary tone L% in Mandarin declaratives, ANAQs and ALTQs represents the ASSERT morpheme. ASSERT is attached to ANAQs by paratactic association. The rule of paratactic association is formulated in (51).

(51) Paratactic association:

a. If α is a sentence made up of a syntactic node β and an intonation that can be represented as a semantic feature γ, $[\![\alpha]\!] = [\![\beta]\!] \otimes [\![\gamma]\!] = [\![\beta \otimes \gamma]\!]$.

b. (i) If $\varphi \in ME_c$, $\psi \in ME_a$, and $\gamma \in ME_{\langle a,b\rangle}$, $[\![(\varphi \times \psi) \otimes (\gamma)]\!] = [\![\varphi]\!] \times [\![\gamma(\psi)]\!]$

(ii) If $\varphi \in ME_a$, $\psi \in ME_c$, and $\gamma \in ME_{\langle a,b\rangle}$, $[\![(\varphi \times \psi) \otimes (\gamma)]\!] = [\![\gamma(\varphi)]\!] \times [\![\psi]\!]$
(ME_a represents the set of all meaningful expressions of type a.)

(51-a) says that the semantic feature γ encoded in an intonational morpheme is not syntactically integrated into the main text β, but is rather attached to the main text β to return a formula $\beta \otimes \gamma$. Following (51-a), the syntactic structure of a ANAQ can be represented as in Figure 9, where the assertive morpheme ASSERT encoded by the final low tone in ANAQs is attached to the Force Phrase of ANAQs to return 'ForceP $\otimes$ ASSERT'.

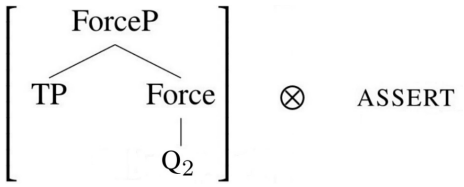


Figure 9: Syntactic structure of ANAQs

(51-b) tells us how to interpret the formula $\beta \otimes \gamma$. As depicted in (52), β projects its at-issue meaning φ and its side-issue meaning ψ.

(52)

$$\begin{array}{c} \beta \otimes \gamma \\ | \\ \varphi \times \psi \end{array}$$

The semantic feature γ is free to attach to either the at-issue content φ or the side-issue content ψ. As shown in (51-b-i), γ is of type $\langle a, b\rangle$, and thus it can take the side-issue content ψ (of type a) as an argument but not the at-issue content φ (of type c). In this case, γ attaches to the side-issue

content ψ to return $\gamma(\psi)$, and the at-issue content φ remains unmodified. (51-b-ii) shows another case, where γ (of type $\langle a, b\rangle$) can take the at-issue content φ (of type a) as an argument but not the side-issue content ψ (of type c). In this case, γ attaches to the at-issue content φ to yield $\gamma(\varphi)$, and the side-issue content ψ remains unmodified.

Let us return to the paratactic association of ASSERT with ANAQs. ASSERT is attached to ANAQs by paratactic association, that is, ASSERT is not integrated with the sentence syntactically, but rather paratactically attached to either of the two formulae in (43), i.e., λC. [QUD(C) $\oplus$ {p, $\neg$p}] or (p $\vee$ $\neg$p). Following (51-b-i), since ASSERT is a force head of type $\langle\langle s, t\rangle, \langle \text{C}, \text{C}\rangle\rangle$, ASSERT should be attached to the side-issue formula p $\vee\neg$p (of $\langle s, t\rangle$ type) rather than the at-issue formula λC. [QUD(C) $\oplus$ {p, $\neg$p}] (of $\langle \text{C}, \text{C}\rangle$ type).

Now, after the paratactic association of the low boundary tone, the semantics of (37) is as in (53). The semantics of an ANAQ consists of two parts: 1) the at-issue meaning λC. [QUD(C) $\oplus$ {p, $\neg$p}], which updates the QUD with the Hamblin-set {p, $\neg$p}; 2) the side-issue meaning, i.e., an assertion 'p$\vee\neg$p'. ANAQs express two forces at the same time, i.e., question force and assertion force.

(53) $[\![(37)]\!]$
=[λC. [QUD(C) $\oplus$ {p, $\neg$p}] $\times$ (p $\vee\neg$p)] $\otimes$ ASSERT
= λC. [QUD(C) $\oplus$ {p, $\neg$p}] $\times$ ASSERT(p $\vee\neg$p) p = 'Xiaoli likes Xiaowu'

This section showed that ANAQs update the QUD and make an assertion 'p $\vee\neg$p'. This assertion meaning is derived from the paratactic association of the low boundary tone L% with the ForceP. In Section 5, we will see how this asserted content signals the speaker's ignorance and how the speaker's ignorance accounts for the neutrality requirement of ANAQs.

4.3 Mandarin alternative questions (ALTQs)

This section provides a semantic analysis of ALTQs by proposing that *haishi* generates a Hamblin-set of propositions. Like ANAQs, ALTQs involve an assertion.

Following Huang (1991), we propose that the deep structure of alternative questions like (8), repeated here as (54), is as in (55). Conjunction Reduction (CR) applies to the deep structure and deletes the second occurrence of *Xiaoli*.

(54) Xiaoli xihuan Xiaowu haishi xihuan Xiaozhang (ne)?
Xiaoli like Xiaowu or like Xiaozhang Q_2
'Does Xiaoli like Xiaowu or Xiaozhang?'

(55) [$_{\text{ForceP}}$ [$_{\text{TP}}$ [$_{\text{TP}}$ Xiaoli xihuan Xiaowu] [$_{\text{Conj}}$ haishi] [$_{\text{TP}}$ ~~Xiaoli~~ xihuan Xiaozhang]] [$_{\text{Force}}$ Q_2]]

The proposals regarding the semantics of ALTQs are summarized below:

(56) a. The alternative generator *haishi* generates a set of alternatives $\{p_1, p_2, ..., p_n\}$, n$\geqslant$2.
b. The question operator Q_2, phonologically realized as the particle *ne*, adds this set onto the QUD and creates a disjunction of the alternatives, $p_1 \vee p_2 ... \vee p_n$.
c. The low boundary tone attaches to the disjunction to produce an assertion '$p_1 \vee p_2 ...\vee p_n$'.

Let us illustrate (56-a) first. Haspelmath (to appear) considers the word *haishi* 'or' to be an interrogative disjunction since it is used in interrogatives. The other disjunction *huozhe* is used only in declaratives:

(57) Xiaoli xihuan Xiaowu huozhe xihuan Xiaozhang.
Xiaoli like Xiaowu or like Xiaozhang
'Xiaoli likes Xiaowu or Xiaozhang.'

We propose that *haishi* is an alternative generator rather than a disjunction for a question, since it collects two or more propositions and creates a set which contains these propositions, as shown in (58). In contrast, *huozhe* collects two or more propositions and yields the disjunction of these propositions, as in (59).

(58) $[\![\textit{haishi}]\!] = \lambda p_1.\lambda p_2.\ldots.\lambda p_n.\{p_1, p_2, \ldots, p_n\}$, n⩾2.

(59) $[\![\textit{huozhe}]\!] = \lambda p_1.\lambda p_2.\ldots.\lambda p_n.p_1 \vee p_2 \vee \cdots \vee p_n$, n⩾2.

The term 'alternative generator' is more suitable than 'interrogative disjunction', since our analysis can not only account for interrogtives with *haishi* but also unconditionals with *haishi*, such as (60). *Haishi* in (60) generates a set which contains two propositions: 'it rains' and 'it snows'. This set composes with the singleton set {'he goes jogging every morning'} (i.e., the denotation of the second clause *ta meitian zaoshang dou qu paobu*) through pointwise functional application (Hamblin, 1973) to give the right interpretation of (60): a set containing two conditionals {'If it rains, he goes jogging every morning', 'If it snows, he goes jogging every morning'}. A more detailed account of Mandarin unconditionals is given in Section 6.

(60) (Wulun) xiayu haishi xiaxue, ta meitian zaoshang dou qu paobu.
no-matter rain or snow he everyday morning DOU go jog
'No matter it rains or snows, he goes jogging every morning.'

In (55), *haishi* creates a set {'Xiaoli likes Xiaowu', 'Xiaoli likes Xiaozhang'}, as shown in (61). As stated in (56-b), the operator Q_2 adds this set onto the QUD and creates a disjunction of the two alternatives. Therefore, the interpretation of the ForceP in (55) will be as in (62).

(61) $[\![\text{TP}]\!]$ = {'Xiaoli likes Xiaowu', 'Xiaoli likes Xiaozhang'}

(62) $[\![\text{ForceP}]\!] = [\![Q_2]\!]([\![\text{TP}]\!])$
$= (\lambda Q.\lambda \text{C}.\ [\text{QUD(C)} \oplus Q]\ \times\ \lambda S.(r_1 \vee r_2 \vee \ldots \vee r_{|S|}))(\{\text{p, q}\})$
$= \lambda \text{C}.\ [\text{QUD(C)} \oplus \{\text{p, q}\}] \times (\text{p} \vee \text{q})$
p = 'Xiaoli likes Xiaowu', q = 'Xiaoli likes Xiaozhang'

After the paratactic association of the low boundary tone with the ForceP, as stated in (56-c), we get the semantics of (54) shown in (63).[6] An ALTQ indicates an update to QUD with the set {p, q}, and makes an assertion 'p ∨ q'.

(63) $\lambda \text{C}.\ [\text{QUD(C)} \oplus \{\text{p, q}\}]\ \times\ \textsc{assert}(\text{p} \vee \text{q})$
p = 'Xiaoli likes Xiaowu', q = 'Xiaoli likes Xiaozhang'

[6] See Erlewine (To appear) for a similar derivation of the semantics of ALTQs.

The alternative generator *haishi* produces a set of possible answers. The particle *ne* adds this set onto the QUD stack and creates a disjunction of the answers. The low boundary tone attaches to the disjunction to make an assertion. Thus, like ANAQs, ALTQs update the QUD and make an assertion.

4.4 Mandarin *wh*-questions (WHQs)

This section derives the semantics of WHQs on the basis of Hamblin's (1973) pointwise functional application. Like ANAQs and ALTQs, WHQs involve an assertion.

We propose that a WHQ like (9), repeated here as (64), has the syntactic structure as in (65).[7]

(64) Xiaoli xihuan shei (ne)?
Xiaoli like who Q_2
'Who does Xiaoli like?'

(65) $[_{\text{ForceP}}\ [_{\text{TP}}\ [_{\text{NP}}\ \text{Xiaoli}]\ [_{\text{VP}}\ [_{\text{V}}\ \text{xihuan}]\ [_{\text{NP}}\ \text{shei}]]]\ [_{\text{Force}}\ Q_2]]$

The proposals regarding the semantics of WHQs are given below:

(66) a. The *wh*-phrase denotes a set of alternatives, and other constituents denote singleton sets.
b. The *wh*-phrase combines with other constituents through pointwise functional application to build a set of propositions.
c. The question operator Q_2, phonologically realized as the sentence-final particle *ne*, adds this set onto the QUD and creates a disjunction of the propositions.
d. The low boundary tone L% attaches to the disjunction to create an assertion.

Let us illustrate these proposals. (66-a) and (66-b) are based on Hamblin (1973). According to Hamblin (1973), a WHQ denotes a set of propositions which count as the possible answers to this WHQ. Suppose that we have three individuals: Xiaowu, Xiaozhang and Xiaowang in our model. Then, the TP in (65) denotes the set in (67).

(67) {Xiaoli likes Xiaowu, Xiaoli likes Xiaozhang, Xiaoli likes Xiaowang}

Now, let us see how this semantics is achieved through point-wise functional application. Following Hamblin (1973), the *wh*-phrase *shei* 'who' denotes a set of contextually salient individuals, the verb *xihuan* 'like' denotes a singleton set which contains one function from individual to one-place predicate, and the subject NP *Xiaoli* denotes a singleton set which contains the individual Xiaoli:

(68) $[\![\textit{shei}]\!] = \{x | x \text{ is a person}\} = \{\text{Xiaowu, Xiaozhang, Xiaowang}\}$

(69) $[\![\textit{xihuan}]\!] = \{\lambda x.\lambda y.\ y \text{ likes } x\}$

(70) $[\![\textit{Xiaoli}]\!] = \{\text{Xiaoli}\}$

The combination of *shei* with the verb *xihuan* is accomplished through the rule of point-wise functional application, defined in (71):

[7]For simplicity, here we assume that *wh*-phrase is in situ and there is no *wh*-movement in Mandarin.

(71) Pointwise functional application rule:
If α is a branching node with daughters β and γ, and $[\![\beta]\!] \subseteq D_{\langle\sigma\rangle}$ and $[\![\gamma]\!] \subseteq D_{\langle\sigma,\tau\rangle}$, then $[\![\alpha]\!]$ = $\{a \in D_{\langle\tau\rangle}$: $\exists b.\exists c.[b \in [\![\beta]\!]$ & $c \in [\![\gamma]\!]$ & $a = c(b)]\}$
(Modified from Kratzer & Shimoyama 2002: 7)

Following (71), each individual in the set {Xiaowu, Xiaozhang, Xiaowang} composes with the function $\lambda x.\lambda y.$ y likes x to build a set of one-place predicates. The semantics of the VP *xihuan shei* in (65) would be like:

(72) $[\![$*xihuan*(*shei*)$]\!]$
=$\{a$: $\exists b.\exists c.[b \in [\![$*shei*$]\!]$ & $c \in [\![$*xihuan*$]\!]$ & $a = c(b)]\}$
=$\{a$: $a = c(b)\}$
=$\{\lambda x.\lambda y.$ y likes x(Xiaowu), $\lambda x.\lambda y.$ y likes x(Xiaozhang), $\lambda x.\lambda y.$ y likes x(Xiaowang)$\}$
= $\{\lambda y.$ y likes Xiaowu, $\lambda y.$ y likes Xiaozhang, $\lambda y.$ y likes Xiaowang$\}$

The VP also combines with the subject NP through pointwise functional application:

(73) $[\![$TP$]\!]$
=$[\![$*xihuan*(*shei*)(*Xiaoli*)$]\!]$
=$\{a$: $\exists b.\exists c.[b \in [\![$*Xiaoli*$]\!]$ & $c \in [\![$*xihuan*(*shei*)$]\!]$ & $a = c(b)]\}$
= $\{a$: $a = c(b)\}$
= $\{\lambda y.[y$ likes Xiaowu](Xiaoli), $\lambda y.[y$ likes Xiaozhang](Xiaoli), $\lambda y.[y$ likes Xiaowang](Xiaoli)$\}$
= {Xiaoli likes Xiaowu, Xiaoli likes Xiaozhang, Xiaoli likes Xiaowang}

Recall (66-c) and (66-d) and now let us derive the semantics of ForceP. As shown in (74), the question force head Q_2, realized as the particle *ne*, combines with the TP to form the ForceP. Q_2 adds the set {p, q, r} onto the QUD and yields a disjunction, p ∨ q ∨ r.

(74) $[\![$ForceP$]\!]$ = $[\![Q_2]\!]([\![$TP$]\!])$ = λC. [QUD(C) ⊕ {p, q, r}] × (p ∨ q ∨ r)
p = 'Xiaoli likes Xiaowu', q = 'Xiaoli likes Xiaozhang', r = 'Xiaoli likes Xiaowang'.

Then, the low boundary tone L% attaches to the disjunction to create an assertion, as in (75). The semantics of a WHQ consists of two parts: 1) the at-issue meaning λC. [QUD(C) ⊕ {p, q, r}], which updates the QUD with the set {p, q, r}; 2) the side-issue meaning, i.e., an assertion 'p ∨ q ∨ r'.

(75) λC. [QUD(C) ⊕ {p, q, r}] × ASSERT(p ∨ q ∨ r)
p = 'Xiaoli likes Xiaowu', q = 'Xiaoli likes Xiaozhang', r = 'Xiaoli likes Xiaowang'.

To summarize this section, we have derived the semantics of WHQs through pointwise functional application. The *wh*-phrase denotes a set of alternatives and other constituents denote singleton sets. Each alternative composes with other constituents to yield a Hamblin-set of propositions. After the combination with the particle *ne* and the paratactic association of L%, this set results an update to the QUD and an assertion of the disjunction of all the possible answers.

5 The assertion meaning: speaker's ignorance

The previous section showed that all anti-bias questions involve an assertion meaning. In this section, we propose that the assertion meaning of anti-bias questions expresses the speaker's ignorance about any possible answer and thus requires a neutral context. This accounts for the neutrality requirement of anti-bias questions and explains why anti-bias questions cannot be used when an answer has been suggested.

As shown in Section 4, the semantics of all anti-bias questions consists of an at-issue meaning, i.e., an update to the QUD, and a side-issue meaning, i.e., an assertion of the disjunction of the possible answers:

(76) a. λC. [QUD(C) $\oplus$ {p, $\neg$p}] $\times$ ASSERT(p $\vee$ $\neg$p) (ANAQs)
b. λC. [QUD(C) $\oplus$ {p, q}] $\times$ ASSERT(p $\vee$ q) (ALTQs)
c. λC. [QUD(C) $\oplus$ {p, q, ..., r}] $\times$ ASSERT(p $\vee$ q ... $\vee$ r) (WHQs)

We propose that the assertion meaning of anti-bias questions expresses the speaker's ignorance about all the possible answers. Let us illustrate this proposal by considering how it applies to ANAQs. The proposition 'p $\vee\neg$p' is a tautology, i.e., the informativeness of this assertion is zero since it is always true. When the speaker asserts a tautology such as (77), the speaker can have at least three possible states of mind: First, the speaker in fact knows that Xiaoli likes Xiaowu (or knows that Xiaoli does not like Xiaowu), but does not want to provide the addressee with this information.

(77) Xiaoli likes Xiaowu or Xiaoli does not like Xiaowu.

Second, the speaker does not care whether Xiaoli likes Xiaowu or not. In other words, the speaker is indifferent to the issue. For example, in an unconditional like (78), the speaker indicates that whether Xiaoli likes Xiaowu or not does not matter to him.

(78) Whether Xiaoli likes Xiaowu or Xiaoli does not like Xiaowu, I recommend Xiaowu to be our chairman.

Third, the speaker has no idea if Xiaoli likes Xiaowu or not, i.e., the speaker is ignorant about this issue. In case of ANAQs, we show below that the first two possibilities should be ruled out due to the incompatibility with the question meaning of ANAQs; thus, the assertion 'p $\vee$ $\neg$p' in ANAQs indicates the speaker's ignorance.

The first possibility that the speaker knows p but conceals this information is eliminated, because the speaker's knowledge about p would make the question infelicitous. According to Searle (1969), a question is felicitous only when it meets the following conditions:

(79) a. Preparatory: S [= speaker] does not know the answer to the question.
b. Sincerity: S wants the missing information.

(Modified from Searle 1969: 66)

Suppose that the speaker knew p. Then, the question would be infelicitous, since both the preparatory condition and the sincerity condition are not met: the speaker knows the answer to the question, and the speaker does not want the information. Thus, the first possibility does not arise in case of ANAQs.

Now, let us see why the second possibility is eliminated. Suppose that the assertion 'p ∨ ¬p' represented the speaker's indifference towards the issue of whether p or not p. Then, the meaning of an ANAQ would be contradictory: according to the primary meaning λC. [QUD(C) ⊕ {p, ¬p}] of an ANAQ, the speaker adds the question onto the QUD stack, indicating that the speaker is interested in the issue and thus seeks the answer. However, the assertion meaning conveys that the speaker is indifferent to this issue. Therefore, the indifferent reading of a tautology is incompatible with ANAQs.

Finally, the third interpretation, the speaker's ignorance about the issue, is compatible with the question meaning (i.e., the speaker is interested in the issue). Therefore, the assertion 'p ∨ ¬p' in ANAQs indicates that the speaker is totally ignorant about the issue of whether p or ¬p. In other words, no bias towards either p or ¬p is indicated, i.e., the context is neutral towards the issue of whether p or ¬p. Let us show in detail how the speaker's ignorance gives rise to the neutrality of context. Gunlogson (2003) provides a definition for bias context in (11), modified here as (80). When a proposition p is publicly asserted, the speaker is committed to p. In this case, it is possible that both the speaker and the addressee commit themselves to p in the end. However, there is no possibility that both participants are committed to ¬p. That is, p has a higher chance to enter the CG than ¬p, hence the context is biased towards p.

(80) If a proposition p is publicly asserted, the context is biased towards p, i.e., $\mathrm{Prob_c(p)} > \mathrm{Prob_c(\neg p)}$.
($\mathrm{Prob_c}$ is a probability function that takes a proposition and returns its probability in context C.) (Modified from Gunlogson 2003: 47)

Following Gunlogson (2003), we provide a definition for neutral context in (81). When the proposition p ∨ ¬p is publicly asserted and the speaker is ignorant towards p or ¬p, the speaker indicates no bias towards either p or ¬p. It is possible that both the speaker and the addressee commit themselves to p in the end, and it is possible that both participants commit themselves to ¬p. That is, p and ¬p have the same probability of entering the CG. In this sense, the context is neutral regarding the issue of p ∨ ¬p.[8]

(81) If a proposition p ∨ ¬p is asserted by some discourse participant and that participant is ignorant about the issue p or not p, the context is neutral towards the issue p or not p, i.e., $\mathrm{Prob_c(p)} = \mathrm{Prob_c(\neg p)}$.

Following (81), the semantics of ANAQs is rewritten as (82).

(82) The semantics of ANAQs:
λC. [QUD(C) ⊕ {p, ¬p}] × [$\mathrm{Prob_c(p)}$=$\mathrm{Prob_c(\neg p)}$]

Similarly, when the speaker makes an assertion 'p ∨ q' by using ALTQs, the assertion 'p or q' indicates that the speaker is ignorant about the issue of whether p or q. When the speaker makes an assertion 'p ∨ q ...∨ r' by using WHQs, the assertion 'p ∨ q ... ∨ r' indicates that the speaker is ignorant about the issue of whether p, q or r. The semantics of ALTQs and WHQs can be rewritten as follows:

[8]It is worth emphasizing that an assertion p ∨ ¬p indicates the context's neutrality towards the issue p or not p, not the speaker's neutrality. In fact, the speaker can have some private bias towards one of the alternatives, but by using ANAQs, the speaker can pretend that the context has no bias towards one or the other alternative.

(83) The semantics of ALTQs:
λC.[QUD(C) $\oplus$ {p, q}] × [$\mathrm{Prob_c(p)}$ = $\mathrm{Prob_c(q)}$]

(84) The semantics of WHQs:
λC.[QUD(C) $\oplus$ {p, q, r}] × [$\mathrm{Prob_c(p)}$ = $\mathrm{Prob_c(q)}$ = $\mathrm{Prob_c(r)}$]

The assertion meaning of anti-bias questions explains why anti-bias questions cannot occur in biased contexts. In a biased context like (15), repeated here as (85), one possible answer p 'Xiaoli likes Xiaowu' has already been asserted and thus the context is biased towards p, i.e., $\mathrm{Prob_c(p)} > 0.5$. This contradicts the assertion meaning of ANAQs ($\mathrm{Prob_c(p)}$ = $\mathrm{Prob_c(\neg p)}$ = 0.5), the assertion meaning of ALTQs ($\mathrm{Prob_c(p)}$ = $\mathrm{Prob_c(q)}$ = 0.5), and the assertion meaning of WHQs ($\mathrm{Prob_c(p)}$ = $\mathrm{Prob_c(q)}$ = $\mathrm{Prob_c(r)}$ ≈ 0.33). Therefore, anti-bias questions cannot appear after the assertion of a possible answer. Unlike anti-bias questions, MAQs simply indicate an update to the QUD. MAQs lack the meaning of the assertion and thus can occur when an answer has already been provided.

(85) A: Xiaoli xihuan Xiaowu.
Xiaoli like Xiaowu
'Xiaoli likes Xiaowu.'
B: ✓Xiaoli xihuan Xiaowu ma? (MAQ)
#Xiaoli xihuan bu xihuan Xiaowu? (ANAQ)
#Xiaoli xihuan Xiaowu haishi xihuan Xiaozhang? (ALTQ)
#Xiaoli xihuan shei? (WHQ)

Although our semantic analysis of anti-bias questions presented above is compositional and accounts for the neutrality requirement, it faces some potential problems. We will present two of these problems here and discuss some possible solutions. The first problem is that a disjunction of all the possible answers is a single proposition, and thus it is not clear how each disjunct becomes a probability function. Let us illustrate this problem by examining ANAQs. An ANAQ makes an assertion p ∨ ¬p, and then this assertion is transformed to $\mathrm{Prob_c(p)}$ = $\mathrm{Prob_c(\neg p)}$. Although we explained pragmatically how an assertion of p or ¬p derives the neutrality of context, the transformation from ASSERT(p ∨ ¬p) to $\mathrm{Prob_c(p)}$ = $\mathrm{Prob_c(\neg p)}$ is formally problematic. The disjunction p ∨ ¬p is a single proposition, hence the disjuncts p and ¬p are embedded and not available as propositional arguments anymore. It is unclear how these disjuncts p and ¬p turn to two probabilities $\mathrm{Prob_c(p)}$ and $\mathrm{Prob_c(\neg p)}$ in the end.

This problem might be solved following along the line of Biezma & Rawlins (2012), who present a compositional semantic account for English polar questions and alternative questions. Following Zimmermann (2000), Biezma & Rawlins (2012) propose that the final low tone L- in English alternative questions represents a closure operator. This closure operator applies to the set of alternatives spelled out in the alternative question, and gives rise to an exhaustivity presupposition which says that the spelled-out alternatives are the only alternatives available. For example, the alternative question in (86) presupposes that the only possibilities for Mary are making pasta or making fish. Anything else cannot have been made by Mary. This alternative question introduces an exhaustive list.

(86) Is Mary making pasta or fish? **L-**L% (Modified from Biezma & Rawlins 2012: 364)

In contrast, polar questions do not end with the final low tone and thus do not have such an exhaustivity presupposition. For example, (87) only presents one alternative among the set of available alternatives. The questioner signals that the present alternative 'Mary is making pasta' is a possibility, but leaves open what other alternatives might be available. The polar question introduces a non-exhaustive list.

(87) Is Mary making pasta? **H-**H% (Modified from Biezma & Rawlins 2012: 364)

Biezma & Rawlins' (2012) analysis accounts for the differences between English polar questions and alternative questions, and it can also be adopted in the analysis of Mandarin MAQs and anti-bias questions. Following this analysis, MAQs and anti-bias questions share the same question meaning (e.g., an update to the QUD), while anti-bias questions have an additional side-issue meaning CLOSE(Q), where CLOSE is the closure operator signalled by the low boundary tone L%, and Q is the set of propositions that count as possible answers to the questions. Although this analysis cannot account for the neutrality requirement of anti-bias questions in its current form, it keeps all the propositions in Q alive instead of collapsing these propositions into a single proposition (as in our analysis). In this way, each proposition in the set Q can be transformed to its own probability, and thus the problem mentioned above can be solved.[9]

The second problem caused by our semantic analysis is concerned with the interpretation of tautology. As pointed out by Jeroen Groenendijk (personal communication), since $p \vee \neg p$ and $q \vee \neg q$ are both tautologies in classical truth-conditional semantics, the assertion '$p \vee \neg p$' is identical to the assertion '$q \vee \neg q$'. This means that the assertion '$p \vee \neg p$' also indicates the speaker's ignorance towards the issue q or not q, which seems to be wrong. Of course, this problem can be avoided if we adopt Biezma & Rawlins' (2012) analysis. This problem can also be solved in the framework of inquisitive semantics (Ciardelli, 2009; Groenendijk & Roelofsen, 2009, 2010, 2013, among others). In inquisitive semantics, '$p \vee \neg p$' and '$q \vee \neg q$' denote two different objects, and thus the problem do not arise. For example, Hara (2014) adopts an inquisitive-semantics approach and proposes that ANAQs semantically negate any anticipation of prior expectation-rejection shift toward p or ¬p, which accounts for the neutrality requirement of ANAQs.

To sum up, anti-bias questions have an assertion meaning, which indicates the speaker's ignorance and requires a neutral context. Therefore, anti-bias questions cannot be used after an answer has been suggested. MAQs have no assertion meaning and thus can occur after the suggestion of an answer.

6 Unconditionals and anti-bias questions

Previous sections discussed the semantics of anti-bias questions. In this section, we extend our analysis to unconditional structures, which are closely related to anti-bias questions.

Unconditional structures are structures that involve a complex sentence made up of two clauses, in which the truth of the main clause is independent of the truth of the adjoined clause. As shown

[9]It is also promising to transform each proposition in Q into its utility value. Following van Rooy & Safárová (2003), Biezma & Rawlins (2012) entertain a proposal that the utility values of the alternatives spelled out in alternative questions are equal, while the utility value of the content proposition is higher than its negation in polar questions. When the formal details of this proposal are worked out, the neutrality requirement of anti-bias questions can also be explained.

in (88), the adjoined clause, *wulun Xiaoli qu naer*, is referred to as the antecedent, whereas the main clause, *wo dou hui gen ta qu*, is referred to as the consequent. Mandarin unconditionals are obligatorily marked by the adverb *dou* 'all' in the consequent.

(88) (Wulun) Xiaoli qu naer, wo dou hui gen ta qu.
no-matter Xiaoli go where I DOU will with him go
'No matter where Xiaoli goes, I will go with him.'

Unconditional structures are closely related to anti-bias questions in that unconditional antecedents contain anti-bias constructions, i.e., *wh*-constructions, A-not-A constructions and p-*haishi*-q constructions, shown in (88), (89) and (90) respectively.

(89) Wulun Xiaoli xihuan bu xihuan wo, wo dou hui gen ta qu.
no-matter Xiaoli like not like me I DOU will with he go
'No matter Xiaoli likes or not likes me, I will go with him.'

(90) Wulun Xiaoli qu Meiguo haishi Riben, wo dou hui gen ta qu.
no-matter Xiaoli go USA or Japan I DOU will with he go
'No matter Xiaoli goes to the U.S. or Japan, I will go with him.'

Other constructions, such as declarative clauses, cannot occur in the antecedent of unconditionals, as shown in (91).

(91) *Wulun Xiaoli qu Meiguo, wo dou hui gen ta qu.
no-matter Xiaoli go USA I DOU will with he go
'No matter Xiaoli goes to the U.S., I will go with him.'

One semantic property of unconditionals is that they have an indifference implication (Rawlins, 2008, 2013). For example, (88) indicates that the speaker is indifferent towards where Xiaoli goes, as the speaker will go with Xiaoli in any case. Rawlins (2008, 2013) derives the indifference implicature of English unconditionals from the question-denoting antecedent and a covert universal operator. We follow Rawlins (2008, 2013) in our analysis of Mandarin unconditionals and propose that the covert universal operator in English is overtly marked by the adverb *dou* in Mandarin. Before presenting our analysis of Mandarin unconditionals, let us briefly review Rawlins (2008, 2013).

Rawlins (2008, 2013) provides a semantic account for English unconditionals that explains the relationship between unconditionals and conditionals. Intuitively, unconditionals can be paraphrased as a list of conditionals. For example, the unconditional in (92-a) can be interpreted as a list of two conditionals in (92-b).

(92) a. Whether Alfonso has a cold or the flu, Alfonso should stay home from school.
(Rawlins 2013: 136)

b. If Alfonso has a cold, Alfonso should stay home from school;
If Alfonso has the flu, Alfonso should stay home from school.

According to Rawlins (2008, 2013), one difference between conditionals and unconditionals is that unconditionals have an indifference implication but conditionals do not. For example, (92-a) shows that the speaker is indifferent towards the issue of whether Alfonso has a cold or the flu. However,

neither conditional listed in (92-b) has this indifference implication. Rawlins (2008, 2013) argues that this difference follows from the structure of the antecedents: unconditional antecedents denote a set of propositions (i.e., a question meaning), whereas conditional antecedents denote a single proposition.

Let us see how Rawlins (2008, 2013) derives the indifference implication of unconditionals. Rawlins (2008, 2013) proposes that the antecedent of unconditionals is an interrogative structure and denotes a set of propositions. Thus, the antecedent of (92-a) denotes a set containing two propositions, as shown in (93).

(93) $[\![$Whether he has a cold or the flu$]\!]$ = {'Alfonso has a cold', 'Alfonso has the flu'}

This set of propositions combines with the consequent, which denotes a singleton set, through pointwise functional application (Hamblin, 1973) to yield a set of conditionals. Thus, (92-a) denotes a set of conditionals as in (94). This explains the intuition that unconditionals can be paraphrased as a list of conditionals.

(94) $[\![$Whether he has a cold or the flu, Alfonso should stay home from school$]\!]$
= {'If Alfonso has a cold, Alfonso should stay home from school', 'If Alfonso has a flu, Alfonso should stay home from school.'}

Inspired by Menéndez-Benito (2006), Rawlins (2008, 2013) proposes that a default universal operator, as defined in (95), is inserted in the LF of an unconditional. This operator collects a set of propositions and asserts that each of the proposition is true.

(95) $[\![\forall\alpha]\!] = \{\lambda w.\forall p \in [\![\alpha]\!] : p(w) = 1\}$ (Rawlins 2008: 140)

Thus, an unconditional like (92-a) denotes a conjunction of all the conditionals in (94), as shown in (96).

(96) $[\![$Whether he has a cold or the flu, Alfonso should stay home from school$]\!]$
='If Alfonso has a cold, Alfonso should stay home from school.' $\wedge$ 'If Alfonso has a flu, Alfonso should stay home from school.'

(96) says that if Alfonso has a cold, he should stay home from school and if Alfonso has the flu, he should stay home from school. This means that the consequent 'Alfonso should stay at home' is true under any condition. In other words, the choice of the alternatives presented in the antecedent does not change the truth value of the consequent, which gives rise to the indifference implication. In contrast, a conditional indicates that the consequent is true under the condition presented in the antecedent. Since the truth of the consequent under other conditions is not known, conditionals do not have an indifference implication.

To summarize, Rawlins (2008, 2013) made two important proposals about unconditional structures. First, unconditional antecedents are interrogative structures which denote Hamblin-sets of propositions. Second, there exists a default universal operator in unconditionals, which quantifies over the propositions in the Hamblin set. These semantic components give rise to the indifference implication of unconditionals. Our analysis of Mandarin unconditionals is built upon these two proposals. The proposals regarding the semantic computation of Mandarin unconditionals are summarized in (97).

(97) a. Unconditional antecedents are anti-bias constructions, each denoting a Hamblin-set of propositions.
b. The operator *dou* 'all' universally quantifies over the propositions in the Hamblin-set. Thus, an unconditional claims that every proposition in the set denoted by the antecedent will make the consequent true.

(97-a) specifies the semantics of unconditional antecedents. As mentioned above, unconditional antecedents contain anti-bias constructions such as A-not-A constructions, p-*haishi*-q constructions and *wh*-constructions. Recall from Section 4, that anti-bias constructions denote a set of propositions, and thus unconditional antecedents also denote a set of propositions. For example, in (88), repeated here as (98), the antecedent *Xiaoli qu naer* is a *wh*-construction and denotes a set of propositions as in (99).

(98) (Wulun) Xiaoli qu naer, wo dou hui gen ta qu.
no-matter Xiaoli go where I DOU will with him go
'Wherever Xiaoli goes, I will go with him.'

(99) ⟦*Xiaoli qu naer*⟧
= {'Xiaoli goes to Japan', 'Xiaoli goes to the U.S.', ... 'Xiaoli goes to China'}

(97-b) specifies the contribution of the adverb *dou* in unconditionals. This semantics of *dou* is based on Pan (2006), who proposes that *dou* is a universal operator and introduces tripartite structures. For example, *dou* in (100) introduces a tripartite structure as in (101). The plural element located to the left of *dou*, i.e., the noun phrase *zhexie shu* 'these books', is mapped to the restrictor, and the other part of the sentence, i.e., *ta kan guo le* 'he has read' is mapped to the nuclear scope. (101) says that for every x, such that x is a member of 'these books', he has read x.

(100) Zhexie shu ta dou kan guo le.
these book he DOU read EXP PERF
'These books he has read them all.'

(101) *dou*[$x \in$ ⟦these books⟧][he has read x]
$\forall x$[$x \in$ ⟦these books⟧ $\rightarrow$ he has read x]

Similarly, the universal operator *dou* introduces a tripartite structure in unconditionals. For example, *dou* in (98) introduces a tripartite structure as in (102). The plural element located to the left of *dou*, i.e., the *wh*-construction *Xiaoli qu naer* 'where Xiaoli goes' denoting a set of propositions, is mapped to the restrictor, and the consequent of the sentence is mapped to the nuclear scope. (102) says that for every p, if p is a proposition of the set ⟦where Xiaoli goes⟧, 'I will go with Xiaoli' is true.

(102) *dou*[$p \in$ ⟦where Xiaoli goes⟧][I will go with Xiaoli]
$\forall p$[$p \in$ ⟦where Xiaoli goes⟧ $\rightarrow$ I will go with Xiaoli]

Following this analysis, the semantics of *dou* is defined as in (103). The universal quantifier *dou* takes in a proposition r, where r is the denotation of the consequent, and a set of propositions Q, where Q is the denotation of the antecedent, to create an unconditional structure *dou*(r)(Q). This unconditional claims that all the worlds that make the proposition p true also make r true.

(103) $[\![dou]\!] = \lambda r.\lambda Q.\forall p \in Q.\forall w[p(w) \rightarrow r(w)]$

Consequently, the unconditional in (98) has the semantics as (104).

(104) $[\![dou(\mathrm{r})(\mathrm{Q})]\!] = \forall p \in [\![\mathrm{Q}]\!].\forall w[p(w) \rightarrow \mathrm{r}(w)]$
$[\![\mathrm{Q}]\!]$ = {'Xiaoli goes to Japan', 'Xiaoli goes to the U.S.', ... 'Xiaoli goes to China'}
$[\![\mathrm{r}]\!]$ = 'I will go with Xiaoli'

(104) says that for each proposition p in the set Q denoted by the antecedent and for each world w, if w is a world where p is true, w is a world where r is true. This amounts to saying that an unconditional denotes a conjunction of a list of conditionals. (98) indicates that if Xiaoli goes to the U.S., the speaker will go with Xiaoli, and if Xiaoli goes to Japan, the speaker will go with Xiaoli and if Xiaoli goes to China, the speaker will go with Xiaoli, etc. The choice of the alternatives listed in the antecedent does not change the truth value of the consequent r 'I will go with Xiaoli'. This is why unconditionals have an indifference implication.

This section showed that Mandarin unconditionals and anti-bias questions involve the same Hamblin-set of propositions and provided a compositional semantics for Mandarin unconditionals. The obligatory adverb *dou* universally quantifies over the set of propositions denoted by the antecedent. Thus, an unconditional indicates that all the propositions introduced in the antecedent will make the consequent true. The choice of the alternatives listed in the antecedent does not matter to the truth of the consequent, which gives rise to the indifference implication of unconditionals.

7 Conclusion

In this paper, we showed that the Hamblin-set of propositions is deployed differently in Mandarin MAQs and anti-bias questions (i.e., ANAQs, ALTQs and WHQs), which accounts for the distinction between these two groups of questions. MAQs and anti-bias questions both encode an update to the QUD with a Hamblin-set. anti-bias questions additionally involve an assertion of the disjunction of all the propositions in the Hamblin-set. We derived this assertion meaning compositionally from the syntactic structure of the questions, the sentence-final particle *ne* and the low boundary tone L%. The asserted content of anti-bias questions expresses the speaker's ignorance about the issue and thus requires that the context be neutral regarding any possible answer. Therefore, anti-bias questions cannot be used in biased contexts in which a possible answer has been asserted. In contrast, MAQs do not have the assertion meaning and thus can be used in both neutral and biased context.

Furthermore, we extended the analysis of anti-bias questions to Mandarin unconditional structures. Mandarin unconditionals and anti-bias questions involve the same Hamblin-set of propositions. The obligatory adverb *dou* universally quantifies over this Hamblin-set denoted by the antecedent. Thus, an unconditional indicates that all the propositions introduced in the antecedent will make the consequent true, which gives rise to the indifference implication of unconditionals.

Many recent semantic studies have raised concern over the neutrality requirement of anti-bias questions. For example, van Rooy & Safárová (2003) propose that the utility values of the alternatives spelled out in alternative questions are equal, which explains why English alternative questions cannot be used in biased contexts. Biezma & Rawlins (2012) argue that English alternative questions spell out all the alternatives that are available and introduce an exhaustive

list. No bias towards any of the alternatives is indicated and hence the neutrality requirement. Hara (2014) proposes that Cantonese A-not-A questions conventionally encode lack of expectation towards p or ¬p, and thus can only be used in neutral contexts. Although the neutrality requirement of anti-bias questions is widely recognized, it is still an open question how to derive this requirement compositionally. The analyses of van Rooy & Safárová (2003) and Hara (2014) are not completely compositional and must stipulate the semantics of anti-bias questions in order to account for their behavior.[10] Our study derived the neutrality requirement of anti-bias questions compositionally from the L% tone and the syntactic structure, but as shown in Section 5, further work is needed to spell out how the speaker's ignorance about possible answers gives rise to the neutrality requirement in a compositional way.

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[10] See Roelofsen & van Gool (2010) and Ciardelli & Roelofsen (2014) for compositional analyses of alternatives and questions within the framework of inquisitive semantics.

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