How contextual bias rules the distribution of Mandarin polar questions and their answers

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Abstract The goal of this paper is to define the notion of contextual bias and to provide a compositional semantic analysis that explains the different bias meanings arising from three types of Mandarin polar questions: positive *ma* questions, negative *ma* questions and A-not-A questions. First, we show that bias meanings arising from these questions are best characterized by the notion of contextual bias rather than the speaker's bias, and we provide a formal definition that unifies contextual bias from different sources based on the subjective probability distribution and the Table model (Farkas & Bruce 2010). Second, we provide a compositional semantic analysis of each polar question. The three questions all denote an update of the Table with a Hamblin-set. The difference between positive and negative *ma* questions is attributed to the pragmatic competition. An A-not-A question is different from a *ma* question in that the former is uttered with the low boundary tone L% that gives rise to an exhaustivity meaning, which in turn is responsible for its unbiased connotation. Our analysis further explains what kinds of answers are possible as responses to these questions.

1 Introduction

According to Hamblin (1958; 1973), a question denotes a set of propositions that count as possible answers to it. For example, a positive polar question (1a) denotes a set containing the proposition 'Jack is nice' and its negation, as illustrated in (2). The negative polar question (1b) and the alternative question (1c) can also be responded with these two propositions, and thus they are analyzed to denote the same Hamblin-set in (2).

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

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

In other words, Hamblin's theory predicts no semantic difference between English positive polar questions, negative polar questions and alternative questions in the form of 'p or not p?'.[1] However, many subsequent studies present evidence that these questions have different properties and are not always interchangeable (Bolinger 1978; Ladd 1981; Büring & Gunlogson 2000; van Rooy & Safárová 2003; Romero & Han 2004; Asher & Reese 2007; Roelofsen & van Gool 2010; Biezma & Rawlins 2012; Sudo 2013; Krifka 2015; Domaneschi et al. 2017; Farkas & Roelofsen 2017: a.o.).

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[1] Other classic approaches like Karttunen (1977) and Groenendijk & Stokhof (1984) also predict no difference between these questions.

Mandarin Chinese also has three types of polar questions that are not interchangeable: positive *ma* questions, negative *ma* questions and A-not-A questions. *Ma* questions, henceforth MAQs, are constructed by adding the particle *ma* to a positive or negative declarative sentence, as illustrated respectively in (3) and (4). A-not-A questions, henceforth ANAQs, conjoin the verb and its negative counterpart and end with a final low tone L%,[2] as exemplified in (5).

(3)   Xia yu le   ma?
        fall rain PFV ma
        'Did it rain?'   (positive MAQ)

(4)   Mei xia yu   ma?
        not fall rain ma
        'Did it not rain?'   (negative MAQ)

(5)   Xia mei xia yu?
        fall not fall rain
        'Did it rain or not rain?'   (ANAQ)

While intuitively these three are asking the same question of whether it rained, they are used in different contexts. For example, when the context is biased towards the positive answer, as in (6), (3) can be used, whereas (4) and (5) cannot. Although the difference between MAQs and ANAQs has long been observed (Li & Thompson 1981), it is still unclear how this difference is represented in the semantics and how to derive this difference compositionally. If positive MAQs, negative MAQs and ANAQs simply denoted Hamblin-sets, (3), (4) and (5) would denote the same set {'It rained', 'It did not rain'}. In this way, we could not account for the distinction in (6).

(6)   B enters A's windowless room wearing a wet raincoat.

        A: √(3) positive MAQ   #(4) negative MAQ   #(5) ANAQ

This paper provides a compositional semantic analysis of MAQs and ANAQs and accounts for their different felicity in contexts like (6). While the narrow goal of this paper is a compositional account of Mandarin questions, we believe our discussion sheds light on a few larger issues. It attempts to explain why polar questions always come with contextual bias towards the alternative that is overtly realized in the question's form, and provides a formal definition that unifies contextual bias from various sources, such as bias from discourse participants' conversational moves and bias from contextual compelling evidence. The paper is structured as follows: Section 2 presents empirical observations about the differences between MAQs and ANAQs in syntactic/prosodic properties, felicity and answers. Section 3 reviews the previous analyses of Mandarin questions. It is shown that traditional approaches, which characterize MAQs and ANAQs in terms of the speaker's bias, fail to account for the distinction between these questions. Then, we provide our analysis of MAQs and ANAQs respectively in Sections 4 and 5. We show that MAQs and ANAQs each involve a Hamblin-set, but this set is deployed by MAQs and ANAQs in different ways. Furthermore, ANAQs end with the L% tone, which contributes to an exhaustivity meaning that all the issues on the Table (Farkas & Bruce 2010) amount to the set containing both the positive and negative answers. This explains why ANAQs cannot be used in biased contexts like (6), where only the positive answer is on the Table. Section 6 concludes this study.

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[2] The phonological system adopted in this paper is Pan-Mandarin ToBI system (Peng et al. 2005).

2 Differences between MAQs and ANAQs

This section provides informal characterizations of the two types of questions. MAQs and ANAQs have distinct syntactic/prosodic properties, license different answers and have different felicity in contexts.

2.1 Syntactic and prosodic properties

MAQs are different from ANAQs in terms of syntactic and prosodic properties. MAQs make only one possible answer p syntactically explicit with the form p-*ma*, as in (3) and (4). Syntactically, (3) consists of the positive answer *Xia yu le* 'It rained' and the particle *ma*, while (4) is made up of the negative answer *Mei xia yu* 'It did not rain' and *ma*. Unlike MAQs, ANAQs make both the positive and negative answers explicit in their surface structures by conjoining the verb and its negative counterpart, as in (5). Furthermore, ANAQs are optionally marked by the sentence-final particle *ne*, unlike MAQs, which are obligatorily marked by the particle *ma*.

Another difference is that MAQs cannot be embedded while ANAQs can (Li & Thompson 1981; Li 2006; Tang 2010), as demonstrated by (7) and (8).[3] However, if the particle *ne* is attached, the ANAQ cannot be embedded either, as in (9).

(7)   *Li (bu) zhidao [xia yu   le   ma].
        Li not know   fall rain PFV ma
        Intended: 'Li (does not) know(s) if it rained.'

(8)   Li (bu) zhidao [xia mei xia yu].
        Li not know   fall not fall rain
        'Li (does not) know(s) if it rained.'

(9)   *Li (bu) zhidao [xia mei xia yu   ne].
        Li not know   fall not fall rain ne
        Intended: 'Li (does not) know(s) if it rained.'

Prosodically, ANAQs obligatorily end with a final low tone L%, whereas MAQs do not (see Section 5.2). The differences between MAQs and ANAQs are summarized as follows:

(10)   a.   Syntactic differences:
                  •MAQs make one answer explicit, ANAQs make both answers explicit
                  •MAQs obligatorily end with *ma,* ANAQs optionally end with *ne*
                  •MAQs are not embeddable, ANAQs are embeddable without *ne*
        b.   Prosodic difference:

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[3] Bhatt & Dayal (2020) claim that MAQs, just like Hindi-Urdu *kya:,* can be embedded under *xiang zhidao* 'want to know', e.g., *John xiang zhidao xiayu le ma zuotian* 'John wants to know if it rained yesterday'. However, this MAQ may well be a direct quotation 'John wants to know: 'Did it rain yesterday?''. We have created several sentences like (i), and native speakers' judgments regarding these sentences varied. Some native speakers we consulted accept them in informal Mandarin, while others do not accept them at all. They find (i) much less felicitous than the counterpart embedding an A-not-A construction.

(i)   John xiang zhidao Mary renshi wo ma
        John want know   Mary know   me ma
        Intended: 'John wants to know if Mary knows me.' (*wo* 'me' = the speaker in the context)

This is not a central topic in this study, so we just follow most literature in assuming that MAQs are not embeddable and leave this issue for future study. If MAQs can indeed be embedded under *xiang zhidao*, then it serves as evidence for the Quasi-Subordination Hypothesis (Dayal & Grimshaw 2009).

•MAQs lack a final low tone, ANAQs end with a final low tone

In Sections 4 and 5, we will see how these syntactic and prosodic differences derive the semantic distinction between MAQs and ANAQs.

2.2   Different felicity in contexts

As mentioned in Section 1, MAQs and ANAQs are felicitous in different contexts. The empirical observation regarding their felicity is summarized in (11).

(11)   a.   MAQs are felicitous in biased contexts, whereas ANAQs are not.
       b.   Both MAQs and ANAQs are felicitous in neutral contexts.

We generalize the concept of 'biased context' in (11) as in (12), and we will provide a formal definition for contextual bias/neutrality in Section 4.1.

(12)   A context is biased towards a proposition p if it is a common belief that some individual x entertains the possibility of p.

(12) is a weak version of 'contextual bias' compared with previous definitions like Gunlogson (2003), who proposes that a context is biased towards p only if some discourse participant has been publicly committed to p. (12) makes better predictions regarding the felicity of MAQs than previous definitions. For example, in (13), A asserts ◇p 'Maybe it rained last night' and every discourse participant is aware of A's assertion, hence it is a common belief that A entertains the possibility of p. The context is biased towards p according to (12) and the MAQ is felicitous whereas the ANAQ is not.

(13)   A: Zuowan   keneng xia yu   le.
            last-night maybe fall rain PFV
            'Maybe it rained last night.'
       B: √Xia yu le ma? 'Did it rain?'   (MAQ)
            #Xia mei xia yu? 'Did it rain or not rain?'   (ANAQ)

In (14), A has asserted p 'It rained'. Every participant is aware that A considers p possible, hence the context is also biased towards p. A MAQ is felicitous in this biased context, whereas an ANAQ is not.

(14)   A: Zuowan xia yu le.
            'It rained last night.'
       B: √Xia yu le ma? 'Did it rain?'   (MAQ)
            #Xia mei xia yu? 'Did it rain or not rain?'   (ANAQ)

(12) also predicts that the context is biased towards p when p is supported by contextual compelling evidence (Büring & Gunlogson 2000). As in (6), repeated here as (15), p 'It rained' is not asserted by any discourse participant but supported by the evidence that B's raincoat is wet.

(15)   B enters A's windowless room wearing a wet raincoat.
       A: √Xia yu le ma? 'Did it rain?'   (MAQ)
            #Xia mei xia yu? 'Did it rain or not rain?'   (ANAQ)

According to Büring & Gunlogson (2000), contextual compelling evidence for a proposition p is evidence that has just become mutually available to the participants and it

would allow all the participants to assume p. This does not mean that all the participants will definitely increase their degree of belief in p and commit themselves to p after observing the evidence. If some participant has already committed himself to p or $\neg p$ based on another piece of (more reliable) evidence, then the current evidence will not change his mind. For example, in (15), B can answer A's question by uttering 'No, it did not rain. I just walked near a fountain to see if my raincoat leaks.' In this case, B is already committed to ¬p 'It did not rain' based on the evidence that B has seen no rain, so his wet raincoat will not increase his degree of belief in p. In contrast, A is in a windowless room and can only rely on B's raincoat to judge the truth of p, hence B's wet raincoat will increase A's degree of belief in p (assuming that A is a reasonable participant who can infer from the wet raincoat that it rained). So we can relativize the notion of contextual compelling evidence to a specific participant as in (16) based on McCready & Ogata's (2007) definition of evidence.

(16) a. Contextual Evidence: Evidence that has just become mutually available to the participants in the current context.
      b. Compelling: Evidence for p is compelling to a discourse participant A if it increases A's degree of belief in p so that A takes p to be probably but not certainly true.

For example, in (15), A can only rely on B's raincoat to judge whether it rained. Following the reasoning in (17), it is reasonable to assume that A has increased his degree of belief in p 'It rained' after observing B's raincoat. That is, B's wet raincoat serves as contextual compelling evidence to A. B also knows that A takes p to be probably, because B knows that A can only rely on B's raincoat to judge the truth of p and that his raincoat would serve as compelling evidence to A. It is a common belief that A entertains the possibility of p, and thus the MAQ is felicitous in this biased context, whereas the ANAQ is not.

(17)

| If someone's raincoat is wet, it rained. |
B's raincoat is wet.
It rained.   ∴

Note that the individual x can be the speaker (as in (15)), the addressee (as in (14)) or someone else. As in (18), John, who is neither the speaker nor the addressee in the current context, entertains the possibility of p and both A and B are aware of this fact, so the context is biased towards p.

(18) A: John shuo/juede zuowan   xia yu   le.
          John say/believe last-night fall rain PFV
          'John said/believes that it rained last night.'
      B: √Xia yu le ma? 'Did it rain?'   (MAQ)
          #Xia mei xia yu? 'Did it rain or not rain?'   (ANAQ)

Now let us turn to neutral contexts. Both MAQs and ANAQs are felicitous in neutral contexts like (19).

(19) The first question in a questionnaire investigating the relationship between weather and people's mental states is:

    a. (Ni de   chengshi zuotian) xia yu le   ma?
        you GEN city   yesterday fall rain PFV ma
        'Did it rain (yesterday in your city)?'   (MAQ)
    b. (Ni de   chengshi zuotian) xia mei xia yu?
        you GEN city   yesterday fall not fall rain
        'Did it rain or not rain (yesterday in your city)?'   (ANAQ)

Here, it is not a common belief that some individual entertains the possibility of p 'It rained' or ¬p 'It did not rain', hence the context is neither biased towards p nor biased towards ¬p. That is, the context is neutral and the speaker can use either an ANAQ or a MAQ.

Above we have only discussed the different felicity between MAQs and ANAQs. In fact, positive and negative MAQs are also felicitous in different contexts:

(20)   a. Positive MAQs are felicitous in neutral contexts and contexts biased towards the positive answer.
        b. Negative MAQs are felicitous in contexts biased towards the negative answer.

For example, the positive MAQ is felicitous in (21) (a neutral context) and (22) (a context biased towards the positive answer) while the negative one is not.

(21)   The first question in a questionnaire investigating the relationship between weather and people's mental states is:
        Q: (Ni de chengshi zuotian) xia yu le ma? 'Did it rain (yesterday in your city)?'
        Q':#(Ni de chengshi zuotian) mei xia yu ma? 'Did it not rain (yesterday in your city)?'

(22)   B enters A's windowless room wearing a wet raincoat.
        A: √Xia yu le ma? 'Did it rain?'
        A':#Mei xia yu ma? 'Did it not rain?'

In contrast, in a context like (23), the contextual compelling evidence 'B's raincoat is dry' has suggested the truth of ¬p 'It did not rain' and thus A takes ¬p to be probably. The context is biased towards ¬p and a negative MAQ is felicitous.

(23)   B leaves A's windowless room carrying a raincoat. When B returns, A notices that B's raincoat is dry.
        A: Mei xia yu ma? 'Did it not rain?'
        A':#Xia yu le ma? 'Did it rain?'

The use of positive MAQs, negative MAQs and ANAQs in different contexts are summarized in (24).

		Neutral contexts	Contexts biased to-wards p	Contexts biased to-wards ¬p
(24)	positive MAQs	√	√	#
	negative MAQs	#	#	√
	ANAQs	√	#	#

2.3 Answers

MAQs and ANAQs are answered in different ways. In a biased context, where MAQs are felicitous but ANAQs are not, MAQs can be responded by verb-echo answers (i.e., by repeating the main verb) or the answer particles *(bu) shide* '(not) be':[4]

(25)   Biased context: B enters A's windowless room wearing a wet raincoat.

    A: Xia yu le   ma?
         fall rain PFV ma
         'Did it rain?'   (MAQ)

    B: Xia (yu) le. / Mei xia (yu).
         fall rain PFV / not fall rain
         'It rained.'/'It didn't rain.'   (verb-echo answers)

    B': Shide. / Bu-shide.
          yes   / no
          'Yes.'/'No.'   (answer particles)

In a neutral context like (26), both MAQs and ANAQs are felicitous and can be responded by verb-echo answers that denote p 'It rained' and ¬p. However, it is not felicitous to answer MAQs in a neutral context with the particles *(bu) shide* (Yuan 1993; Guo 2000), unlike in a biased context.

(26)   Neutral context: The first question in a questionnaire investigating the relationship between weather and people's mental states is:

    Q: (Ni de chengshi zuotian) xia yu le ma?
         'Did it rain (yesterday in your city)?'   (MAQ)

    Q': (Ni de chengshi zuotian) xia mei xia yu?
          'Did it rain or not rain (yesterday in your city)?'   (ANAQ)

    A: Xia (yu) le. / Mei xia (yu).
         'It rained.'/'It didn't rain.'   (verb-echo answers)

    A':#Shide. / #Bu-shide.
         'Yes.'/'No.'   (answer particles)

To sum up, MAQs used in neutral contexts and ANAQs can only be responded by verb-echo answers, while MAQs used in biased contexts can be responded by both verb-echo answers and answer particles.

2.4 Summary

This section provided an empirical description of the similarities and differences between MAQs and ANAQs: (i) ANAQs (without *ne*) can be embedded, whereas MAQs cannot; (ii) MAQs are felicitous in neutral and biased contexts, while ANAQs are only felicitous in neutral contexts; (iii) MAQs and ANAQs both license verb-echo answers, but only MAQs in biased contexts license answer particles. A satisfactory semantic account should be able to capture these similarities and differences.

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[4] Note that the particles *(bu) shide* cannot be simply translated to English 'yes/no'. When *(bu) shide* is used to answer a positive MAQ *p-ma*?, *shide* confirms the positive proposition *p* and *bu shide* rejects *p*. When *(bu) shide* is used to answer a negative MAQ *¬p-ma*?, *shide* confirms *¬p* and *bu shide* rejects *¬p* (see Section 4.2 for more details).

3   Previous studies and their problems

3.1   Studies on the semantics of MAQS and ANAQS

Traditional Chinese linguistics characterizes the semantics of MAQs and ANAQs in terms of the speaker's bias. Most researchers agree that ANAQs express the speaker's neutrality towards both answers, but no consensus has been reached regarding the semantics of MAQs. For example, Wang (1943: 168) claim that MAQs are confirmation-seeking questions that express the speaker's bias towards the presented alternative, while Chao (1968: 356) and Shao (1996: 72) argue that MAQs express the speaker's bias towards the negation of the presented alternative.

There are several problems with this traditional approach. First, the semantic distinctions between MAQs and ANAQs are stipulated, not derived compositionally. Second, MAQs do not lexically encode the speaker's bias. For example, the speaker of the MAQ in (25) is biased towards the positive answer but the speaker in (26) is neutral towards the answers. The same MAQ is compatible with various speaker bias in different contexts, as shown in (27). If a MAQ lexically encoded a certain kind of speaker bias, for example, if a MAQ mandatorily expressed the speaker's bias towards the positive answer, then (27a) and (27c) would be infelicitous because of semantic contradiction.

(27)   a.   Xia yu le ma? Wo bu juede. 'Did it rain? I don't think so.'
       b.   Xia yu le ma? Wo cai xia le. 'Did it rain? I guess it rained.'
       c.   Xia yu le ma? Wo wanquan bu qingchu. 'Did it rain? I totally have no idea.'

Third, ANAQs not necessarily express the speaker's neutrality towards answers. The speaker of an ANAQ can be neutral towards the answers, as exemplified in (26), and she can also be biased in some contexts. For example, A in (28) is privately biased towards the positive answer 'You have questions':

(28)   A believes that his audience usually have questions to raise after his speech:

       A: Nimen you mei you wenti?
            you   have not have questions
            'Do you have or not have questions?'

To sum up, MAQs and ANAQs do not lexically encode the speaker's bias, and they cannot be distinguished in terms of the speaker's bias. Using the notion of 'contextual bias' is more suitable to capture the distinction between MAQs and ANAQs, and we will provide a formal definition for contextual bias in Section 4.1.

Recently, there have been several formal studies which derive the semantics of MAQs and ANAQs compositionally. For example, Dong (2009) argues that the particle *ma* is a generic form of negation and hence MAQs share the same semantics as ANAQs, both denoting a Hamblin set. This line of analysis fails to account for the differences between MAQs and ANAQs that are observed in Section 2. For example, it cannot explain the contrast in a biased context like (25), repeated here as (29), where MAQs are felicitous but ANAQs are not.

(29)   B enters A's windowless room wearing a wet raincoat.

       A: √Xia yu le ma? 'Did it rain?'   (MAQ)
       A': #Xia mei xia yu? 'Did it rain or not rain?'   (ANAQ)

Krifka (2015) proposes that a MAQ *p-ma*? is a biased monopolar question which restricts the future development of the context in such a way that the only legal continuation is the commitment to p by the addressee, whereas ANAQs are neutral bipolar questions which allow two legal continuations, i.e., the commitment to p (by the addressee) and the commitment to $\neg p$. This analysis explains the difference between these questions in biased contexts, but it is not clear how this accounts for the similarity between MAQs and ANAQs in neutral contexts like (26), repeated here as (30). Here, both MAQs and ANAQs can be answered with p 'It rained' and ¬p. That is, MAQs in neutral contexts allow both continuations, i.e., the commitment to p and the commitment to ¬p by the addressee, just like bipolar neutral questions.

(30)   The first question in a questionnaire investigating the relationship between weather and people's mental states is:

    Q: (Ni de chengshi zuotian) xia yu le ma?
        'Did it rain (yesterday in your city)?'   (MAQ)
    Q': (Ni de chengshi zuotian) xia mei xia yu?
        'Did it rain or not rain (yesterday in your city)?'   (ANAQ)
    A: Xia (yu) le. / Mei xia (yu).
        'It rained.'/'It didn't rain.'

Previous semantic studies of MAQs and ANAQs are not fine-grained enough to capture the similarities and distinctions between these questions. In the next subsection, let us see if the semantic accounts of English questions can be applied to Mandarin.

3.2 Studies on English polar and alternative questions

As mentioned in Section 1, a number of accounts have been proposed to explain the differences between English polar questions and alternative questions. For example, Biezma & Rawlins (2012) point out that answering an English polar question involves accepting or rejecting the mentioned alternative, and hence a polar question denotes a singleton set containing the mentioned proposition, as exemplified in (31a). In contrast, an alternative question denotes a non-singleton set, as in (31b).

(31)   a.   ⟦Did it rain?⟧ = {'It rained'}
      b.   ⟦Did it rain or not?⟧ = {'It rained', 'It did not rain'}

This analysis cannot be extended to Mandarin MAQs. English polar questions always license the answer particles *yes* (accepting the mentioned alternative) or *no* (rejecting the alternative):[5]

(32)   The first question in a questionnaire investigating the relationship between weather and people's mental states is:

    Q: Did it rain (yesterday in your city)?
    A: Yes. / No.

In contrast, Mandarin MAQs do not license *shide* (accepting the alternative) or *bu-shide* (rejecting the alternative) in neutral contexts, as in (30), repeated here as (33).

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[5] The experiment results from Kramer & Rawlins (2012) show that bare particle responses like *yes/no* are felicitous in neutral contexts. Note that bare particle responses to negative polar questions are less felicitous than that to positive polar questions because *yes* and *no* are ambiguous (Roelofsen & Farkas 2015).

(33)   The first question in a questionnaire investigating the relationship between weather
        and people's mental states is:
        Q: (Ni de chengshi zuotian) xia yu le ma?
              'Did it rain (yesterday in your city)?'
        A: Xia (yu) le. / Mei xia (yu). / #Shide. / #Bu-shide.
              'It rained.'/'It didn't rain.'/'Yes.'/'No.'

For any MAQ, the type of answer which is always licensed is the verb-echo answer
that denotes the mentioned proposition p or its negation $\neg p$ (Li & Thompson 1981), as
illustrated in (33) and (34). Given that the semantics of a question corresponds to its
possible answers, if a MAQ denoted a singleton set $\{p\}$, it would be difficult to explain
why the MAQ allows $\neg p$ as its answer.

(34)   B enters A's windowless room wearing a wet raincoat.
        A: √Xia yu le ma? 'Did it rain?'
        B: Xia (yu) le. / Mei xia (yu). / Shide. / Bu-shide.
              'It rained.'/'It didn't rain.'/'Yes.' / 'No.'

Another semantic account is proposed by Roelofsen & van Gool (2010), who argue
that an English polar question p? only highlights the mentioned possibility p, whereas
an English alternative question 'p or q?' highlights both possibilities p and q. This is
motivated by the fact that a polar question can be answered with the particle *yes* but an
alternative question cannot. They propose that a *yes* answer to a question Q presupposes
that Q highlights exactly one possibility. Since a polar question highlights one possibility,
the presupposition of *yes* is satisfied and can be used. An alternative question highlights
two possibilities, and therefore does not license the use of *yes*. Still, this analysis is not
applicable to Mandarin questions. Remember that MAQs cannot be answered with *(bu)-
shide* in neutral contexts. So if we followed Roelofsen & van Gool (2010), we would need
to provide two different definitions for MAQs: a MAQ highlights one possibility in biased
contexts, and highlights two possibilities in neutral contexts. This would miss the core
semantic contribution of MAQs in different contexts and be forced to have two distinct
definitions for one construction, hence it is not an ideal account of MAQs.

As can be seen, Mandarin MAQs are answered in different ways from English polar ques-
tions, hence the analyses of English questions cannot be extended to Mandarin questions
straightforwardly.

3.3   Summary

Previous analyses of MAQs and ANAQs fail to capture the similarities and differences be-
tween these questions. The studies on English questions are enlightening but not appli-
cable to Mandarin data. In the following sections, we present our analysis which carries
forward the advantages of previous accounts and overcomes their shortcomings.

4   Mandarin *ma* questions

This section discusses the semantics of MAQs. As shown in Section 2, contextual bias
rules the distribution of MAQs (and ANAQs), so we will first provide a formal definition
for contextual bias in Section 4.1, and then move to the formalization of MAQs. Section
4.2 proposes that the particle *ma* is a question force marker and that a MAQ denotes an

update of the Table with a Hamblin set. Section 4.3 accounts for the differences between positive and negative MAQs by adopting the Elsewhere Condition.

4.1 Formalization of contextual bias

We formalize the notion of contextual bias based on the subjective probability distribution (Davis et al. 2007) and the Table model (Farkas & Bruce 2010).

4.1.0.1 Subjective probability distribution

As stated in Section 2.2, a context is biased towards p if it is commonly known that some individual x entertains the possibility of p. We will use the subjective probability distribution to characterize x's epistemic state. We adopt the formalization of Davis et al. (2007) to model a proposition (i.e., a set of possible worlds) as a probability distribution:

(35)   A probability distribution for a countably finite set W is a function P^W from subsets of W into real numbers in the interval [0,1] obeying the conditions:

    a. $P^W(W) = 1$

    b. $P^W(\{w\}) \geqslant 0$ for all $w \in W$

    c.   If p and q are disjoint subsets of W, then $P^W(p \cup q) = P^W(p) + P^W(q)$. (We henceforth suppress the superscript W.)

<div align="right">(Davis et al. 2007: 77)</div>

Davis et al. (2007) take the proposition $\mathrm{Dox_A}$ (a finite set of possible worlds that are doxastically accessible for A) as representing the epistemic state of the individual A. Then, a uniform distribution is conditionalized as in (36).

(36)   Let $P(\text{-}|p)$ be the function that maps any proposition q to

$$P(q|p) = \frac{P(q \cap p)}{P(p)}$$

where P is a probability distribution. That is, $P(\text{-}|p)$ maps propositions to their conditional probabilities (for P) given p. $P(q|p)$ is undefined if $P(p) = 0$.

<div align="right">(Davis et al. 2007: 77)</div>

This uniform distribution is then adopted to define a function $\mathrm{Cred_A}$ (Cred for 'credence'), which models the epistemic state of an individual A, as in (37). The function $\mathrm{Cred_A}$ maps any proposition p to A's degree of belief in p.

(37)   The subjective probability distribution for an individual A:
$\mathrm{Cred_A} = P(\text{-}|\mathrm{Dox_A})$
in which P is a uniform distribution over W, i.e., $P(\{w\}) = \frac{1}{|W|}$ for all $w \in W$.

<div align="right">(Modified from Davis et al. 2007: 77)</div>

Following (36) and (37), an individual A's degree of belief in a proposition p would be like (38).

(38)

$$\mathrm{Cred_A(p)} = P(p|\mathrm{Dox_A}) = \frac{P(p \cap \mathrm{Dox_A})}{P(\mathrm{Dox_A})}$$

Let us see how (38) characterizes different belief states. When A is committed to the proposition p, it means that all the worlds in Dox_A are worlds in which p is true, i.e., $p \cap \text{Dox}_A = \text{Dox}_A$. Thus, Cred_A maps p to the number 1:

(39)
$$\text{Cred}_A(p) = P(p|\text{Dox}_A) = \frac{P(p \cap \text{Dox}_A)}{P(\text{Dox}_A)} = \frac{P(\text{Dox}_A)}{P(\text{Dox}_A)} = 1$$

When A is committed to ¬p, no worlds in Dox_A are worlds in which p is true. In this case, Cred_A will map p to 0:

(40)
$$\text{Cred}_A(p) = P(p|\text{Dox}_A) = \frac{P(p \cap \text{Dox}_A)}{P(\text{Dox}_A)} = \frac{\frac{0}{|W|}}{P(\text{Dox}_A)} = 0$$

A proposition that x entertains the possibility of p is formalized as '$\text{Cred}_x(p) > 0$':

(41) x entertains the possibility of p iff $\text{Cred}_x(p) > 0$ where $x \in I$ and I is a set of individuals.

Let us illustrate (41) with examples. As shown in (14) and (18), repeated here as in (42) and (43), A or John is committed to p 'It rained'. That is, $\text{Cred}_A(p)$ (or $\text{Cred}_{\text{John}}(p)$) = 1 > 0, so A or John entertains the possibility of p and the context is biased.

(42)   A: Zuowan xia yu le.
               'It rained last night.'

(43)   A: John shuo/juede zuowan xia yu le.
               'John said/believes that it rained last night.'

In (44), contextual compelling evidence that B wears a wet raincoat has raised A's degree of belief in p 'It rained' so that A takes p to be probably but not certainly true. That is, after observing B's wet raincoat, A's degree of belief in p has increased and becomes greater than 0.5 but smaller than 1 ($1 > \text{Cred}_A(p) > 0.5 > 0$, see McCready & Ogata, 2007), so A entertains the possibility of p and the context is biased.

(44)   B enters A's windowless room wearing a wet raincoat.

4.1.0.2   The Table model

Remember that a context is biased when it is publicly known that some individual x entertains the possibility of p. We adopt the Table model (Farkas & Bruce 2010) to formalize how x's epistemic state enters the common belief of all discourse participants. The Table is a set of sets of propositions representing issues under discussion and it is temporarily ordered. When the Table is not empty, the immediate goal of the conversation is to resolve the issue and empty the Table. Here, we represent the Table stack T as an ordered pair, either empty or consisting of an issue and a Table, as defined in (45). An issue is a set of propositions, of type $\langle \langle s, t \rangle, t \rangle$.

(45)   Let I be an issue, a set of propositions.
         a. $\langle \, \rangle$ is a Table.
         b.   If I is an issue and T is a Table, then $\langle I, \text{T} \rangle$ is a Table.
         c.   Nothing else is a Table.

  d. If T is a Table, then T[n] is the nth element in the Table (counting from 0 at the top).

Farkas & Bruce (2010) also define the stack operations 'push' and 'remove' to model the operation of the Table. 'push(I, T)' represents the new stack obtained by adding the issue I to the top of the stack T:

(46) For any issue I and Table T:
   push(I, T) $=$ $\langle I, T \rangle$

In contrast, 'remove(I, T)' represents the stack obtained by removing the topmost occurrence of I from the Table stack. If one proposition p in the set I enters the CG, the issue I is resolved and hence removed from the Table.

Farkas & Bruce (2010) propose that there are speech act operators that take sentences as arguments and that are functions from input context states to output context states, and a context state can be understood as a tuple which contains several elements such as the Common Ground (the CG, Stalnaker, 1978), the Table, etc (see also Roelofsen & Farkas, 2015). We assume that speech acts are functions from input contexts to output contexts, and a discourse context is of type C, which is a basic semantic type in our formal system (see also Davis, 2011). For example, an assertion operator, of type $\langle \langle s, t \rangle, \langle C, C \rangle \rangle$, combines with a proposition p and returns a context change potential of type $\langle C, C \rangle$:

(47) ASSERT operator (first version):[6]
   ASSERT(p)(C) $=$ C$'$ such that

  a. CG(C$'$) $=$ CG(C) $\cup$ (Cred$_{\text{spkr}}(p) \geqslant 0.98$)
  b. T(C$'$) $=$ push($\{p\}$, T(C))

(47) says that an assertion of p changes the context in two ways. First, it adds to the CG that the speaker has a very high degree of belief ($\geqslant 0.98$) in p. Second, it pushes $\{p\}$ onto the top of the Table, which is supported by the fact that A's assertion of p 'It rained' is directly assented or dissented with by B in (48), that is, p is negotiated directly and hence is an at-issue content on the Table that affects the future direction of the discourse (Farkas & Bruce 2010; Tonhauser 2012; Northrup 2014).

(48) A: Zuowan xia yu le.
    'It rained last night.'
  B: Shide, xia yu le. / Bu-shide, meiyou xia yu.
    'Yes, it rained'/'No, it did not rain.'

In the framework of Farkas & Bruce (2010), only a conversational move like an assertion or a question can change the context. We believe that contextual compelling evidence can also change the context. For example in (49), the evidence for p 'It rained' that B wears a wet raincoat will increase A's degree of belief in p to some degree above 0.5.

(49) B enters A's windowless room wearing a wet raincoat.

Thus, we treat contextual compelling evidence as a context change potential that is defined in (50) based on McCready & Ogata (2007). The contextual compelling evidence operator E combines with a proposition p and returns a CCP, which changes the context by adding the proposition that 'A's degree of belief in p is larger than 0.5' into the CG and pushing the issue of p onto the Table.

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[6] The Table part will be dispensable according to our proposal, so (47b) will be removed later.

(50) E_A operator (first version):[7]
         Let p be a proposition and A be a discourse participant, $E_A(p)(C) = C'$ such that
         a. $CG(C') = CG(C) \cup (Cred_A(p) > 0.5)$
         b. $T(C') = push(\{p\}, T(C))$

Discourse participants can respond to a piece of evidence for p 'It rained' by showing their agreement or disagreement with p, as shown in (51). That is, p is at-issue and up for debate, just like the issues pushed onto the Table by conversational moves. Also, A's use of the anaphoric expression *zheyang* 'this' in (51) refers to p 'It rained' ('I expected it rained'/'I don't believe it rained'), showing that the contextual compelling evidence for p allows p to be the antecedent of the anaphora. That is, the contextual compelling evidence for p raises an issue p that can be discussed in the following discourse (see Snider, 2017 for the discussion of at-issueness and anaphoric salience).

(51)   B enters A's windowless room wearing a wet raincoat.
         A: Wo jiu zhidao (hui zheyang). / Bu keneng, wo bu xiangxin (hui zheyang).
              'This is what I expected.'/'No way, I don't believe this.'

   As can be seen from (48) and (51), as long as some individual publicly entertains the possibility of p, p becomes an issue with which discourse participants can show their agreement or disagreement, that is, the issue p is pushed onto the Table for discussion. To implement this intuition, we propose that as long as some individual's consideration of the possibility of p is made public in a context C, the issue $\{p\}$ is pushed onto the Table in C:

(52)   Pushing an issue onto the Table:
         If $CG(C') = CG(C) \cup (\exists x.Cred_x(p) > 0)$,
         Then $T(C') = push(\{p\}, T(C))$.
         where C' and C are the output context and input context respectively and $x \in$ I(C).

   Since (52) now allows an issue p to be on the Table as long as some individual considers p possible, the definitions of ASSERT and E_A are simplified as below:

(53)   ASSERT operator (final version):
         $ASSERT(p)(C) = C'$ such that $CG(C') = CG(C) \cup (Cred_{spkr}(p) \geqslant 0.98)$

(54) E_A operator (final version):
         $E_A(p)(C) = C'$ such that $CG(C') = CG(C) \cup (Cred_A(p) > 0.5)$

   Now the contextual bias and neutrality can be defined as follows:

(55)   Contextual bias and neutrality:
         a.   A context C is biased towards a proposition p if the issue $\{p\}$ is pushed onto the Table in C and $\{\neg p\}$ is not.
         b.   The context C is neutral if no issue is on the Table in C or if both $\{p\}$ and $\{\neg p\}$ are pushed onto the Table.

Let us illustrate how (55) correctly predicts the felicity of MAQs and ANAQs in different contexts. As shown in (42), repeated here as (56), A has asserted p 'It rained'. That is, $CG(C') = CG(C) \cup (Cred_A(p) \geqslant 0.98)$, hence the issue $\{p\}$ is pushed onto the Table and the

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[7] The Table part will be dispensable according to our proposal, so (50b) will also be removed later.

context is biased towards p. A MAQ is felicitous in such a biased context while an ANAQ is not.

(56)   A: Zuowan xia yu le. 'It rained last night.'
          B: √Xia yu le ma? 'Did it rain?'   (MAQ)
              #Xia mei xia yu? 'Did it rain or not rain?'   (ANAQ)

Similarly, in (57), John publicly entertains the possibility of p and the context is biased towards p, where the MAQ is felicitous but an ANAQ is not.

(57)   A: John shuo/juede zuowan xia yu le.
             'John said/believes that it rained last night.'
          B: √Xia yu le ma? 'Did it rain?'   (MAQ)
              #Xia mei xia yu? 'Did it rain or not rain?'   (ANAQ)

(55) predicts that the context is biased towards p if p is supported by some contextual compelling evidence. In (49), repeated here as (58), it is publicly known that A takes p to be probably after observing B's raincoat ($\text{CG}(\text{C}') = \text{CG}(\text{C}) \cup (\text{Cred}_A(\text{p}) > 0.5)$), hence the issue of p is also pushed onto the Table and the context is biased towards p.

(58)   B enters A's windowless room wearing a wet raincoat.
          A: Xia yu le ma? 'Did it rain?'   (MAQ)
              #Xia mei xia yu? 'Did it rain or not rain?'   (ANAQ)

(55) also predicts that the context is biased towards p if $\Diamond p$ is asserted, as in (59). $\Diamond p$ indicates the there is at least some possible world doxastically accessible for the speaker in which p is true, that is, $\text{Cred}_{\text{spkr}}(p) > 0$. After A's assertion, this is known publicly ($\text{CG}(\text{C}') = \text{CG}(\text{C}) \cup (\text{Cred}_A(\text{p}) > 0)$) and thus issue p 'it rained' is added onto the Table and the context is biased towards p.

(59)   A: Zuowan keneng xia yu le.
             'Maybe it rained last night.'
          B: √Xia yu le ma? 'Did it rain?'   (MAQ)
              #Xia mei xia yu? 'Did it rain or not rain?'   (ANAQ)

Both MAQs and ANAQs are felicitous in contexts like (60), which is a neutral context with no issue on the Table.

(60)   The first question in a questionnaire investigating the relationship between weather and people's mental states is:
          Q: (Ni de chengshi zuotian) xia yu le ma?
              'Did it rain (yesterday in your city)?'
          Q': (Ni de chengshi zuotian) xia mei xia yu?
              'Did it rain or not rain (yesterday in your city)?'

(61) is also a neutral context in which both MAQs and ANAQs are felicitous, because {p} and {¬p} are both pushed onto the Table after A and B's assertions.

(61)   A: Zuowan xia yu le.
             'It rained last night.'
           B: Bu, meiyou xia.
             'No, it did not rain.'

> C: (Suoyi/Daodi) Xia mei xia yu?
>   '(So/After all,) Did it rain or not rain?'
> C': (Suoyi) Xia yu le ma?
>   '(So,) Did it rain?'

This section provided a formal definition for contextual bias: a context is biased towards a proposition p if $\{p\}$ is pushed onto the Table, that is, if it is publicly known that some individual's degree of belief in p is larger than 0. This definition unifies contextual bias arising from default assertions, contextual compelling evidence and possibility claims.

4.2 Semantics of MAQS

We adopt the hypothesis that sentential force is syntactically represented as force operators such as the assertive operator ASSERT and the question operator Q (Sadock & Zwicky 1985; Han 1998; König & Siemund 2007). We propose that the *ma* particle in MAQs is a force marker, which introduces a question force head Q_1 (cf. Paul, 2014; Pan & Paul, 2016). Q_1 occupies the head position of a ForceP, so the structure of a MAQ (62) is (63).

(62)   Li he   jiu   ma?
       Li drink alcohol Q_1
       'Does Li drink alcohol?'

(63)

The analysis of *ma* as a force marker correctly predicts that MAQs cannot be embedded, since clauses that include sentential forces cannot be embedded in Mandarin. As pointed out by Han (1998), there are many languages in which embedded clauses cannot express force. 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, *wo jige le ma* in (64) is a direct quotation of the question 'Did I pass' uttered by Li, and *ni lai wo jia ba* in (65) is a direct quotation of the command 'Come to my home' uttered by Li.

(64)   Li wen laoshi   [wo jige le   ma]
       Li ask teacher I   pass PFV Q
       √ Li asks the teacher: 'Did I pass?' ('I' = Li)
       # Li asks the teacher if I passed. ('I' = the speaker of the whole sentence)

(65)   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)

We follow Farkas & Bruce (2010) in assuming that a question indicates an update of the Table. The semantics of Q_1 is defined in (66). Q_1 takes in a proposition, and then puts the set containing this proposition and its negation onto the top of the Table.

(66)   Semantics of the operator Q_1:
        $Q_1(p)(C) = C'$ such that $T(C') = \text{push}(\{p, \neg p\}, T(C))$

The analysis of the particle *ma* as deriving a Hamblin set is motivated by the fact that *ma* is historically derived from a negative word *bu* 'not' (Ota 1958; Aldridge 2011). Given that the denotation of a question corresponds to its possible answers, this correctly predicts that MAQs in all contexts can be responded by the verb-echo answer, i.e., *xia yu le*, which denotes the positive proposition p or *mei xia yu*, which denotes ¬p, as shown in (29) and (30), repeated here as (67) and (68). In other words, MAQs originated from ANAQs, and MAQs inherit the answer pattern of ANAQs (i.e., verb-echo answers). This is consistent with the Persistence Principle in Grammaticalization (Hopper 1991), which predicts that when a form undergoes grammaticalization, certain functions or features of its original form tend to adhere to it.

(67)   B enters A's windowless room wearing a wet raincoat.
        A: Xia yu le ma? 'Did it rain?'
        B: Xia (yu) le. / Mei xia (yu). / Shide. / Bu-shide.
            'It rained.'/'It didn't rain.'/'Yes.'/'No.'

(68)   The first question in a questionnaire investigating the relationship between weather and people's mental states is:
        Q: (Ni de chengshi zuotian) xia yu le ma? 'Did it rain (yesterday in your city)?'
        A: Xia (yu) le. / Mei xia (yu). / #Shide. / #Bu-shide.
            'It rained.'/'It didn't rain.'/'Yes.'/'No.'

Now let us explain why MAQs in biased contexts like (67) can be answered by the particles *(bu) shide* while MAQs in neutral contexts like (68) cannot. The answer particles *(bu) shide* convey the answerer's agreement/disagreement with some proposition that already exists in the discourse. If there is no such proposition in the discourse, then there is nothing to agree or disagree with. For example, *shide* indicates the answerer's agreement with p 'He passed' in (69a) and his agreement with ¬p 'He did not pass' in (70a), whereas *bu-shide* indicates the answerer's disagreement with p in (69b) and his disagreement with ¬p in (70b).

(69)   Ta jige le ma? 'Did he pass?'
        a.   Agreement: Shide(, ta jige le). 'Yes, he passed.'
                        #Bushide(, ta jige le). 'No, he passed.'
        b.   Disagreement: #Shide(, ta mei jige). 'Yes, he didn't pass.'
                           Bushide(, ta mei jige). 'No, he didn't passed.'

(70)   Ta mei jige ma? 'Did he not pass?'
        a.   Agreement: Shide(, ta mei jige). 'Yes, he didn't pass.'
                        #Bushide(, ta mei jige). 'No, he didn't passed.'
        b.   Disagreement: #Shide(, ta jige le). 'Yes, he did pass.'
                           Bushide(, ta jige le). 'No, he did pass.'

Based on these data, we propose that *(bu) shide* presupposes that one singleton set has been pushed onto the Table:[8]

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[8] Roelofsen & Farkas (2015) propose that polarity particles across languages function as the morphological realization of two types of polarity features, absolute features [+]/[-] and relative features [agree]/[reverse]. Clearly, Mandarin *(bu) shide* only realize the relative polarity features [agree]/[reverse].

(71)   The semantics of answer particles:

    a.   The answer particle *(bu) shide* presupposes that one singleton set $\{p\}$ has been pushed onto the Table.

    b.   When the presupposition is satisfied, *shide* indicates a confirmation of p, whereas *bu shide* indicates a rejection of it.

Now we are ready to account for the contrast between (67) and (68). In (67) where p 'It rained' is supported by contextual compelling evidence, the issue {p} has been pushed onto the Table and thus the answer particles can be used. A entertains the possibility of p but is not committed to p, so A is now trying to confirm the truth of p by using a MAQ, which has pushed the issue {p, ¬p} onto the top of the Table and invites B to provide the answer. By answering *shide*, B confirms p. By answering *bu-shide*, B denies p. In (68), no issue has been pushed onto the Table and the particles cannot be used. The questioner pushes {p, ¬p} onto the Table and asks for answers.

In another biased context like (14), repeated here as (72), A has asserted p 'It rained', hence the issue {p} is also on the Table and the answer particles can be used. B's question has pushed the issue {p, ¬p} onto the Table. That is, B is still asking the question after A has asserted one answer p, showing that B doubts the truth of p and B requests for more evidence for p.

(72)   A: Zuowan xia yu le. 'It rained last night.'

        B: Xia yu le ma? 'Did it rain?'

        A: Shide. Wo bei yusheng chao xing le. 'Yes. I was waken up by the sound of rain.'

In one word, MAQs only license *(bu) shide* in biased contexts, and the interpretation of *(bu) shide* depends on a salient proposition in the previous context, hence it is the biased context which supplies the salient proposition for the answer particles, not MAQs. In contrast, English polar questions can license *yes/no* in any context, so it is reasonable to analyze English polar questions as highlighting a certain proposition in order to provide an antecedent for the anaphoric answer particles (Roelofsen & van Gool 2010).

Note that (71b) states that *shide* indicates a confirmation of p whereas *bu shide* indicates a rejection of it. Confirmation and rejection requires that the speaker is the source for the relevant information (Gunlogson 2008; Ye 2021), that is, the speaker of *(bu) shide* is committed to p or $\neg p$ based on his own judgement, independent of other participants' testimony. As shown in (73), although the presupposition of *shide* is satisfied ({p} is pushed onto the Table by A), the use of *shide* is still infelicitous, because B's commitment to p is dependent on A's testimony.

(73)   A: Zuowan xia yu le. 'It rained last night.'

        (B did not know that it rained.)

        B: #Shide(, xia yu le). 'Yes, it rained.'

        B': Ou(, wo zhidao le). 'Oh, I see.'

In summary, the particle *ma*, as a force head, cannot be embedded, and hence MAQs cannot be embedded. MAQs denote an update of the Table with a Hamblin-set, which explains why MAQs always license verb-echo answers. When MAQs occur in biased contexts, one singleton set has been pushed onto the Table. Since *(bu) shide* presupposes the existence of one singleton issue on the Table, MAQs in biased contexts can be responded by the answer particles.

4.3 Positive and negative MAQS

The analysis in Section 4.2 would predict that a positive MAQ and a negative one denote an update of the Table with the same set, which cannot explain their different felicity in contexts like (21) and (22), repeated here as (74) and (75). This subsection adopts the Elsewhere Condition to explain their differences.

(74)   The first question in a questionnaire investigating the relationship between weather and people's mental states is:

  Q: (Ni de chengshi zuotian) xia yu le ma? 'Did it rain (yesterday in your city)?'
  Q':#(Ni de chengshi zuotian) mei xia yu ma? 'Did it not rain (yesterday in your city)?'

(75)   B enters A's windowless room wearing a wet raincoat.

  A: √Xia yu le ma? 'Did it rain?'
  A':#Mei xia yu ma? 'Did it not rain?'

It has long been recognized that negative forms are more marked than positive ones. One defining feature of unmarked members is that they can be used in neutral questions like *Is it (he, she) X?* (Greenberg 1966; Lyons 1977; Lehrer 1985: a.o.). For example, the adjective *good* is unmarked, while *bad* or *not good* is marked. Hence, *Is the film good?* can be used as a neutral question, without any supposition for the quality of the film. In contrast, *Is the film bad?* or *Is the film not good?* are not neutral questions, since they suggest that there is some evidence that the film is not good.

Similarly, the positive MAQ is unmarked, while the negative one is marked. So *Xia yu le ma?* 'Did it rain?' can be used as a neutral question, as in (74), while the negative one cannot. The negative MAQ always suggests some contextual bias towards 'It did not rain', as shown in (23), repeated here as (76). In other words, because of the markedness of negative forms, a speaker will not use a negative polar question, unless there is already some contextual bias towards the negative proposition.

(76)   B leaves A's windowless room carrying a raincoat. When B returns, A notices that B's raincoat is dry.

  A: Mei xia yu ma? 'Did it not rain?'
  A':#Xia yu le ma? 'Did it rain?'

As can be seen from these examples, negative MAQs are used in more restricted contexts (only in contexts biased towards the negative answer) than positive ones (in neutral contexts and contexts biased towards the positive answer). We can predict the distribution of the positive and negative MAQs by using the Elsewhere Condition (henceforth the EC, Kiparsky, 1973; Aronoff, 1976, etc.). The EC states that a more specific rule can always override a general one.[9] The general rule of using a MAQ is simple, that is, the speaker can use a MAQ as long as she does not know the answer and that she wants to know the answer (Searle 1969). We add a specific rule for negative MAQs in (77), which says that a negative MAQ is felicitous only if the negative answer is contained in the issues on the Table and the positive answer is not.

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[9] For example, a general rule in morphology is to form an English plural by adding a morpheme *-s* to a stem. Some words have special plural forms, e.g., *goose* has *geese* as its plural. So one specific rule in English morphology is to form the plural of the word *goose* by changing the stem *goose* to *geese*. This specific rule has the application condition 'stem = *goose*', which is more specific than the application condition 'stem = *x*' of the general rule for plural formation. According to the EC, the general rule for plural formation does not apply to *goose*.

(77)   Felicity condition of negative MAQs:
        The use of a negative MAQ $\neg p$-*ma*? is felicitous in a context C only if $\neg p \in \bigcup_{x=0}^{n} T(C)[x]$ and $p \notin \bigcup_{x=0}^{n} T(C)[x]$.

(77) is more specific than the application condition for the general rule of questioning. It follows by the EC that the use of negative MAQs is ruled out in other conditions.

(77) correctly predicts that the speaker uses a negative MAQ when the context is biased towards the negative answer, as in (76). Similarly, it is felicitous to use a negative MAQ to respond to A in (78), because A's utterance indicates that some individual entertains the possibility of $\neg p$ 'It did not rain' and thus the issue $\{\neg p\}$ is pushed onto the Table. That is, $\bigcup_{x=0}^{n} T(C)[x] = T(C)[0] = \{\neg p\}$, which contains $\neg p$ but not p, hence the negative MAQ is felicitous.

(78)   A1: Zuowan (keneng) mei xia yu. '(Maybe) it did not rain last night.'
        A2: Wo bu juede zuowan xia yu le. 'I don't think that it rained last night.'
        A3: John shuo zuowan mei xia yu. 'John said that it did not rain last night.'
        B: √Mei xia yu ma? 'Did it not rain?'
             #Xia yu le ma? 'Did it rain?'

(77) also correctly predicts that the speaker would use a positive MAQ elsewhere, for example, when the context is neutral, as in (74), and when the context is biased towards the positive answer, as in (75) and (79).

(79)   A: Zuowan xia yu le. 'It rained last night.'
        B: Xia le ma? 'Did it rain?'
        B': #Mei xia ma? 'Did it not rain?'

Furthermore, (77) accounts for the felicity of the negative MAQ in (80), which is translated from the English example used by Romero & Han (2004) to show that English low negative questions can convey the speaker's epistemic neutrality towards answers.

(80)   The speaker is organizing a party and she is in charge of supplying all the non-alcoholic beverages for teetotalers. The speaker is going through a list of people that are invited. She has no previous belief or expectation about their drinking habits.
        A: Jane he Mary bu hejiu.
             'Jane and Mary do not drink.'
        S: Haode. John ne? Ta (ye) bu hejiu ma?
             'OK. What about John? Does he not drink (either)?'

In (80), because the context is about 'supplying non-alcoholic beverages' and A has asserted 'Jane and Mary do not drink', the current issue under discussion is a negative *wh*-question 'Who does not drink?'. This negative *wh*-question is pushed onto the Table, and after A's assertion the negative propositions $\neg p$ 'Jane does not drink' and $\neg q$ 'Mary does not drink' are also pushed onto the Table, i.e., $\bigcup_{x=0}^{n} T(C)[x] = T(C)[0] \cup T(C)[1] \cup T(C)[2] = \{\neg q\} \cup \{\neg p\} \cup \{\neg p, \neg q, \neg r$ 'John does not drink', ...$\} = \{\neg p, \neg q, \neg r, ...\}$, which contains $\neg r$ but not r, hence the use of the negative MAQ is felicitous.

Our analysis avoids the problems of traditional approaches, which characterize the distinction between positive and negative MAQs in terms of the speaker's bias. For example, Tang (1981) proposes that positive MAQs express the speaker's assumption for the positive answer and negative ones express the speaker's assumption for the negative answer. In contrast, Zhang (1997) claims that negative MAQs indicate the speaker's bias towards

the positive answer. In fact, positive and negative MAQs express no mandatory speaker bias. In (75) where p is supported by the evidence 'B wears a wet raincoat', the speaker A is biased towards p. In (79), the speaker is still asking a MAQ to seek an answer after the answer p is asserted, from which we can infer that the speaker is biased towards ¬p. In (76) where ¬p 'It did not rain' is supported by the evidence, the speaker is biased towards ¬p. In (81), ¬p has been asserted and the speaker is still asking a MAQ, showing his bias towards p.

(81) B enters A's windowless room. A asks B about the weather and B tells A that it is sunny. However, the weather report said that it is going to be rainy all day long.

   A: Mei xia yu ma? 'Did it not rain?'

Our study verified Gärtner & Gyuris' (2017) 'Polarity Match' principle (see also Büring & Gunlogson 2000; van Rooy & Safárová 2003; AnderBois 2011; Trinh 2014), that is, polar questions always come with contextual bias towards the alternative which is overtly realized in the question's form. In terms of why the polarity of the question form matches the contextual bias, most studies explained it from the answerer's point of view. For example, Roelofsen & Farkas (2015) formulate this as a maxim 'Avoid [reverse]', which says that in formulating a polar question, a cooperative speaker always tries to maximize her answerer's chances to give an unmarked response, i.e., to agree with the polarity of the question form. So in a context with evidence supporting the positive answer p 'It rained' (such as someone wears a wet raincoat), the speaker will choose the positive question 'Did it rain?' instead of a negative one to avoid eliciting a 'no' response.

We have further shown that the speaker not only considers the context following the question (i.e., her answerer's response), but also considers the previous context, that is, the speaker also tries to be consistent with the polarity of the alternative already existing in the context. When an alternative has been brought into the current discussion and thus on the Table, a cooperative questioner would naturally respond to this alternative and question the truth of this alternative, hence utter a polar question which has a polarity form consistent with this alternative. So when someone wears a wet raincoat, the speaker will choose the positive question not only to avoid a 'no' response, but also to show the speaker's response to the alternative p that has already been brought onto the Table by the evidence. This also explains why the speaker chooses a positive question when the addressee has already asserted the positive answer p. The speaker does so not to avoid a 'no' response, but to be responsive to the positive answer that is on the Table.

4.4 Summary

This section analyzed the particle *ma* as a force marker, which adds a Hamblin set onto the Table. We have shown that bias meanings arising from MAQs are best characterized by the notion of contextual bias rather than the speaker's bias, and we have provided a formal definition for contextual bias. A negative MAQ is used when the negative answer is pushed onto the Table. It follows by the EC that a positive MAQ is used elsewhere.

5 Mandarin A-not-A questions

This section derives the meaning of ANAQs compositionally from the meaning of a reduplication feature R, the particle *ne* and the low boundary tone L%, and accounts for the differences between MAQs and ANAQs.

5.1   The feature ʀ and the particle *ne*

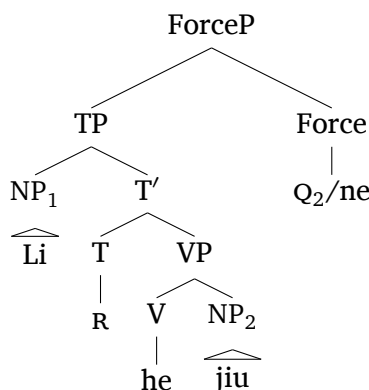Our proposals regarding the compositional analysis of ANAQs are summarized as below:

(82)   a.   The feature ʀ, located between the subject NP and the VP in the deep struc-
               ture of ANAQs, is realized by a reduplication rule.
        b.   The feature ʀ combines with the VP and the subject NP to create a set which
               contains a proposition p 'NP VP' and its negation.
        c.   The question operator Q$_2$, phonologically realized as the particle *ne*, is a
               force marker which combines with a Hamblin set and adds this set onto the
               Table.[10]

Let us illustrate these proposals. (82a) is based on Huang's (1991) analysis of ANAQs.
For example, (83) is derived from the deep structure in (84). The feature ʀ is realized by
a reduplication rule, which copies a sequence following T (here the verb *he*) and inserts
bu 'not' between the original and its copy. The question operator Q$_2$, phonologically
realized as the particle *ne*, introduces the question force and occupies the head position
of a ForceP.

(83)   Li he   bu he   jiu   (ne)?
        Li drink not drink alcohol Q$_2$
        'Does Li drink or not drink alcohol?'

(84)

```
                              ForceP
                      _____/    _____
                    TP                      Force
               ____/  \____                   |
            NP₁          T′                  Q₂/ne
             |         __/  \__
             Li       T        VP
                      |       /  \
                      R      V    NP₂
                             |     |
                             he   jiu
```

The feature ʀ derives the semantics described in (82b). We propose that the semantics
of ʀ is as in (85), which states that ʀ combines with the VP (of type $\langle e, \langle s, t\rangle\rangle$) and the
subject NP (of type e) and returns a set of propositions (of type $\langle\langle s, t\rangle, t\rangle\rangle$). The formula
$\lambda P.\lambda x.\{P(x), \neg P(x)\}$, derived from the reduplication rule, creates a Hamblin-set, as in
(86).

(85) $[\![\text{ʀ}]\!] \in D_{\langle\langle e, \langle s, t\rangle\rangle, \langle e, \langle\langle s, t\rangle, t\rangle\rangle\rangle}$
        $[\![\text{ʀ}]\!] = \lambda P.\lambda x.\{P(x), \neg P(x)\}$

(86) $[\![\text{TP}]\!] = [\![\text{ʀ(drink.alcohol)(Li)}]\!] = \{p, \neg p\}$ p = 'Li drinks alcohol'

The operator Q$_2$ adds this set (i.e., Q) onto the top of the Table, as in (87a). The semantic
composition of (83) is depicted in (87b).

---

[10] The force head Q$_2$ can either be covert or phonologically realized. In other words, we assume that there
exists such a question operator in root ANAQs with or without *ne*. Researchers have not reached a consensus
regarding the syntax and semantics of *ne*. For simplicity, here we treat *ne* as an interrogative force head.
The particle *ne* might have other semantic contributions as well (Shao 1996; Constant 2014; Pan & Paul
2016).

(87)   a.   Semantics of the operator Q_2:
$$Q_2(Q)(C) = C' \text{ such that } T(C') = push(Q, T(C))$$
         b. $\llbracket ForceP \rrbracket = \llbracket Q_2 \rrbracket(\llbracket TP \rrbracket)$
$$= \lambda C.C' \text{ such that } T(C') = push(\{p, \neg p\}, T(C))$$

The A-not-A construction, i.e., the TP in (84) does not require a force head to create a Hamblin-set, hence the A-not-A construction can be embedded, as in (88). However, once the force marker *ne* is attached as in (89), it cannot be embedded since sentential forces cannot be embedded.

(88)   Ta zhidao [Li he   bu he   jiu].
         he know   Li drink not drink alcohol
         'He knows whether Li drinks alcohol or not.'

(89)   *Ta zhidao [Li he   bu he   jiu   ne].
         he know Li drink not drink alcohol ne
         Intended: 'He knows whether Li drinks alcohol or not.'

Our analysis of ANAQs in this section and the analysis of the *ma* particle in Section 4.1 correctly predict that ANAQs are incompatible with the particle *ma*, as in (90). According to our proposal, Q_1/*ma* requires a proposition of type $\langle s, t \rangle$ as an argument, whereas the A-not-A construction *Li he bu he jiu* denotes a set of propositions of type $\langle \langle s, t \rangle, t \rangle$. Because of the type mismatch, *ma* cannot be used in ANAQs.

(90)   *Li he   bu he   jiu   ma?
         Li   drink not drink alcohol Q_1
         Intended: 'Does Li drink or not?'

5.2   The L% tone as a closure operator and paratactic association

The previous subsection derived the meaning of the ForceP. However, the semantics of ANAQs is not complete yet. There is another element, i.e., the final low tone, that also contributes to the semantics of ANAQs. This subsection proposes that the L% tone denotes a closure operator and shows how the paratactic association of L% to the ForceP derive an exhaustivity meaning of ANAQs.

Shen (1990) points out that MAQs end with a final H% tone, while ANAQs end with a final L% tone, which is characteristic of declarative intonation. This distinction is depicted in Figure 1, which is a summary of Shen (1990) given by Schack (2000).

The proposals regarding the semantics of L% and its relation to ANAQs are summarized as below:

(91)   a.   L% in ANAQs and declaratives represents a closure operator.
         b.   The closure operator is paratactically associated to ANAQs.

(91a) proposed the semantics of the L% tone. It may seem unconventional to treat intonational features as lexical elements which engage in the semantic computation. However, recent researchers have present convincing evidence that certain phonological features do make semantic contributions (Bartels 1997; Gunlogson 2003). According to Zimmermann (2000), the final falling intonation in English disjunction declaratives represents a closure operator, which applies to a list and indicates that nothing but the list items has the property in question. For example, in (92), the closure operator, signalled

Figure 1: The average F0 in Shen's study (Schack 2000: 29)
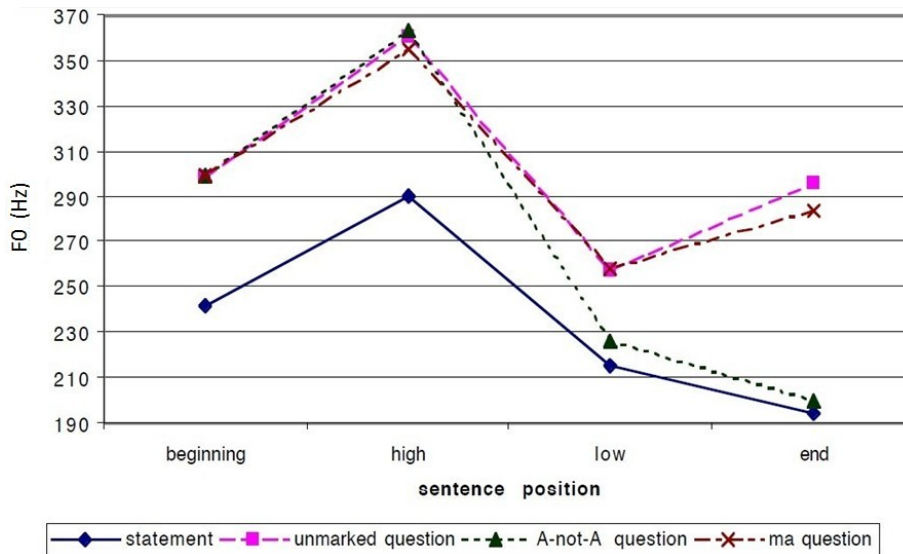
by the falling tone ↓, indicates that no other stations but the listed ones are each one stop from Oxford Circus.

(92)   A: Which tube stations are one stop from Oxford Circus?
       B: Piccadilly Circus, Bond Street, Tottenham Court Road, Green Park, Warren Street, Regent's Park ↓

   Biezma & Rawlins (2012) assume that the falling tone accompanying English alternative questions denotes the same closure operator as in (92), which expresses that only the presented alternatives are salient alternatives in the context, i.e., only the presented alternatives are possible answers to the Question Under Discussion (QUD, Roberts, 1996). Following Biezma & Rawlins (2012), we propose that the L% tone on ANAQs also indicates the presence of this closure operator. The QUD is reconceptualized as the Table in the framework of Farkas & Bruce (2010), so in our model, the closure operator in an ANAQ expresses that all the issues on the Table amount to {p, ¬p}. As stated in (91b), we assume that the closure operator is paratactically associated (Lyons, 1977; Bartels, 1997) to the force head, as in (93) (paratactic association is indicated by '⊗'), and we adopt a composition rule of paratactic association proposed by Hara (2019) and Hara & Yuan (2019).

(93)   ForceP
                                           /   \
                                        TP   Force
                                                    |
                                              $Q_2 \otimes L\%$

This composition rule, as shown in (94), merges two functions into one by abstracting over the argument type of the two functions (♦ is a metalogical operator that combines expressions of different types). The resulting function, $\lambda\chi.\alpha(\chi)\blacklozenge\beta(\chi)$, is combined with an expression χ by functional application and outputs a pair of expressions $\alpha(\chi)\blacklozenge\beta(\chi)$.

(94) Paratactic Association (Hara 2019; Hara & Yuan 2019)
$$\lambda\chi.\alpha(\chi)\blacklozenge\beta(\chi): \langle\sigma,\tau\times\upsilon\rangle$$

$$\lambda\chi.\alpha(\chi): \langle\sigma,\tau\rangle \qquad \lambda\chi.\beta(\chi): \langle\sigma,\upsilon\rangle$$

With the rule of paratactic association, we are ready to define the semantics of L%. As defined in (95), L% combines with a Hamblin set (e.g., {p, ¬p}) and creates a proposition which says that all the issues on the Table amount to this Hamblin set (i.e., $\bigcup_{x=0}^{n}T(C)[x]$ = {p, ¬p}) or that there is no issue on the Table (i.e., $\bigcup_{x=0}^{n}T(C)[x]$ = ∅, e.g., when the ANAQ occurs at discourse-initial position).

(95) $[\![L\%]\!] \in \langle\langle\langle s,t\rangle,t\rangle,\langle C,\langle s,t\rangle\rangle\rangle$
   $[\![L\%]\!] = \lambda\varphi.\ \lambda C.\ (\bigcup_{x=0}^{n}T(C)[x] = \varphi$ or ∅)

The paratactic association of L% with the ANAQ is depicted in (96) based on (94). (96) shows that an ANAQ has a two-dimensional semantics: an ANAQ adds the issue {p, ¬p} onto the Table and at the same time expresses that all the issues on the Table amount to {p, ¬p} or that there is no issue on the Table.

(96) $\lambda C.C's.t.T(C')=push(\{p,\neg p\},T(C))\blacklozenge\lambda C.L\%(\{p,\neg p\}):$
   $\langle C,C\rangle\times\langle C,\langle s,t\rangle\rangle$

{p, ¬p}:
$\langle\langle s,t\rangle,t\rangle$

$\lambda\varphi.\lambda C.C's.t.T(C')=push(\varphi,T(C))\blacklozenge\lambda C.L\%(\varphi):$
$\langle\langle\langle s,t\rangle,t\rangle,\langle C,C\rangle\times\langle C,\langle s,t\rangle\rangle\rangle$

$\lambda\varphi.\lambda C.C's.t.T(C')=push(\varphi,T(C)):$
$\langle\langle\langle s,t\rangle,t\rangle,\langle C,C\rangle\rangle$

$\lambda\varphi.\lambda C.L\%(\varphi):$
$\langle\langle\langle s,t\rangle,t\rangle,\langle C,\langle s,t\rangle\rangle\rangle$

Now we can explain why ANAQs can be used in neutral contexts but not in biased contexts. For example, an ANAQ like *Xia mei xia yu?* 'Did it rain or not?' denotes an interrogative meaning (i.e., an update of the Table with a Hamblin set) and an exhausitivity meaning that all the issues on the Table amount to {p, ¬p} or there is no issue. On this account, the ANAQ is correctly predicted to be felicitous in neutral contexts like (68), repeated here as (97), where no issue is on the Table ($\bigcup_{x=0}^{n}T(C)[x]$ = T(C)[0] = ∅).

(97) The first question in a questionnaire investigating the relationship between weather and people's mental states is:
   Q: (Ni de chengshi zuotian) xia mei xia yu?
      'Did it rain or not rain (yesterday in your city)?'

Also, the ANAQ is correctly predicted to be felicitous in (98), where both the issues {p} and {¬p} have been pushed onto the Table by A and B. All the issues on the Table amount to {p, ¬p} ($\bigcup_{x=0}^{n}T(C)[x]$ = T(C)[0] ∪ T(C)[1] = {¬p} ∪ {p} = {p, ¬p}), hence the use of ANAQ is felicitous.

(98) A: Zuowan xia yu le.
      'It rained last night.'

    B: Bu, meiyou xia.
          'No, it did not rain.'
    C: (Suoyi/Daodi) Xia mei xia yu?
          '(So/After all,) Did it rain or not rain?'

In biased contexts like (99), a singleton set {p} is pushed onto the Table by A ($\bigcup_{x=0}^{n}$T(C) [x] = T(C)[0] = {p}). This contradicts the exhaustivity meaning of ANAQs that all the issues on the Table amount to {p, ¬p} ($\bigcup_{x=0}^{n}$T(C)[x] = {p, ¬p} or ∅), hence the use of an ANAQ is infelicitous. In contrast, MAQs lack the falling tone and do not express this exhaustivity. Therefore, MAQs can occur in both neutral and biased contexts.

(99)   A: Zuowan xia yu le. 'It rained last night.'
        B: #Xia mei xia yu? 'Did it rain or not rain?'

Similarly, A-not-A questions cannot be used in (100) where T(C)[0] = {p}.

(100)   B enters A's windowless room wearing a wet raincoat.

        A: #Xia mei xia yu? 'Did it rain or not rain?'

Our account also makes correct predictions about the answers to ANAQs. ANAQs cannot be responded by the answer particles *(bu) shide*. This is because ANAQs indicate that either a size-two Hamblin set is on the Table or no issue is on the Table, which does not satisfy the presupposition of the answer particles that one singleton set is on the Table.

5.3 Summary

This section derived the semantics of ANAQs and accounted for the differences between ANAQs and MAQs. The A-not-A construction denotes a set of propositions, which can be embedded. The force head *ne* adds this set onto the Table, hence ANAQs containing *ne* cannot be embedded. The L% tone on ANAQs contributes to a proposition which says that all the issues on the Table amount to a set containing both the positive and negative answers. This explains why ANAQs cannot be used in biased contexts where the issue on the Table contains only one answer.[11]

6 Conclusion

A longstanding puzzle in the semantics of questions has been the subtle difference between positive polar questions, negative polar questions and alternative questions. In the past few decades, researchers have been exploring various ways to modify Hamblin semantics in order to account for the differences between these questions, and our study has constituted an interesting case of interlanguage variation in solving this puzzle.

In order to explain the similarities and differences between Mandarin MAQs and ANAQs, we have proposed for the following compositional semantics of these questions: MAQs and ANAQs both denote an update of the Table with a Hamblin set, and hence both license verb-echo answers. However, the Hamblin set is composed differently in each question. The particle *ma*, as a question force marker, combines with a proposition and creates a Hamblin-set, therefore MAQs cannot be embedded. The negative MAQs are

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[11] Another type of Mandarin questions, *shi-bu-shi* questions (with the copula *shi* 'be' and its negative form *bu shi* 'not be'), looks similar to ANAQs in the surface structure. However, many studies present evidence that *shi-bu-shi* questions are different from ANAQs regarding both semantics and syntax (Schaffar & Chen, 2001; Tsai & Yang, 2015, etc.) See Ye (2020) for the semantic analysis of *shi-bu-shi* questions.

used if the negative answer is pushed onto the Table, while the positive ones are used in other contexts. The A-not-A construction, on the other hand, denotes a Hamblin-set, which is embeddable. ANAQs end with a low boundary tone L%, which contributes to an exhausitivity meaning that all the issues on the Table amount to a set containing both the positive and negative answers. Therefore, ANAQs cannot be used in biased contexts where the issue on the Table contains only one answer. Since the answer particles *(bu) shide* presuppose the existence of one singleton set on the Table, the particles cannot be used to answer ANAQs and MAQs in neutral contexts.

Our study identified the source of the bias in MAQs and ANAQs. We showed that these two questions do not encode the speaker's bias/neutrality, contra the predictions of the traditional approaches. The bias meanings arising from these questions are best characterized by the notion of contextual bias rather than the speaker's bias. We have also shown that polar questions are ways of responding to the previous discourse, hence polar questions always come with contextual bias towards the alternative overtly realized in the question's form. Compared with previous studies, our study has provided a more fine-grained formal definition that unifies contextual bias arising from different sources, e.g., bias from default assertions, possibility claims, and contextual compelling evidence.

Abbreviations

PFV = perfective, GEN = genitive

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