Extracting commitments: rising intonation and *ba* in Mandarin[1]

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Abstract. This paper investigates the particle *ba* and its interaction with the rising intonation in Mandarin. The paper presents novel data showing that *ba* can appear with rising tone only when the speaker is very certain about the prejacent, and that she invites the addressee to be committed to the prejacent as well by using the rising intonation. This is contrary to falling *ba*-declaratives, which typically express the speaker's uncertainty. We formalize the effects of a rising *ba*-declarative by associating *ba* and the rising intonation to the following context-updating conventions: one, *ba* adds the content of the prejacent to the speaker's projected commitment set; two, the rising tone adds the content of the prejacent to the addressee's projected commitment set. The account reconciles the seemingly contradictory effects of rising/falling *ba*-declaratives, and explains the 'special' effect of rising tone in *ba*-declaratives.

Keywords: Discourse particles, Table stack, speech acts, Mandarin.

1. Introduction

The meaning of questioning in Mandarin Chinese can be expressed in two ways: either by attaching the question particle *ma* (morpho-syntactically), or by using a rising intonation (prosodically, '↑' for rising intonation, '↓' for falling intonation).

(1)   a.   Yuehan you che **ma**↑/↓
           Yuehan has car MA
           'Does John have a car?'

      b.   Yuehan you che↑
           John   has car
           'John has a car?'

As we can see clearly in (1b), the interpretation of a prosodic question in Mandarin is similar to rising declaratives in English: the rising intonation weakens or cancels the speaker's commitments (Gunlogson 2004; Malamud and Stephenson 2015; Jeong 2018; Farkas and Roelofsen 2017; Truckenbrodt et al. 2008; Rudin 2018, 2019; Westera 2017 a.o.). This paper concerns with a special effect that rising intonation gives when it interacts with a Mandarin discourse particle *ba*. *ba* is an unembeddable utterance-final particle. When *ba* co-occurs with falling intonation, it typically shows effects such as confirmation-seeking or uncertainty when attached to declaratives with a falling tone[2].

(2)   *A: Department's party is at 8 tonight.*

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[2]*ba* can also attach to morphosyntactically marked interrogatives. We will not discuss interrogative cases in this paper, but see Yuan (2020), Yang (2020) for details about *ba*-interrogatives.

B: ni yao qu **ba** ↓
B: *You are going, right?* (Confirmation-seeking)

(3) *A: How is Sue's English?*
B: ting hao de **ba** ↓
B: *(Should be) very good.* (Uncertainty)

ba can also be used with rising intonation very naturally. However, in contrast to falling *ba*-declaratives, rising *ba*-declaratives are felicitous only when the speaker is **very sure** about the prejacent, as shown in (4).

(4) [CAUGHT A COLD: The temperature dropped significantly. A told B to wear more, otherwise B would catch a cold. B did not listen to A. After a few days, B caught a cold.]
A: ganmao le **ba**$_{str}$
A: *(As I've told you), you caught a cold **ba**$_{str}$!*

ba's meaning in declaratives has been widely discussed in the previous literature. For instance, Li and Thompson (1989) have described the function of *ba* as 'soliciting-agreement'. Han (1995) proposes that *ba* weakens the "neustic" in declaratives. Chu (2009) generalizes the uses of *ba* as 'speaker's uncertainty' of the propositional content. More recently, Ettinger and Malamud (2015) try to provide a unified account of the meaning of *ba*. They argue that *ba* marks a contingent move (see also Gunlogson 2008), serves to weaken the force of the assertion or the directive it attaches to[3]. To account for this meta-linguistic intuition, Ettinger and Malamud (2015) propose an extended Table model (Farkas and Bruce 2010 a.o.), which articulates the Table into two parts, and it is the addressee's responsibility to advance objects on Table1 to Table2 or to the target domain (i.e. the common ground). By this, they argue that updates of *ba*-marked utterances target Table1, and that the weakening effect is generated from this "delegation of the authority" for the discourse moves.

Ettinger and Malamud (2015)'s proposal of *ba*-declaratives is the starting point of my own analysis. I take the idea underlying their proposal as essentially correct, in that it accounts for the intuition that *ba* has something to do with marking the contingency of a discourse move. While capturing some crucial intuitions about the meaning of *ba*, Ettinger and Malamud (2015) do not discuss the intonational influences on *ba*-declaratives (i.e. the rising cases). In this paper, I will show that rising intonation contributes significantly to the meaning of *ba*-declaratives. I argue that the discourse effects of rising *ba*-declaratives can be considered as contributed by the effects of *ba*-declarativess, plus the effects of the rising tone. I propose that *ba*-declaratives make no contribution to the speaker's present discourse commitments, but express the speaker's intention of making *tentative commitments* (Gunlogson 2001, 2008; Malamud & Stephenson 2015). I add that the function of the rising tone in rising *ba*-declaratives is to extract the addressee's explicit commitment of the prejacent: either because the addressee is unwilling to be committed to the prejacent (as in 4), or her commitment is implicit (i.e. inferred from the context). The speaker will choose to use a rising *ba*-declaratives if she finds that the addressee's

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[3]Imperatives are not necessarily marked in Mandarin. When strings like (1) and (2) are used for directive speech acts, Ettinger and Malamud (2015) call them imperatives.

commitment is expected given the context (e.g. strong evidence, addressee's facial gestures). The sureness of that rising *ba*-declaratives express is a derived effect from the particle *ba* and the rising tone.

The paper is organized as follows. §2 lays out the properties and (in-)felicity conditions for falling/rising *ba*-declaratives. §3 introduces the theoretical framework used in the current paper. §4 proposes an account which captures and reconciles the seemingly contradictory effects of rising/falling *ba*-declaratives. §5 raises some open questions and concludes.

2. Prosody and *ba*

This section presents the observations on the properties of *ba*-marked utterances along with their interactions with the falling and rising intonation contours. As noted in §1, *ba* is used more widely and frequently with declarative prejacents in the language. I use *ba*-declaratives to refer to *ba*-utterances whose prejacents are not morphosyntactically marked as interrogatives. It has been known for a long time that *ba*-declaratives typically show effects such as confirmation-seeking (5a), epistemic uncertainty (5b), politeness (5c), and reluctance (5d). These four sub-types of uses are first identified by Ettinger and Malamud (2015), but discussions along those lines can be found widely in the prior literature (a.o., Chao, 1968; Chu, 1998, 2009; Li and Thompson, 1989; Li, 2006; Han, 1995; Zhu, 1982). I observe that *ba*-declaratives can appear either with a falling or a rising intonation very naturally. For all functions observed, the most natural intonation carried by sentences in (5) is a falling one, and I add that a falling *ba*-declarative can also be used when speaker is not sure about some meta-linguistic issue (e.g. relevance), shown in (5e)[4].

(5) a. CONFIRMATION SEEKING
         Ni mingtian qu xuexiao **ba**↓
         You will go to school tomorrow, won't you?

     b. UNCERTAINTY
         A: Do you know how well Mary cooks?
         B: Ting hao de **ba**↓
         B: (Maybe) very good.

     c. POLITENESS
         qu kai chuang **ba**↓
         Open the window.

     d. RELUCTANCE
         [A wants to donate $100, B is in charge of the donation, and B thinks A should give more.]
         A: Na wo juan liangbai **ba**↓
         A: I'll donate 200 then.   (Chu 2009)

     e. META-LINGUISTIC UNCERTAINTY (i.e. being uncertain of the relevance)
         A: Do you know if John is going to the party?

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[4]Chu (1998) also noted that *ba* can co-occur with an imperative marker *bie* 'don't' in Mandarin.

(1) ni **bie** guan zhege xianshi **ba**.
     You better not meddle with this damn thing! (Chu 1998)

B: Ta gangcai zhunbei qu **ba**↓

B: He was preparing to go...

The next question we ask is whether *ba*-attached declaratives are assertions or not. Following Asher and Reese (2007) and Kamali (2020), here I adopt the "tell me" test: assertions cannot appear after an utterance of "tell me", whereas utterances that carry a questioning speech act can. As we can see in (6), a *ba*-declarative is infelicitous in the "tell me" environment, while the same sentence with the Mandarin polar question construction *A-not-A* can co-occur with "tell me" in (6b). This contrast tells us that there is at least some assertive component in *ba*-declaratives.

(6) a. #gaosu wo, ni mingtian qu xuexiao **ba**
         tell   me you tomorrow will go   school BA
         '#Tell me, you will go to school tomorrow **ba**.'

     b. gaosu wo, ni mingtian **qu bu qu** xuexiao
         tell   me you tomorrow go NEG go school
         'Tell me, will you go to school tomorrow?'

The same point can also be tested with Asher and Reese (2007)'s "after all" test. According to Asher and Reese (2007), an assertion, or a complex speech act that is partially assertive, is compatible with utterances of "after all", while a simple questioning speech act is not. This is borne out in (7), where the utterance with *ba* (7a) is felicitous but the utterance with the *A-not-A* construction is not.

(7) a. bijing, ni mingtian yao qu xuexiao **ba**.
         *After all, you will go to school tomorrow **ba**.*

     b. # bijing, ni mingtian **qu bu qu** xuexiao?
         # After all, will you go to school tomorrow?

2.1. Falling *ba*-declaratives

Speaker's commitment. With these basic properties in mind, let us now examine the contextual restrictions that falling *ba*-declaratives are sensitive to. As we have seen in (6) and (7), a *ba*-declarative contains some element of 'assertiveness'. In other words, a *ba*-declarative expresses at least some degree of speaker's commitment to its prejacent. We test this point in (8) and (9). In both cases in (8), the infelicity of B's *ba*-utterances is either because B is neutral (ignorant) towards the prejacent (8a), or that B is skeptical about the prejacent (8b). Without *ba* the sentences become felicitous with a rising tone, similar to the uses of rising declaratives in English. (9) exemplifies a scenario of *indifference* where the speaker B has no opinion about whether the addressee should open the window. Here B's utterance with *ba* results in infelicity.

(8) a. *A: John plans to drive to the store.*
         B: # Yuehan you che **ba**↓/↑
         B: (What?) John has a car?
         B' Yuehan you che ↑
         B': John has a car?

b. *A: I heard that John bought a new car.*
B: # Yuehan mai le che **ba**↓/↑ bukeneng, ta bu hui kaiche.
B: John bought a car? No way, he can't drive.
B': Yuehan mai le che ↑ bukeneng, ta bu hui kaiche.
B' John bought a car? No way, he can't drive.

(9) *A: Should I open the window?*
B: # kai **ba** huozhe bu kai le **ba**, wo wusuowei.
B: Open it or don't open it, I don't care.

In contrast to canonical falling declaratives, falling *ba*-declaratives cannot be used to express a speaker's full commitment. For an example that illustrates this point, consider (10). The infelicity of A's utterance is due to the presence of *ba*. If *ba* is omitted, as in A', the sentence becomes acceptable[5].

(10) ⌈A and B directly sees that it's raining. A to B:⌉
A: # xiayu le **ba**↓
*A: It's raining **ba***
A': xiayu le ↓
A': It's raining.

Conversation starter. A falling *ba*-declarative can be uttered without an immediate discourse move. Namely, speakers can use a falling *ba*-declarative as a conversation starter, as shown in (11).

(11) a. ⌈A and B sit in a linguistic conference. A does not know that B is a philosopher. A noticed that B is reading a philosophical paper.⌉
A: ni shi xue zhexue de **ba**↓
*A: You are a philosopher **ba***
b. ⌈A approaches a stranger on the street who just dropped her wallet⌉
A: buhaoyisi, zhe shi ni de qianbao **ba**↓
*A: Excuse me, this is your wallet **ba***

Notice that the cases shown in (11) are different from truly out-of-the-blue contexts in that they both contain some contextual information (here is extralinguistic) which supports the speaker's belief about the prejacents in the previous discourse. For instance, if the speaker in (11b) did not witness that it is indeed the person she approaches who dropped the wallet, then uttering (11b) would be infelicitous. In other words, here *ba* picks up some evidence supporting its prejacent in the previous discourse which is accessible to both interlocutors[6]. In a truly out-of-the-blue scenario as in (12), using *ba* is degraded.

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[5]The sentence with *ba* in (10) can be uttered with a rising intonation in contexts like (10) where the speaker directly witnesses the raining event.

[6]When the piece of evidence is only accessible to the speaker but is not exposed to the addressee, uttering a *ba*-declarative results in infelicity.

(1) ⌈Neither A and B went to a department party. On the next day, A saw a lot of empty alcohol bottles in the kitchen, while B went to her office directly and did not see the bottles.⌉
A: # tamen zuotian dou he duo le **ba**↓

(12)   [A approaches a stranger on the street.]
      A: ? buhaoyisi, jintian shi bayuewuhao **ba**↓/↑
      A: *Excuse me, today is August 5 **ba***

2.2. Rising *ba*-declaratives

This section focuses on some special pragmatic effect carried by rising *ba*-declaratives, which is different from all the five flavors listed in (5). As in many other langauges, the meaning of questioning in Mandarin can be expressed prosodically just with the so-called Rising Ending prosody (Chao 1968; Shen 1990 a.o., labeled as H% in Pan-Mandarin ToBI system[7], Peng et al. 2005). *ba* can also occur with both falling and rising ending tones very naturally in declaratives:

(13)   ganmao le   **ba**
      cold   PERF BA
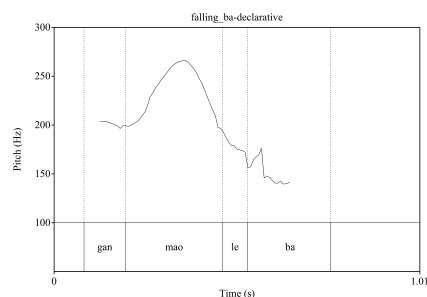   '(You) got a cold **ba**.'
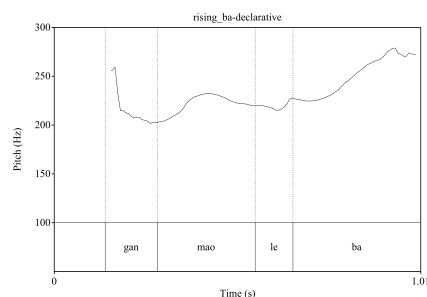

Figure 1: Falling *ba*-declaratives   Figure 2: Rising *ba*-declaratives

However, contrary to falling *ba*-declaratives, rising *ba*-declaratives can only be used only when the speaker is very sure about the prejacent. If the speaker is ignorant about the issue under discussion before, or the speaker is also uncertain about the prejacent, then using rising *ba*-declaratives results in unacceptability. In the ALLERGY OR COLD example (14), A observed B's sneezing and thus infers that it could be that B is ill. Here it is acceptable to use a falling *ba*-declarative as a hedge, but a rising *ba*-declarative is infelicitous since A cannot be sure about the reason of B's sneezing. Note that in (14) it is felicitous to use a rising declarative without *ba* (A') to express the speaker's uncertainty.

(14)   [ALLERGY OR COLD: A saw B sneezing. A guesses B has cold, but it could be that B shows allergy symptoms.]
      A: ganmao le **ba**↓ / #↑
      A: *You got a cold **ba***
      A': ganmao le # ↓ /↑
      A': *You got a cold. / You got a cold?*

      A: *They were all drunk yesterday **ba**.*

[7]Whether there exists boundary tones in Mandarin is still debated in the literature. I set this issue aside since it is not the main focus of this paper. For arguments in favor of the existence of boundary tones, see Peng et al. (2005) a.o.; for arguments against boundary tones, see Yuan et al. (2002) a.o.

The rising *ba*-declarative '*you got a cold **ba***' in (14) becomes felicitous if we modify the scenario by adding the speaker's public commitment in the previous discourse in the CAUGHT A COLD example (15). In (15), prior to the *ba*-utterance, A has committed herself to the prejacent, which is rejected by B. Later on a strong piece of evidence appears in the context which supports A's commitment, so in (15) A uses a rising *ba*-declarative to bring up her previous commitment and asks B whether B wants to be committed to the prejacent now given the evidence.

(15) [CAUGHT A COLD: The temperature drops significantly.]
      A: duo chuan dian, buran hui ganmao.
      A: Put on more clothes, otherwise you will get a cold.
      B: bie danxin, wo buhui.
      B: Don't worry, I won't.
      [After a few days, B sneezes.]
      A: ganmao le **ba**↑/?↓
      *A: (As I've told you), you got a cold **ba**!*

Unlike the falling ones, rising *ba*-declaratives can be felicitously uttered when there is established fact supporting the prejacent in the context. For an example which illustrates this point, consider BROKEN BOX in (16).

(16) [BROKEN BOX: A told B not to heat a locked glass lunchbox in a microwave because it might break. B didn't listen to A, and the glass lunchbox did break. Both A and B witness the broken box.]
      a. A: lie le **ba**↑/#↓
          *A: It broke **ba** (as I've told you)*
      b. A': # lie le↑
          A': It broke?

In (16), the rising *ba*-declarative '*it broke **ba***' is not used as a confirmation of the current status of the lunch box, but rather a confirmation of A's previous opinion, similar to asking B '*are you going to accept my words now*'.

Commitment asymmetry. As we have seen so far, uttering rising *ba*-declaratives requires the speaker's commitment towards the prejacent in the previous discourse. I observe that the requirement of previous commitments is asymmetric between speaker and addressee: only the speaker's previous commitment is required, the addressee need not to have opposite beliefs; she can be neutral/ignorant until she actually sees the evidence. In (17), for example, before '*it is tasty **ba***' is uttered, B is neutral towards the prejacent '*it is tasty*' since B does not have any experience before.

(17) [NEW COFFEE: A brings a type of coffee which B has never tasted before.]
      A: changchang zhe ge! tebie hao he.
      A: Try this! It is very tasty.
      [B takes a sip. She nods and smiles.]
      A: hao he **ba** ↑/?↓
      *A: It's tasty **ba** (as I've told you)!*

For an example which illustrates the point that the speaker's commitment is necessary for rising *ba*-declaratives, consider the ALLERGY OR COLD example (14), and also (18). The difference between the contexts in (18) and in (17) is that here the speaker herself has no experience on the new chocolate. Therefore, she is not capable to judge the taste in the first place, nor can she uses *ba* to report other interlocutor's belief given that *ba* is particularly sensitive to the speaker's perspective in declaratives.

(18) [NEW CHOCOLATE: A brings a type of spicy chocolate which both of them have never tasted before.]
A: changchang zhe ge, dan xiaoxin, wo ye buzhidao hao bu haochi.
A: Try this, but be careful, I don't know whether it's tasty or not either.
[B tried. She nods and smiles.]
A: # hao he **ba** ↑/↓
*A: It's tasty **ba**!*

2.3. Interim summary

So far from the empirical data we have observed that (i) a *ba*-declarative always involves certain degree of the speaker's commitment; (ii) a rising *ba*-declarative is felicitous only if the speaker has been committed to its prejacent in the previous discourse.

	ϕ-**ba**↓	ϕ-**ba**↑
speaker's bias	✓	✓
certainty	✗	✓
discourse-initial	✓	✗
public evidence	not necessary	✓

Table 1: Observations of the (in-)felicity of falling/rising *ba*-declaratives

3. Theoretical preliminaries

The investigation of the data in the previous sections shows that the discourse effects of a *ba*-declarative differ significantly according to the intonation it bears. In this section, we introduces the theoretical preliminaries adopted in the paper before making proposals.

The discourse model adopted in the paper is a Lewisian 'conversational scoreboard', which keeps track of discourse moves and contextual information exchange, representing the conversational state in the course of conversation (Lewis, 1979). The original Lewisian scoreboard is enriched and further developed, in particular, by Farkas and Bruce (2010), Malamud and Stephenson (2015), Farkas and Roelofsen (2017), and many others cited in (26). The paper will adopt the notations of contextual components used by Farkas and Bruce (2010) and Malamud and Stephenson (2015), with modifications from Farkas and Roelofsen (2017) in which sentence meanings are formalized within the Inquisitive Semantics framework.

We start out with the relevant notions and notations of inquisitive semantics that are used in this paper (for details see Ciardelli et al. 2013, Ciardelli et al. 2018). Traditionally, the sentence meaning is construed as a proposition (a set of possible worlds). In inquisitive semantics, both declarative and interrogative sentences are treated as *issues*, and hence receive the same semantic type (a set of propositions).

(19)   An issue I is a non-empty, downward closed set of propositions.

In this way, the denotation of a declarative or an interrogative sentence is always a set of sets of possible worlds. A declarative sentence thus differs from an interrogative only in how many *alternatives* the issue raised by the sentence contains. Here the alternatives for an issue I are defined as the maximal elements in $[\![I]\!]$.

(20) $\text{alt}(I) := \{p | p \in I \text{ and there is no } q \in I \text{ such that } p \subset q\}$

If an issue only contains a single maximal element ($|\text{alt}(I)| = 1$), i.e. it is a singleton set, then it is raised by a declarative; if $|\text{alt}(I)| \geq 2$, then it is an interrogative. Finally, the *informative content* of an issue, **info**(I), is defined as $\bigcup I$. A sentence with an issue I is true in a world w just in case $w \in \bigcup I$. We call an issue containing a single alternative *informative*, an issue containing more than one alternatives such that the informative content covers the entire logical space *inquisitive* (namely, iff **info**$(I) = W$).

(21)   **info**$(I) := \bigcup I$

(22)   A sentence with an issue I is true in w just in case $w \in$ **info**(I)

For a quick illustration, let us see how this framework works for a plain declarative and a polar interrogative. The former is considered as an informative sentence, while the latter is an inquisitive one, assuming that Mary exists throughout W.

(23)   a. Mary left.
        b. Did Mary leave?

First, the issue raised by a declarative *Mary left* (23a) is a downward closed set of propositions. This set contains one alternative (a singleton set), i.e. it contains the set of all worlds in which Mary left, as well as all its subsets. We follow the notations from Ciardelli et al. (2018) and Farkas and Roelofsen (2017), which write $\{\{w : \text{Mary left in } w\}\}^{\downarrow}$ as a downward closed set of propositions[8].

(24) $[\![\text{Mary left}]\!] = \{\{w : \text{Mary left in } w\}\}^{\downarrow 9}$

Next, a polar interrogative like *did Mary leave* (23b) is composed as a set containing two alternatives, $\{w : \text{Mary left in } w\}$, and $\{w : \text{Mary didn't leave in } w\}^{10}$. By downward closure, this means that all propositions contained in the two alternatives are also in the issue raised by (23b). Note that (23b) is considered as *purely inquisitive* under the current definitions, as info($[\![\text{Did Mary leave}]\!]$) is the entire logical space.

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[8]In the standard two-step approach, (23a) can be written as $(\text{Mary left})' = \lambda p. \forall w \in p : \text{LEAVE}(m)(w)$, the notation $(\alpha)'$ is the translation of sentence α.

[9]In inquisitive semantics, issues are always *downward closed*: if I contains a proposition p and proposition $q \subset p$, then $q \in [\![I]\!]$.

[10]If we use $[\![\alpha]\!]$ to represent $\{w : \text{Mary left in } w\}$, then $\{w : \text{Mary didn't leave in } w\}$ should be represented as $[\![\neg\alpha]\!]$. The sentential negation of a sentence α in inquisitive semantics is defined below:

(1) $[\![\neg\alpha]\!] := \lambda p. \forall q \in [\![\alpha]\!] : p \cap q = \varnothing.$

(25)　⟦Did Mary leave⟧ $= \{\{w : \text{Mary left in } w\}, \{w : \text{Mary didn't leave in } w\}\}^{\downarrow}$

So far, we have seen that declaratives and interrogatives are treated uniformly in inquisitive semantics. Bearing these in mind, we now specify the basic discourse context that the paper uses, summarized below. The current model is adapted from Farkas and Bruce (2010), with modifications of adding the *projected commitments* of the interlocutors from Malamud and Stephenson (2015).

(26)　Context $c = \langle \text{A}, \text{T}, \text{DC}_x, \text{DC}_x^*, \text{CG}, \text{CG}^* \rangle$, where

   a. Participants (A): a set of discourse participants (*s* for speaker, *a* for addressee);

   b. The Table (T): a stack of sets of propositions (issues) (Ginzburg, 1996; Roberts, 1996; Büring, 2003; Farkas and Bruce, 2010);

   c. Discourse Commitments (DC_x): the set of propositions that each discourse participant is publicly committed to (Gunlogson, 2004, 2008);

   d. Projected Commitment Set (DC_x^*): the set of propositions that the interlocutor x is expected to become committed to in the normal course of conversation (Malamud & Stephenson, 2015);

   e. Common Ground (CG): the set of propositions that all discourse participants are publicly committed to, i.e. that are mutual joint belief (Stalnaker, 1978);

   f. Projected Set (CG*): the set of supersets of the current CG that projects future common grounds relative to which the issue on the Table is decided (Farkas and Bruce, 2010).

The two most fundamental components in the context are the Table and the Common Ground. The Table is defined as a stack of issues (sets of propositions), which keeps track of the *proposals* (the QUDs in Ginzburg 1996 and Roberts 1996) for updating the common ground (Farkas and Bruce, 2010). Interlocutors are expected to 'steer' the conversation towards increasing the common ground, i.e. to resolve what is on top of the stack in a normal course of conversation. The Table will be 'emptied' once the current issue gets resolved. In other words, Farkas & Bruce's model elaborates the Stalnakerian update of assertions in a way that it models an intermediate step in the update process: before updating the common ground, the content of an utterance is first put onto the Table; the addressee can either choose to accept or reject the proposals on the Table. The Common Ground is updated by the content only when the content is accepted by all interlocutors.

Apart from the Table, there are three other conversational components that also play crucial roles in my account: the Discourse Commitments sets (DC_x) for each interlocutor x, along with their Projected Commitment sets (DC_x^*), and the Projected Set (CG*). The DC_x used in my account is adapted from the definition of *public beliefs* proposed by Gunlogson (2004): a proposition p is a public belief of A if and only if the belief 'A believes p' is in the common ground (a common belief of A and B). In other words, a public belief of an individual is not necessarily a mutual belief, but propositions in DC_xs are also part of the Common Ground. In this way, a Stalnakerian common ground can be achieved by taking the intersection of the interlocutor's commitment sets[11].

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[11] According to Gunlogson (2004), however, the common ground is construed as the union of two commitment

In order to show the different effects an assertion or a question makes to the contexts, Farkas and Bruce (2010) propose that moves placed on the Table simultaneously project a set of future common grounds, the Projected Set (CG^*). In other words, CG^* suggests possible ways of resolving the current issue. When an assertion is put on the Table, the CG^* will be updated by the informative content of the issue **info**(I). When a question is proposed, the CG^* will be updated by all the possible answers to the question Q. The updating operation $\text{CG}^* \mathbin{\bar{\cup}} P$ is defined in (9), which says that an updated CG^* is a new collection of possible developments of the common ground, and each future cg is created by adding one proposition in P to the previous cg. The future cgs in the new collection CG^* should be consistent; inconsistent future cgs will be eliminated.

(27) Definition of CG^*:
   a. Let $\text{CG}^* = \{cg_1, ..., cg_n\}$ be a collection of sets of propositions (e.g. possible common grounds) and let $P = \{p_1, ..., p_m\}$ be a set of propositions.
   b. $\text{CG}^* \mathbin{\bar{\cup}} P = \{cg_i \cup \{p_j\} \mid cg_i \in \text{CG}^* \text{ and } p_j \in P \text{ and } \bigcap(cg_i \cup \{p_j\}) \neq \varnothing\}$
      (i.e. only keeps the consistent future common grounds)

<div align="right">(Modified from Farkas and Bruce 2010)</div>

In addition to CG^*, we add the Projected Commitment Sets of the interlocutors (DC_x^*) to the context. Just like CG^*, DC_x^* serves to project the interlocutors' future commitments. In other words, DC_x^* represents the set containing the interlocutor x's *tentative commitments* (Malamud and Stephenson 2015). There can be various reasons for a speaker to choose not to commit immediately: the speaker's epistemic uncertainty, the lack of the addressee's explicit commitment (e.g. the addressee's disagreement on the current issue), the speaker's unsureness of a move (i.e. meta-linguistic uncertainty), etc. The notion of the speaker's projected commitments is similar to the notion of *contingent commitments* proposed by Gunlogson (2008) in a way that these tentative commitments of the speaker requires the addressee's ratification to become actual (present) commitments. Malamud and Stephenson (2015) add the addressee's projected commitments to the system, which allows the speaker to not only add her tentative commitments to her own set, but also to operate on the other interlocutor's projected commitment set (i.e. to give her best guess on the addressee's next-stage commitment).

Assumptions from Farkas and Bruce (2010) and Malamud and Stephenson (2015) are inherited in our system. First, although a speaker can operate on both her and the addressee's DC^*, she can never touch the addressee's present commitment set. Second, both the speaker's and the addressee's projected commitments depend on the addressee's ratification. In other words, only the addressee has the authority of lifting a projected commitment (of the speaker or the addressee) to an actual one. Third, all items on the Table are projected in CG^*. This assumption leads to desirable predictions when we model the dynamics of *ba*-declaratives in §4, but see Jeong (2018) for an opposite implementation.

Under this framework, the Farkas and Bruce's speech act operators (assertive and question operator) can be merged as the following basic *conventional discourse effects* (CDE) since declarative and interrogative sentences have the same semantic type (Farkas and Roelofsen 2017;

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sets. Here we adopt the original Stalnakerian conception of common ground: a set of the common beliefs of the interlocutors.

Kaufmann 2012; Lauer and Condoravdi 2012; Condoravdi and Lauer 2012; Portner 2004). CDEs are functions from input contexts (K_i) to output contexts (K_o) determined by a particular sentence form. Only updated discourse components are listed below; unmentioned aspects remain the same as their inputs. The subscripts i and o stand for input and output respectively.

(28) Basic CDEs of updating a sentence S with semantic content I:
$K_i + S = K_o$:
a. $\text{DC}_{s,o} = \text{DC}_{s,i} \cup \{\textbf{info}(I)\}$
b. $\text{T}_o = \text{PUSH}(I, \text{T}_i)$
c. $\text{CG}_o^* = \text{CG}_i^* \bar{\cup} I$

(28) says that when an issue I is raised by a sentence S, three basic updates are made to input contexts: first, the informative content of the issue $\textbf{info}(I)$ is added to the speaker's commitment set. When there is more than one alternatives in I (i.e. a question), a trivial commitment is made by the speaker since the informative content of a question equals to the whole logical space. Second, the denotation of the issue I is pushed on the stack. The effect on CG* results from this operation: when S is an interrogative, each alternative in I can potentially update the CG; when S is a declarative, the CG* is updated with $\textbf{info}(I)$. Usual stack operations are assumed, PUSH (e, T) in (28b) represents the new stack obtained by adding the issue e onto the stack T.

4. Updating conventions of *ba*-declaratives

We are now ready to model the discourse dynamics of *ba*-declaratives. We assume that adding *ba* to a declarative sentence does not change the denotation of the sentence, (i.e. $\llbracket \phi \rrbracket = \llbracket \phi - ba \rrbracket$), but introduces special CDEs and preconditions on the input contexts. I propose that:

(i) *ba* makes no contribution to the speaker's present discourse commitments, but express the speaker's intention of making tentative commitments. This intuition can be formulated as a special CDE that is contributed by *ba*: adding the $\textbf{info}(I)$ to the speaker's projected commitment set.

(29) Contribution of *ba*:
Add $\textbf{info}(I)$ to $\text{DC}_{s,i}^*$ when uttering a *ba*-declarative.

(ii) Rising *ba*-declaratives set preconditions on the input contexts: that $\textbf{info}(I)$ is in the speaker's input commitment set before a rising *ba*-declarative is uttered.

(30) A rising *ba*-declarative can be felicitously uttered only if the input context satisfies:
$\textbf{info}(I) \in \text{DC}_{s,i}$

(iii) I argue that the contribution of the rising intonation ↑ is to add $\textbf{info}(I)$ to the addressee's projected commitment set, following Malamud and Stephenson (2015)'s and Jeong (2018)'s treatment of tag-questions and inquisitive rising declaratives. I assume that ↓ does not make extra contribution to a *ba*-declarative (i.e. the default prosody), while a rising *ba*-declarative is marked.

(31) Contribution of ↑:
Add **info**(I) to $\mathrm{DC}^*_{a,i}$ when uttering a *ba*-declarative.

The context-updating conventions of rising *ba*-declaratives are formalized as follows.

(32) Context Updating Conventions of rising *ba*-declaratives:

  a. Context preconditions:
  info(I) $\in \mathrm{DC}_{s,i}$

  b. Updates:
  (i). $\mathrm{DC}^*_{s,o} = \mathrm{DC}^*_{s,i} \cup \{\mathbf{info}(I)\}$
  (ii). $\mathrm{DC}^*_{a,o} = \mathrm{DC}^*_{a,i} \cup \{\mathbf{info}(I)\}$
  (iii). $\mathrm{T}_o = \mathrm{PUSH}(I, \mathrm{T}_i)$
  (iv). $\mathrm{CG}^*_o = \mathrm{CG}^*_i \cup I$

Let us now consider how the proposal in (32) applies to our CAUGHT A COLD scenario (15), repeated in (33).

(33) [CAUGHT A COLD: The temperature drops significantly.]
A$_1$: duo chuan dian, buran hui ganmao.
A$_1$: *Put on more clothes, otherwise you will get a cold.*
B$_1$: bie danxin, wo buhui.
B$_1$: *Don't worry, I won't.*
[After a few days, B sneezes.]
A$_2$: ganmao le **ba**↑/?↓
A$_2$: *(As I've told you), you got a cold **ba**!*

Before *you got a cold **ba**↑* is uttered, the informative content is already in speaker's commitment set.

(34) K$_1$: The context state after A$_1$: initial commitment

	A$_1$: *You will get a cold*	B: *No, I won't.*	A: *You got a cold **ba**↑*
T	$\langle I \rangle$		
DC$_a$	**info**(I)		
DC$^*_a$			
DC$_b$			
DC$^*_b$			
CG	cg_1		
CG*	$\{cg_1 \cup I\}$		

Next, B express opposite view towards the issue of whether she will get a cold. Here a conversational crisis appears: the issue becomes impossible to resolve if both interlocutors refuse to retract their commitments. The updates of this step in shown in K$_2$.

(35) K_2: The context state after B_1: disagreements

	A₁: You will get a cold	*B: No, I won't.*	*A: You got a cold* **ba↑**
T	$\langle I \rangle$		
DC_a	**info**(I)		
DC_a^*			
DC_b		**info**($\neg I$)	
DC_b^*			
CG	cg_1	$cg_2 = cg_1$	
CG*	$\{cg_1 \cup I\}$	$\{\cancel{cg_1 \cup I \cup \neg I}\}$	

Lastly, when A_2 is uttered, the informative content of the issue is added to both the speaker's and the addressee's projected commitment sets. At this step, the old issue is brought up to the Table again. The speaker A uses the rising tone to extract B's commitment to **info**(I).

(36) K_3: The context state after A_2: updates of a rising *ba*-declarative

	A₁: You will get a cold	*B: No, I won't.*	*A: You got a cold* **ba↑**
T	$\langle I \rangle$		$\langle I \rangle$
DC_a	**info**(I)		
DC_a^*			**info**(I)
DC_b		**info**($\neg I$)	
DC_b^*			**info**(I)
CG	cg_1	$cg_2 = cg_1$	$cg_3 = cg_1$
CG*	$\{cg_1 \cup I\}$	$\{\cancel{cg_1 \cup I \cup \neg I}\}$	$\{cg_1 \cup I\}$

5. Conclusion

In this paper, I have shown that the felicity conditions of *ba*-declaratives are significantly affected by the intonation they bear, which extends the empirical landscape of *ba*-attached sentences. I have argued that the seemingly contradictory effects of rising *ba*-declaratives can be reconciled if we consider the effect of rising intonation and the effect of the particle *ba* separately. I have proposed that adding *ba* to a declarative expresses the speaker's tentative commitments, and the function of the rising tone is to extract the addressee's commitments.

For future research, there are a couple of questions untested: as mentioned in §1, *ba* can also be attached to morpho-syntactically marked interrogatives (Chao 1968; Han 1995, see also Yuan (2020) for an account of *ba*-interrogatives). Is there any commonality among the uses of *ba* in declaratives and interrogatives? Is a unified analysis possible? Another issue concerns with the analysis of the rising intonation: it is worth investigating if we can extend our current analysis of rising intonation to other discourse particles in Mandarin (but see Yang and Wiltschko 2016 for similar observations on the phonetic and semantic properties of Mandarin particle *ha*).

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