The Syntax and Semantics of Mandarin Discourse Adverbs *dique* and *zhende*

1 Introduction

In daily language use, most utterances we make are not isolated from their preceding and following utterances. Utterances are always connected with each other to form a longer unit of language, i.e., discourse. In order to make the discourse coherent and easy to understand, we use a class of lexical expressions to connect individual utterances and 'glue' them together. These expressions are often referred to as discourse markers.[1] This study is concerned with two Mandarin discourse markers, *dique* 'indeed' and *zhende* 'really', which are illustrated below:

(1) *Dique*, Li chuguo le.
indeed Li go-abroad PERF
'Indeed, Li went abroad.'

(2) *Zhende*, Li chuguo le.
really Li go-abroad PERF
'Really, Li went abroad.'

Dique and *zhende* do not contribute to the propositional content of the utterance. (1), (2) and (3) have the same propositional content and the same truth conditions. (3) is true if and only if Li went abroad, and so are (1) and (2).

(3) Li chuguo le.
Li go-abroad PERF
'Li went abroad.'

What *dique* and *zhende* do is to convey information about how the utterance containing them is related to the prior discourse, and hence these two adverbs belong to the group of discourse markers. As a first approximation, *dique* in (1) suggests that this utterance is an agreement with the previous utterance. As in (4), B uses *dique* to show his agreement with A's utterance.

(4) A: Li chuguo le.
Li go-abroad PERF
'Li went abroad.'
B: *Dique*, ta chuguo le.
Indeed he go-abroad PERF
'Indeed, he went abroad.'

[1] A variety of terms are used to refer to this class of expressions, including discourse marker (Schiffrin, 1987), pragmatic marker (Fraser, 1996; Brinton, 1996), discourse particle (Schourup, 1985), connective (Blakemore, 1987), etc. The term 'discourse marker' and 'discourse particle' are both frequently used. We did not adopt the term 'discourse particle' for the adverbs discussed in this study (i.e., *dique* and *zhende*), since they are polysyllabic and contain significant phonetic content, and thus do not fit the label 'particle'.

Zhende works differently. (2) suggests that the speaker is trying to convince the addressee of the proposition p 'Li went abroad', that is, the addressee does not quite believe p in the previous discourse. For example, in (5), by using *zhende*, the speaker C shows that he disagrees with B's utterance and agrees with A's utterance.

(5) A: Li chuguo le.
Li go-abroad PERF
'Li went abroad.'
B: Bu keneng!
no possible
'Impossible!'
C: *Zhende*, ta chuguo le.
really he go-abroad PERF
'Really, he went abroad.'

Deleting the adverbs in (4) and (5) does not change the propositional content of the utterances in which they occur. However, without *dique* and *zhende*, the utterances become isolated from the prior discourse, and it sounds like B in (4) and C in (5) are speaking to themselves rather than responding to the previous utterances.

In this study, we explore the semantic contribution of the discourse adverbs *dique* and *zhende* within the dynamic semantics framework. *Dique* and *zhende* convey information about the previous discourse, and requirements on the previous discourse are generally referred to as presuppositions. Therefore, we propose an analysis of *dique* and *zhende* as presupposition triggers, which modify assertions and questions by contributing to the presuppositional contents. *Dique* and *zhende* differ from each other in the content of the presupposition, which means that (1) and (2) are felicitous in different contexts. This presuppositional analysis is also supported by the behaviors of the discourse adverbs in embedded sentences.

The paper is structured as follows: Section 2 presents informal characterizations of the behaviors of *dique* and *zhende* in assertions, showing that these adverbs impose different presuppositions on the previous discourse. Section 3 presents formal definitions for *dique* and *zhende* in assertions. A dynamic approach to presupposition is adopted and a binary presupposition operator is used to formalize the presuppositions triggered by these two adverbs. Section 4 examines the semantics of *dique* and *zhende* in questions. Section 5 investigates the behaviors of the adverbs when they are embedded, which provides evidence for the analysis of *dique* and *zhende* as presupposition triggers. Based on the semantic analysis, we analyze *dique* and *zhende* as TP adjuncts and propose that the DP position preceding *dique*/*zhende* is a topic position in Section 6. Section 7 reports a naturalness rating experiment on assertions containing *dique* and *zhende*, which verifies the conclusions about the specific presuppositions that *dique* and *zhende* introduce. Section 8 concludes this study.

2 *Dique* and *zhende* in assertions

Xu (2009) claims that the function of both *dique* and *zhende* is to confirm old information and they are thus interchangeable. However, this fails to explain the contrast in (6). In (6), since A has asserted p 'It rained last night', p is old information to B. Xu (2009) would predict that B could

use either *dique* or *zhende* to confirm this old information. However, it is infelicitous for B to use *zhende* to confirm p, indicating that there must be some differences between *dique* and *zhende*.

(6) A: Zuowan xiayu le.
last-night rain PERF
'It rained last night.'
(B heard the sound of rain last night, so he knows that it rained.)
B: *Dique*/#*Zhende* xiayu le.
indeed/really rain PERF
'It indeed rained.'/'#It really rained.'

In order to explain the contrast in (6), we can look at words similar to *dique*/*zhende* in other languages. The meaning of *zhende* is similar to that of English *really*. Romero & Han (2004) argue that *really* has a meaning identical to the semantic operator VERUM. The VERUM operator is an abstract operator manifested as the VERUM focus, which is a contrastive focus on the verb or the complementizer. For example, in (7-a), the speaker uses focal stress on the verb *did* to emphasize that the proposition 'It rained' is true. This focus signals the presence of the VERUM operator. Romero & Han (2004) claim that both *really*(p) and VERUM(p) are used to assert that the speaker is certain that p should be added to the Common Ground (Stalnaker, 1978). For example, both sentences in (7) indicate that the speaker has a high level of certainty that 'It rained last night' should be a common belief shared by everyone.

(7) a. It DID rain.
b. It really rained.

This analysis cannot explain why *zhende* is infelicitous in (6). Suppose *zhende* has the same semantics as *really*, both indicating the speaker's certainty that p should be a common belief. In (6), A is committed to p 'It rained last night', and A's assertion can be understood as inviting B to accept p as a common belief. Thus, it would be appropriate for B to use *zhende* to show his acceptance of p as a common belief. It is not clear why the use of *zhende* turns out to be infelicitous.

Xu's (2009) study on *dique*/*zhende* and Romero & Han's (2004) study of English *really* provide no satisfactory answer for the distinction between *dique* and *zhende*. In this section, we will present a semantic analysis that accounts for the differences between these two adverbs. We show that *dique* and *zhende* add different presuppositions to the same assertion, which explains the contrast in (6).

2.1 *Dique* in assertions

The intuition about assertions containing *dique* is summarized in (8).

(8) Assertions containing *dique* indicate a confirmation of old information.

(8) can be illustrated by (9). Native speakers report an intuition that B in (9) is confirming the old information 'Li went abroad' by using *dique*. 'Li went abroad' is old information since it has been asserted by A in the prior context, and now B is showing his agreement with this old information.

(9) A: Li chuguo le.
Li go-abroad PERF
'Li went abroad.'
B: *Dique*, ta chuguo le.
indeed he go-abroad PERF
'Indeed, he went abroad.'

It is noteworthy that B cannot start a conversation with the assertion *Dique, Li chuguo le* 'Indeed, Li went abroad'. Without A's utterance, B's use of *dique* would be infelicitous, as shown in (10). In other words, *dique* requires that its prejacent 'Li went abroad' is old information.

(10) B: #*Dique*, Li chuguo le.
indeed Li go-abroad PERF
'Indeed, Li went abroad.'
(Here, # means 'infelicitous as discourse initial')

In contrast, a bare assertion like (11) is felicitous at the beginning of a conversation. (11) does not have the meaning of confirmation. B is simply introducing a piece of new information.

(11) B: Li chuguo le.
Li go-abroad PERF
'Li went abroad.'

The intuition in (8) motivates our proposal that the adverb *dique* is a presupposition trigger. We will first illustrate the presuppositions of *dique* in detail, and then show how these presuppositions give rise to the meaning of confirmation and agreement.

An assertion containing *dique*, represented as *dique*(p), imposes the following requirements on the previous context:

(12) Requirements of *dique*(p) on the previous context:
a. p has been suggested by some discourse participant x.
b. All of the discourse participants believe that p has been suggested, and recognize that they share this belief.

Let us illustrate these requirements with examples. The requirement in (12-a) is illustrated by (13). Here, Li's utterance indicates that some discourse participant must have predicted the rain on 1^{st} June some time before 1^{st} June. In other words, the proposition 'It rains on 1^{st} June' must have been suggested by some participant in the previous context. That participant can be the speaker (i.e., Li) or the addressee (i.e., Li's wife), or someone else (such as the weather reporter). If no one had predicted that it would rain on 1^{st} June, Li's use of *dique* would be infelicitous.

(13) Context: On 1^{st} June, waking up in the morning, Li looks outside and says to his wife:
Li: Waimian *dique* xiayu le.
outside indeed rain PERF
'It indeed rains outside.'

In some cases, it appears that *dique* can be used without the proposition p having been overtly mentioned in the previous context. For example, (14) can be used as the very first utterance of a

lecture about the relationship between parents and children. The proposition p is supposed to be known by all discourse participants as part of their world knowledge and common sense. Therefore, p is old information, which renders the use of *dique* felicitous.

(14) *Dique*, fumu dou ai tamen de haizi.
indeed parents all love they GEN children
'Indeed, parents all love their children.'

If p has been suggested by some discourse participant x, as stated in (12-a), then it follows that x is biased towards p.[2] If x is not biased towards p in the prior context, *dique* cannot be used. For instance, if A's utterance in (9) was 'Li didn't go abroad' (A is committed to $\neg p$), as in (15), the use of *dique* would be infelicitous, since 'Li went abroad' has not been suggested.

(15) A: Li mei chuguo.
Li not go-abroad
'Li didn't go abroad.'
B: #*Dique*, ta chuguo le.
indeed he go-abroad PERF
'Indeed, he went abroad.'

On the other hand, epistemic modal adverbs, such as *keneng* and *yexu* 'probably', indicate that the speaker is biased towards p. Thus, B's use of *dique* in (16) is felicitous.

(16) A: Li keneng chuguo le.
Li probably go-abroad PERF
'Li probably went abroad.'
B: *Dique*, ta chuguo le.
indeed he go-abroad PERF
'Indeed, he went abroad.'

The first requirement of *dique*(p) in (12-a) is also shown by the fact that *dique* can occur in answers to biased questions, but not in answers to unbiased questions. Among the various types of questions in Mandarin Chinese, *ba* questions (marked by the particle *ba* in sentence-final position) and *shi bu shi* questions (with *shi bu shi* 'be not be' located in front of the predicate) are compatible with answers containing *dique*:

(17) A: Ta xihuan tian shi ba?
he like sweet food Q
'Does he like sweet food? (I suppose he does)'
B: *Dique*, ta xihuan tian shi.
indeed he like sweet food
'Indeed, he likes sweet food.'

(18) A: Ta shi bu shi xihuan tian shi?
he be not be like sweet food
'Is it the case that he likes sweet food?'

[2]The notion of bias will be formalized in Section 3.2.

B: *Dique*, ta xihuan tian shi.
indeed he like sweet food
'Indeed, he likes sweet food.'

Ba questions (Li & Thompson, 1981: 309-310; Liu et al., 2004: 788) and *shi bu shi* questions (Liu et al., 2004: 792) are considered requests for confirmation, where the speaker is biased towards the affirmative answer. *Dique* is felicitous in answers to these questions because the first requirement of *dique*(p) is met: the proposition p (i.e., the affirmative answer) has been suggested by some participant (the questioner) in the previous context.

Other types of questions in Mandarin, such as A-not-A questions, can only be used in a neutral context and indicate no bias (Li & Thompson, 1981: 550). *Dique* is banned in answers to A-not-A questions, since the questioner is not biased toward the affirmative answer:

(19) A: Ta xi-bu-xihuan tian shi?
he like-not-like sweet food
'Does he like sweet food or not?'
B: #*Dique*, ta xihuan tian shi.
indeed he like sweet food
'Indeed, he likes sweet food.'

The second requirement of *dique*(p) in (12-b) is that all of the discourse participants believe that the proposition p has been suggested and that they all recognize that they share this belief. For example, in (13), Li and his wife both believe that p 'It rains on 1^{st} June' has been suggested, and they both recognize that they share this belief. If the speaker Li is not aware of the suggestion of p, or if Li does not believe that his wife believes that p has been suggested, Li's use of *dique* will be infelicitous. In the above two cases, 'It rains on 1^{st} June' is new information to at least one discourse participant, and the speaker Li will choose a bare assertion *Xiayu le* 'It rains' to inform his wife about this new information (new to Li himself or new to his wife).

In summary, *dique*(p) has two requirements on the prior context, as in (12), repeated here as (20).

(20) Requirements of *dique*(p) on the previous context:
a. The proposition p has been suggested by some discourse participant x.
b. All of the discourse participants believe that p has been suggested and recognize that they share this belief.

The analysis of *dique* as a presupposition trigger is in line with the intuition in (8), i.e., assertions containing *dique* indicate a confirmation of old information. This confirmation meaning results from the combination of the asserted content and the presupposition of *dique*. A bare assertion p encodes the speaker's commitment to p, and *dique* triggers a presupposition that p has already been suggested by some participant x. Thus, the combination of p with *dique* indicates the speaker's confirmation of the old p and the speaker's agreement with the participant who suggested p.

2.2 *Zhende* in assertions

The adverb *zhende* 'really' is derived from the morpheme *zhen* 'truth/reality'. This morpheme gives rise to the intuition that *zhende* is used to emphasize truth, as described in (21).

(21) By using *zhende* in an assertion, the speaker is emphasizing that the propositional content of the assertion is true.

(21) can be illustrated with the example in (22). Intuitively, the speaker C in (22) uses *zhende* to emphasize that the proposition p 'it rained last night' is true. C finds it necessary to emphasize the truth of p, because B refused to believe p even though p has been asserted by A. C is emphasizing the truth of p in order to convince B of p.

(22) A: Zuowan xiayu le.
last-night rain PERF
'It rained last night.'
B: Meiyou xiayu.
not rain
'It didn't rain.'
C (to B): *Zhende*, zuowan xiayu le.
really last-night rain PERF
'Really, it rained last night.'

C's use of *zhende* in (22) would be unacceptable if no one had suggested p, as in (23). Here, 'It rained last night' is new information and must be expressed without *zhende*.

(23) B: Zuowan meiyou xiayu.
last-night not rain
'It didn't rain last night.'
C (to B): #*Zhende*, zuowan xiayu le.
really last-night rain PERF
'Really, it rained last night.'

If B believed p initially, or began to believe p after hearing A's suggestion, it would also be infelicitous for C to use *zhende*, as in (24). This is because all of the discourse participants believe p, and thus there is no need for C to emphasize the truth of p.

(24) A: Zuowan xiayu le.
last-night rain PERF
'It rained last night.'
B: Shide, xiayu le.
yes rain PERF
'Yes, it rained.'
C (to B): #*Zhende*, zuowan xiayu le.
really last-night rain PERF
'Really, it rained last night.'

The intuition in (21) motivates our proposal that *zhende* triggers two presuppositions: First, the prejacent of *zhende* is old information. Second, some participant is uncommitted to the old information. Due to the uncommitment of the participant, the speaker of *zhende* finds it necessary to emphasize the truth of the old information. We will now illustrate the presuppositions of *zhende* in more detail, and show how these presuppositions lead to the meaning of 'emphasis on truth'.

An assertion containing *zhende*, represented as *zhende*(p), imposes three requirements on the previous discourse.

(25) Requirements of *zhende*(p) on the previous context:

a. The proposition p has been suggested by some discourse participant x.
b. All of the discourse participants believe that p has been suggested, and recognize that they share this belief.
c. Some participant y remains uncommitted to p even after knowing that p has been suggested by x.

As can be seen, the first two requirements of *zhende*(p) are the same as the two requirements of *dique*(p), while the third requirement of *zhende*(p) is not shared by *dique*(p).

Like *dique*(p), *zhende*(p) requires that p has been suggested in the prior context and all discourse participants recognize that they all believe that p has been suggested. For example, in (26), the first two requirements of *zhende*(p) are both met: the proposition p 'It rained last night' has been suggested by A and every participant recognizes this.

(26) A: Zuowan xiayu le.
last-night rain PERF
'It rained last night.'
(B is not sure. He opens the window and sees that the ground is wet.)
B: Zuowan *zhende* xiayu le.
last-night really rain PERF
'It really rained last night.'

If no one had suggested p (the first requirement of *zhende*(p) is not met) or if B did not recognize that A had suggested p (the second requirement of *zhende*(p) is not met), it would be infelicitous to use *zhende*. In (27), 'It rained last night' is new information to B and should be expressed without *zhende*.

(27) Context: B opens the window in the morning and sees that the ground is wet.
B: #Zuowan *zhende* xiayu le.
last-night really rain PERF
'It really rained last night.'

Besides the requirements shared with *dique*(p), *zhende*(p) imposes a third requirement on the prior context: *zhende*(p) requires that some discourse participant y remains uncommitted to the proposition p even after recognizing that p has been suggested by x. For example, in (26), A is the suggester x and B is the participant y. Initially, B was not committed to p 'It rained last night' even though he recognized that A had suggested p. After checking the evidence, B commits himself to p using an assertion modified by *zhende*. If B was already committed to p before A's suggestion, the use of *zhende* would be unacceptable, as in (6), repeated here as (28). This is because all the

discourse participants were committed to p, and thus the third requirement of *zhende*(p) is not met.

(28) A: Zuowan xiayu le.
last-night rain PERF
'It rained last night.'
(B heard the sound of rain last night, so he knows that it rained.)
B: #*Zhende* xiayu le.
really rain PERF
'It really rained.'

The analysis of *zhende* as a presupposition trigger is consistent with the intuition in (21), i.e., assertions containing *zhende* indicate an emphasis on truth. The meaning of 'emphasis on truth' results from the interaction between the meaning of a bare assertion and the presupposition of *zhende*. A bare assertion p indicates the speaker's commitment to p, and *zhende* presupposes that p has been suggested by some participant x but y remains uncommitted to p. Thus, the combination of p with *zhende* indicates that the speaker is emphasizing the truth of p in order to convince y of p.

2.3 Summary

This section provided informal characterizations of the semantics of *dique* and *zhende* in assertions. *Dique* adds to the assertion of p a presupposition that p has previously been suggested. Since a bare assertion of p encodes the speaker's commitment to p, *dique*(p) indicates the speaker's confirmation of the old information p. The adverb *zhende* triggers another presupposition that p has been suggested but some participant y remains uncommitted to p. Since a bare assertion of p encodes the speaker's commitment to p, *zhende*(p) indicates that the speaker is emphasizing the truth of p in order to convince y of p.[3]

3 Formal analysis of *dique* and *zhende*

This section provides formal definitions for *dique* and *zhende* in assertions. As discussed in Section 2, both *dique* and *zhende* are presupposition triggers. In order to capture the presuppositions triggered by *dique* and *zhende*, we adopt a binary presupposition operator from Beaver & Krahmer (2001) and define this operator within the dynamic semantics framework.

3.1 Definition of presupposition and the transplication operator

In this subsection, we introduce the definition of presupposition in dynamic semantics, and adopt the transplication operator from Beaver & Krahmer (2001) to characterize presuppositions. The definition of the transplication operator is modified so that it applies to dynamic semantics.

In truth-conditional semantics, presuppositions are understood as definedness conditions (Strawson, 1950). That is, when the presupposition of a sentence is not true, the sentence is not defined, i.e., has no truth value. This definition of presupposition was challenged during 1970s, when the problem of presupposition projection began to gain attention (Langendoen & Savin, 1971;

[3] Our semantic analysis correctly predicts that *zhende*, which triggers a more informative presupposition, is preferred to *dique* when the presuppositions of *zhende* are satisfied. See Appendix A.

Kartunnen, 1973, 1974). The presuppositions of the embedded clause are projected up to the matrix clause in some cases but blocked from projecting up in others. The truth-conditional approach cannot make correct predictions about projection behaviors in every case. It was at this time that dynamic semantics took up the issue and provided a new definition for presupposition.

In dynamic semantics, an utterance denotes an update of the context. Presuppositions are thus regarded as requirements on the context. This means that a presupposition must be evaluated in a context that already entails this presupposition. For example, when the assertion *John's cat is hungry* is made, the context *c* (a set of possible worlds) is updated with the proposition 'John's cat is hungry'. Since this proposition carries a presupposition that John has a unique cat, the update of *c* with 'John's cat is hungry' is defined only if *c* entails that John has a unique cat, i.e., when *c* is a subset of the worlds in which John has a unique cat, as shown in (29).

(29) *c* + 'John's cat is hungry' is defined iff $c \subseteq \{w$: John has a unique cat in $w\}$
(Heim 1992: 186)

To be more precise, the context *c* in this example refers to the context set (Stalnaker, 1978), which denotes the set of possible worlds in which all the common beliefs of the discourse participants are true. Thus, (29) says that the assertion *John's cat is hungry* requires that every discourse participant believes that John has a unique cat. However, to say that a presupposition must be satisfied in the context set is an over-simplification. It makes wrong predictions for complex sentences like (30). Unlike the assertion *John's cat is hungry*, (30) does not require that every participant takes for granted that John has a cat, since 'John has a cat' is already asserted in the first conjunct.

(30) John has a cat and John's cat is always hungry.

Karttunen (1974) solves this problem by proposing that presuppositions are not always evaluated in the same context, i.e., the context set. Instead, presuppositions are evaluated in different contexts, and presuppositions always need to be satisfied in the local context, as defined in (31). For example, the second conjunct in (30) is evaluated with respect to the local context, which is created by updating the context set with the content of the first conjunct. Since the local context already entails that John has a unique cat, the presupposition of the second conjunct is satisfied and thus the entire sentence does not carry this presupposition.

(31) Context X satisfies the presupposition of S just in case the presuppositions of each of the constituent sentences in S are satisfied by the local context. (Karttunen 1974: 187)

The definition of presupposition in (31) will be adopted in this study. In order to formalize (31), we adopt a binary presupposition operator '$\langle\ \rangle$' from Beaver & Krahmer (2001), which is called *transplication*.

(32) If ϕ, π are formulae, then $\phi_{\langle\pi\rangle}$ is a formula. (Beaver & Krahmer 2001: 150)

In (32), π is an elementary presupposition of ϕ. Elementary presuppositions are presuppositions that are triggered in the lexicon. For example, the English verb *regret* triggers an elementary presupposition that the proposition which is regretted is true. Thus, (33) can be represented by a formula $q_{\langle p\rangle}$, where p is the proposition 'Mary is sad', and q is 'Bill regrets that Mary is sad'.

(33) *Bill regrets that Mary is sad.* (Beaver & Krahmer 2001: 150)

Based on the definition of presupposition in (31), transplication is defined as in (34).[4] If the formula π contains an unbound context variable C_i, then an assignment function $g[\mathrm{C}_{local}/\mathrm{C}_i]$ assigns the local context C_{local} to the variable C_i. The presupposition $[\![\pi]\!]^{g[\mathrm{C}_{local}/\mathrm{C}_i]}$ is evaluated with respect to a certain set of possible worlds σ and needs to be satisfied in σ.

(34) Let σ be a set of possible worlds. $[\![\phi_{\langle\pi\rangle}]\!]$ is defined with respect to σ iff $\sigma \subseteq [\![\pi]\!]^{g[\mathrm{C}_{local}/\mathrm{C}_i]}$.

The value of σ varies in different environments. For instance, we will see that in matrix clauses, C_{local} is the utterance context C_u, and σ refers to the context set of the utterance context, as shown in (35). We will also see in Section 5 that the values of C_{local} and σ are different from (35) when $\phi_{\langle\pi\rangle}$ occurs in embedded clauses.

(35) When $\phi_{\langle\pi\rangle}$ occurs in a matrix clause, $[\![\phi_{\langle\pi\rangle}]\!]$ is defined with respect to $\mathrm{CS}(\mathrm{C}_u)$ iff $\mathrm{CS}(\mathrm{C}_u) \subseteq [\![\pi]\!]^{g[\mathrm{C}_u/\mathrm{C}_i]}$, where $\mathrm{CS}(\mathrm{C}_u)$ is the context set of the utterance context.

In the next two subsections, transplication is adopted to characterize the presuppositions triggered by *dique* and *zhende*.

3.2 Formal definition of *dique* in assertions

As discussed in Section 2.1, *dique*(p) imposes two requirements on the previous discourse. First, *dique*(p) requires that p has been suggested by some discourse participant x. Here, 'p is suggested by x' means that x indicates that x is biased towards p. In order to model the epistemic state of the participant x, we will introduce the subjective probability distribution from Davis et al. (2007). Davis et al. (2007) model a proposition (i.e., a set of possible worlds) as a probability distribution:

(36) A probability distribution for a countable 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.)

(Davis et al. 2007: 77)

In order to use a probability distribution to model participants' epistemic states, Davis et al. (2007) take the proposition $\mathrm{Dox}_{\mathrm{A,C}}$ (a set of possible worlds that are doxastically accessible for A in the context C, see Heim, 1992) as representing the epistemic state of the participant A in context C. Then, Davis et al. (2007) conditionalize a uniform distribution, as in (37).

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

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

[4] Beaver & Krahmer (2001) provide a truth-conditional definition for transplication. That is, $[\![\phi_{\langle\pi\rangle}]\!]$ is defined only if π is true. Here, we redefine the definition of transplication in the dynamic semantics framework so that it can account for the problem of presupposition projection. See Section 5 for more discussions about presupposition projection.

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 $P(p) = 0$.

(Davis et al. 2007: 77)

This distribution is adopted to define a function $\mathrm{Cred}_{\mathrm{A,c}}$ (Cred for 'credence'), as in (38). The function $\mathrm{Cred}_{\mathrm{A,c}}$ maps any proposition p to the participant A's degree of belief in p in context C.

(38) The subjective probability distribution for a participant A in context C:
$\mathrm{Cred}_{\mathrm{A,c}} = P(\text{-}|\mathrm{Dox}_{\mathrm{A,c}})$
in which P is a uniform distribution over W, i.e., $P(\{w\}) = \frac{1}{|W|}$ for all $w \in W$.
(Modified from Davis et al. 2007: 77)

Following (37) and (38), a participant A's degree of belief in a proposition p in the context C will be like (39). (39) says that A's degree of belief in p equals to the conditional probability of p given $\mathrm{Dox}_{\mathrm{A,c}}$.

(39)
$$\mathrm{Cred}_{\mathrm{A,c}}(\mathrm{p}) = P(\mathrm{p}|\mathrm{Dox}_{\mathrm{A,c}}) = \frac{P(\mathrm{p} \cap \mathrm{Dox}_{\mathrm{A,c}})}{P(\mathrm{Dox}_{\mathrm{A,c}})}$$

Let us see how (39) characterizes different belief states. When the discourse participant A is committed to the proposition p, it means that all the worlds in $\mathrm{Dox}_{\mathrm{A,c}}$ are worlds in which p is true, i.e., $\mathrm{p} \cap \mathrm{Dox}_{\mathrm{A,c}} = \mathrm{Dox}_{\mathrm{A,c}}$. Thus, $\mathrm{Cred}_{\mathrm{A,c}}$ maps the proposition p to the number 1. When A is committed to ¬p, no worlds in $\mathrm{Dox}_{\mathrm{A,c}}$ are worlds in which p is true. $P(\mathrm{p} \cap \mathrm{Dox}_{\mathrm{A,c}})$ is 0, and thus $\mathrm{Cred}_{\mathrm{A,c}}$ maps p to 0. A lack of bias on A's part for or against p can be interpreted as half of the worlds in $\mathrm{Dox}_{\mathrm{A,c}}$ being worlds in which p is true. Thus, in this case, $\mathrm{Cred}_{\mathrm{A,c}}$ maps p to 0.5:

(40)
$$\mathrm{Cred}_{\mathrm{A,c}}(\mathrm{p}) = P(\mathrm{p}|\mathrm{Dox}_{\mathrm{A,c}}) = \frac{P(\mathrm{p} \cap \mathrm{Dox}_{\mathrm{A,c}})}{P(\mathrm{Dox}_{\mathrm{A,c}})} = \frac{\frac{1}{2}P(\mathrm{Dox}_{\mathrm{A,c}})}{P(\mathrm{Dox}_{\mathrm{A,c}})} = 0.5$$

We adopt the function $\mathrm{Cred}_{x,\mathrm{c}}$ to model the epistemic states of participants. The first requirement of dique(p) says that x is biased towards p, which can be formalized as '$\mathrm{Cred}_{x,\mathrm{c}}(p) > 0.5$':

(41) A discourse participant x is biased towards p in the context C iff $\mathrm{Cred}_{x,\mathrm{c}}(p) > 0.5$.

The second requirement of *dique*(p) is that all discourse participants believe that p has been suggested and they recognize that they share this belief. We will see how this requirement is captured by the definition of presupposition presented in Section 3.1.

Using transplication, the semantics of *dique* in assertions is defined as (42) on the basis of (41). In (42), p is a proposition of type $\langle s,t\rangle$, and *dique* is a modifier of type $\langle\langle s,t\rangle,\langle s,t\rangle\rangle$.

(42) $[\![\textit{dique}]\!] = \lambda p.p_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{c}_i}(p)>0.5\rangle}$
where $x \in \mathrm{D}(\mathrm{c}_i)$ and $\mathrm{D}(\mathrm{c}_i)$ is a set of discourse participants in the context c_i.

The semantics of *dique* consists of two parts. The first part, $\lambda p.p$, says that *dique* takes in a proposition p and returns the same proposition p. The second part is the formula within the angle brackets, i.e., $\exists x.\mathrm{Cred}_{x,\mathrm{c}_i}(p) > 0.5$. This says that the combination of *dique* with p triggers a presupposition that some participant x is biased towards p in a certain context c_i. Therefore, the

modified proposition *dique*(p) carries a presupposition that p has been suggested in C_i, as in (43).

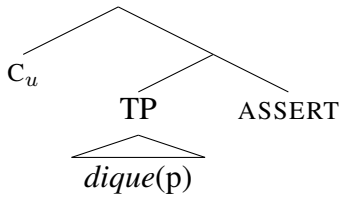
(43) $[\![\textit{dique}(\mathrm{p})]\!] = \mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$

When the two requirements of *dique* are met, an assertion containing *dique* functions just like a bare assertion. Following Stalnaker (1978), we assume that an assertion updates the Common Ground (hereafter, the CG). The CG is a set of propositions representing the common beliefs shared by all discourse participants, and the context set is the set of worlds in which all of the propositions in the CG are true. Thus, an assertion of p indicates an update of the context set with p, as defined in (44). The assertive operator ASSERT is construed as a function that takes in a propositional argument and returns a function from contexts to contexts (i.e., a CCP, see Heim, 1982). The '+' is the notation for assertive update, and $\mathrm{CS}(\mathrm{C}) + p$ denotes the intersection of the context set $\mathrm{CS}(\mathrm{C})$ with the set of p-worlds. That is, an assertion of p updates the context set CS(C), and the updated context set is the set of possible worlds in which p is true.

(44) $[\![\textsc{assert}]\!] = \lambda p.\lambda \mathrm{C}.\mathrm{CS}(\mathrm{C}) + p$

Now, we are ready to see the syntactic structure of assertions containing *dique* and the corresponding semantic composition. Following Speas (2004), Tenny (2006) and Hara (2006, 2008), we assume that a context has a syntactic representation. The utterance context of an assertion is represented as C_u, and thus an assertion containing *dique* has the structure in (45):

(45)



Following (45), the assertive operator ASSERT combines with the modified proposition *dique*(p) to form an assertion containing *dique*. The semantics of an assertion containing *dique* consists of the two parts shown in (46): 1) $\lambda \mathrm{C}.\mathrm{CS}(\mathrm{C}) + \mathrm{p}$, a CCP of type $\langle \mathrm{C}, \mathrm{C}\rangle$, which denotes the meaning of the assertion; 2) $\exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p}) > 0.5$, which formalizes the presupposition added by *dique*.

(46) $[\![\textsc{assert}(\textit{dique}(\mathrm{p}))]\!]$
$= [\lambda p.\lambda \mathrm{C}.\ \mathrm{CS}(\mathrm{C}) + p](\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle})$
$= \lambda \mathrm{C}.\mathrm{CS}(\mathrm{C}) + \mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$

According to (46), $\textsc{assert}(\textit{dique}(\mathrm{p}))$ is defined if $\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$ is defined. Following the definition of presupposition in (34), $\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$ is defined with respect to a set of possible worlds σ only if the presupposition $[\![\exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p}) > 0.5]\!]^{g[\mathrm{C}_{local}/\mathrm{C}_i]}$ is satisfied in σ. As can be seen from (45), the only context and the nearest context to TP (i.e., the modified proposition *dique*(p)) is the utterance context C_u. Thus, C_u is the local context C_{local} for the computation of the presupposition carried by *dique*(p):

(47) $[\![\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}]\!]$ is defined with respect to σ iff σ satisfies $[\![\exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p}) > 0.5]\!]^{g[\mathrm{C}_{local}/\mathrm{C}_i]}$, i.e., when σ satisfies $[\![\exists x.\mathrm{Cred}_{x,\mathrm{C}_u}(\mathrm{p}) > 0.5]\!]$.

Now we need to know the value of σ, i.e., what set of possible worlds satisfies this presupposition. An assertion containing *dique* updates the utterance context set $\textsc{cs}(\mathrm{C}_u)$ with p, and thus the presupposition carried by p is evaluated in $\textsc{cs}(\mathrm{C}_u)$ and must be satisfied in it. That is, σ refers to $\textsc{cs}(\mathrm{C}_u)$. We intensionalize the propositional content of the presupposition, $\exists x.\mathrm{Cred}_{x,\mathrm{C}_u}(\mathrm{p}) > 0.5$, as a set of possible worlds, hence it can be entailed by σ:

(48) $[\![\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}]\!]$ is defined with respect to $\textsc{cs}(\mathrm{C}_u)$ iff $\textsc{cs}(\mathrm{C}_u) \subseteq \lambda w.\exists x.\mathrm{Cred}_{x,\mathrm{C}_u}(\mathrm{p}) > 0.5$ at w.

This amounts to saying that an assertion containing *dique* is defined only if all of the discourse participants in the utterance context share the belief that p has been suggested in this context, which captures the second requirement of *dique*(p). When $\textsc{assert}(\textit{dique}(\mathrm{p}))$ is defined, the context set $\textsc{cs}(\mathrm{C}_u)$ is assertively updated with p.

Let us illustrate how (46) works with (9), repeated here as (49). The assertion containing *dique* used by B indicates an update of $\textsc{cs}(\mathrm{C}_u)$ with the proposition p 'Li went abroad' ($\textsc{cs}(\mathrm{C}_u)$ + p). This entails that the speaker commits himself to p, and presupposes that p has been suggested by someone (A, in this case), as characterized by the formula $\mathrm{Cred}_{\mathrm{A},\mathrm{C}_u}(\mathrm{p}) > 0.5$. The combination of the assertion meaning and the presupposition results in the indication that B is confirming the old information p and showing his agreement with A.

(49) A: Li chuguo le.
'Li went abroad.'
B: *Dique*, ta chuguo le.
'Indeed, he went abroad.'

In short, the adverb *dique* modifies a proposition p by introducing a presupposition that p has been suggested.

3.3 Formal definition of *zhende*

As discussed in Section 2.2, *zhende*(p) imposes three requirements on the previous discourse: First, p has been suggested. Second, all the discourse participants share the belief that p has been suggested. Third, there is some discourse participant y who remains uncommitted to p. This requirement can be formalized based on the concept of 'public belief' (Gunlogson, 2003). In Gunlogson's (2003) model, each discourse participant is associated with a set of propositions that can be taken as their public beliefs (PB), as defined in (50). The CG is then taken to be the intersection of the public beliefs of the participants in that context, i.e., $\textsc{cg}(\mathrm{C}) = \mathrm{PB}_\mathrm{A}(\mathrm{C}) \cap \mathrm{PB}_\mathrm{B}(\mathrm{C})$.

(50) Let PB_A and PB_B be sets of propositions representing the public beliefs of A and B, respectively, with respect to a discourse in which A and B are the participants, where:
a. p is a public belief of A iff 'A believes p' is a mutual belief of A and B
b. p is a public belief of B iff 'B believes p' is a mutual belief of A and B
(Gunlogson 2003: 42)

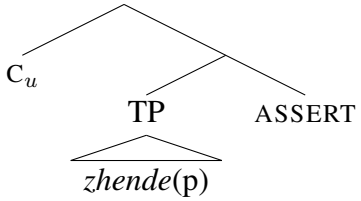
The third requirement amounts to saying that p is not in the public beliefs of y. The semantics of *zhende* in assertions is defined as in (51). Here, *zhende* is a modifier of type $\langle\langle s,t\rangle,\langle s,t\rangle\rangle$.

(51) $[\![\textit{zhende}]\!] = \lambda p.p_{\langle(\exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(p)>0.5)\wedge(\exists y.p\notin\mathrm{PB}_y(\mathrm{C}_i))\rangle}$
where x, $y \in \mathrm{D}(\mathrm{C}_i)$, $x \neq y$ and $\mathrm{D}(\mathrm{C}_i)$ is the set of discourse participants in the context C_i.

The semantics of *zhende* has two parts. The first part, $\lambda p.p$, says that *zhende* takes in a proposition p and returns the same proposition p. The second part, $(\exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(p) > 0.5) \wedge (\exists y.p \notin \mathrm{PB}_y(\mathrm{C}_i))$, says that the combination of *zhende* with a proposition p triggers two presuppositions: First, the proposition p has been suggested by x in a certain context C_i ($\exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(p) > 0.5$). Second, some participant y is uncommitted to p in the context C_i ($\exists y.p \notin \mathrm{PB}_y(\mathrm{C}_i)$).

We now illustrate the semantic composition of an assertion containing *zhende*. An assertion containing *zhende* has the structure in (52):

(52)



The force head ASSERT takes in the modified set *zhende*(p) to yield a CCP, i.e., an assertion containing *zhende*, as shown in (53).

(53) $[\![\textsc{assert}(\textit{zhende}(\mathrm{p}))]\!]$
$= [\lambda p.\lambda \mathrm{C}.\mathrm{CS}(\mathrm{C}) + p](\mathrm{p}_{\langle(\exists x.\mathrm{Cred}_{x,\mathrm{c}_i}(\mathrm{p})>0.5)\wedge(\exists y.\mathrm{p}\notin\mathrm{PB}_y(\mathrm{c}_i))\rangle})$
$= \lambda \mathrm{C}.\mathrm{CS}(\mathrm{C}) + \mathrm{p}_{\langle(\exists x.\mathrm{Cred}_{x,\mathrm{c}_i}(\mathrm{p})>0.5)\wedge(\exists y.\mathrm{p}\notin\mathrm{PB}_y(\mathrm{c}_i))\rangle}$

ASSERT(*zhende*(p)) is defined if $\mathrm{p}_{\langle(\exists x.\mathrm{Cred}_{x,\mathrm{c}_i}(\mathrm{p})>0.5)\wedge(\exists y.\mathrm{p}\notin\mathrm{PB}_y(\mathrm{c}_i))\rangle}$ is defined. According to the structure in (52) and the definition of presupposition, $\mathrm{p}_{\langle(\exists x.\mathrm{Cred}_{x,\mathrm{c}_i}(\mathrm{p})>0.5)\wedge(\exists y.\mathrm{p}\notin\mathrm{PB}_y(\mathrm{c}_i))\rangle}$ is defined only if the context set $\mathrm{CS}(\mathrm{C}_u)$ satisfies the presupposition $(\exists x.\mathrm{Cred}_{x,\mathrm{C}_u}(\mathrm{p}) > 0.5) \wedge (\exists y.\mathrm{p} \notin \mathrm{PB}_y(\mathrm{C}_u))$, as shown in (54). This amounts to saying that an assertion containing *zhende* is defined only if all the discourse participants in the utterance context share the belief that p has been suggested but some participant remains uncommitted to p in this context.

(54) $\mathrm{p}_{\langle(\exists x.\mathrm{Cred}_{x,\mathrm{c}_i}(\mathrm{p})>0.5)\wedge(\exists y.\mathrm{p}\notin\mathrm{PB}_y(\mathrm{c}_i))\rangle}$ is defined with respect to $\mathrm{CS}(\mathrm{C}_u)$ iff
$\mathrm{CS}(\mathrm{C}_u) \subseteq \lambda w.(\exists x.\mathrm{Cred}_{x,\mathrm{C}_u}(\mathrm{p}) > 0.5 \text{ at } w) \wedge (\exists y.\mathrm{p} \notin \mathrm{PB}_y(\mathrm{C}_u) \text{ at } w)$

Let us illustrate (53) with (22), repeated below as (55). C's use of the assertion modified by *zhende* indicates an update of the context set with p 'It rained last night' ($\mathrm{CS}(\mathrm{C}_u)$ + p) and entails C's commitment to p. This assertion also carries two presuppositions. First, p has been suggested by someone, i.e., A, as shown by $\mathrm{Cred}_{\mathrm{A},\mathrm{C}_u}(\mathrm{p}) > 0.5$. Second, some participant, i.e., B, remains uncommitted to p, as shown by $\mathrm{p} \notin \mathrm{PB}_{\mathrm{B}}(\mathrm{C}_u)$. Since C is committed to p but B is not, the assertion modified by *zhende* indicates that C is emphasizing the truth of p in order to convince B of p.

(55) A: Zuowan xiayu le.
'It rained last night.'
B: Meiyou xiayu.
'It didn't rain.'
C (to B): *Zhende*, zuowan xiayu le.
'Really, it rained last night.'

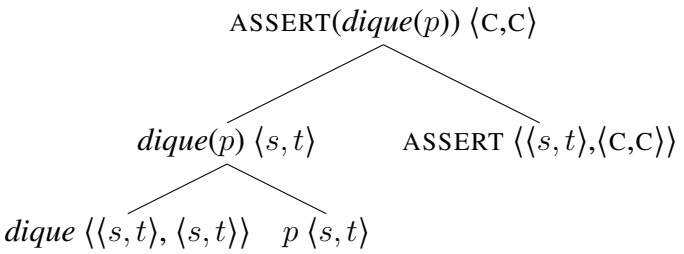
In short, the adverb *zhende* modifies the proposition p by introducing a presupposition that p has previously been suggested, but some participant remains uncommitted to p.

3.4 Semantic computation

Based on the semantic definitions given above, we specify the order of semantic computation involving assertions containing *dique* and *zhende* in this section. This order of semantic computation gives rise to the syntactic analysis in Section 6.

The semantic computation of an assertion containing *dique* or *zhende* is executed based on the typed tree in (56). This computation is carried out in two steps. Take *dique* as an example. First, *dique* combines with a proposition p to yield *dique*(p). *Dique* must first attach to the proposition, because *dique* introduces a presupposition that a proposition has been suggested. If *dique* were not combined with p at the beginning, *dique* would not be able to introduce this presupposition. Second, the assertive operator ASSERT combines with *dique*(p) to yield a CCP. The combination of *dique*(p) and ASSERT imposes presuppositions on the previous context of the assertion.

(56)



We could imagine an alternative order of computation whereby the ASSERT operator combines with p first, and then ASSERT(p) combines with *dique* to yield *dique*(ASSERT(p)). But if the operators combined in this order, the proposition p would be embedded and thus would not be directly associated with *dique*. In this case, *dique* could not introduce the presupposition that p has been suggested. Therefore, we do not adopt this way of computation.

In the semantic computation, *dique* or *zhende* first attaches to a proposition p, and then the assertive operator combines with *dique*(p) or *zhende*(p).

3.5 Section summary

In this section, we adopted the transplication operator to provide formal definitions for *dique* and *zhende* within the dynamic semantics framework. *Dique* imposes a restriction on the domain of the CCP that the proposition p to which *dique* attaches has been suggested. *Zhende* additionally places a restriction on the domain of the CCP that at least one discourse participant remains uncommitted to p. The order of semantic computation involving assertions containing *dique*/*zhende* gives rise to the syntactic structure to be presented in Section 6.

4 *Dique* and *zhende* in questions

The previous sections discussed the semantics of *dique* and *zhende* in assertions. In this section, we move on to examine the semantics of *dique* and *zhende* in questions. It is shown that the

adverbs *dique* and *zhende*, as presupposition triggers, make constant contributions in assertions and questions. We will examine the behaviors of *dique* in questions and provide a formal definition for it in Section 4.1, and then discuss the semantics of *zhende* in questions in Section 4.2.

4.1 *Dique* in questions

As discussed in Section 2.1, an assertion containing *dique* indicates a confirmation of old information. A question containing *dique* has a similar intuitive meaning, as in (57).

(57) Questions containing *dique* indicate a confirmation of old questions.

(57) can be illustrated by the example in (58). Here, the question 'Where did you go last Friday?' has been asked by Mr. Li in the prior context, and now Mrs. Li is using *dique* to show her agreement with Mr. Li that this question should be asked.

(58) Context: Mr. and Mrs. Li just had a meeting with the teacher of their son Xiaoli. The couple are now talking with Xiaoli:

Mr. Li: Shang zhouwu ni qu naer le?
last Friday you go where PERF
'Where did you go last Friday?'

Mrs. Li: *Dique*, ni qu naer le?
indeed you go where PERF
'Indeed, where did you go?'

Motivated by the intuitive meaning of confirmation, we analyze *dique* used in questions as a presupposition trigger. A question Q containing *dique*, represented as *dique*(Q), imposes two requirements on the previous context:

(59) Requirements of *dique*(Q) on the previous context:

a. The question Q has been asked by some discourse participant x.

b. All of the discourse participants believe that Q has been asked, and recognize that they share this belief.

For example, in (58), the question Q 'Where did you go last Friday?' has been asked by Mr. Li in the prior context, and thus the first requirement of *dique*(Q) in (59-a) is met. Without Mr. Li's question, Mrs. Li's use of *dique* would be infelicitous, as shown in (60). Here, Q is a new question and should be expressed without *dique*.

(60) Context: Mr. and Mrs. Li just had a meeting with the teacher of their son Xiaoli. The couple are now talking with Xiaoli:

Mrs. Li: #*Dique*, shang zhouwu ni qu naer le?
indeed last Friday you go where PERF
'Indeed, where did you go last Friday?'

The second requirement of *dique*(Q) in (59-b) is that all of the discourse participants believe that the question Q has been asked and that they all recognize that they share this belief. For instance, Mrs. Li's use of *dique* in (58) suggests that Mrs. Li recognizes that this question has been

asked. If Mr. Li asked 'Where did you go last Friday?' but Mrs. Li does not recognize that Mr. Li did so, Mrs. Li's use of *dique* will also be infelicitous.

These requirements explain why questions containing *dique* indicate a confirmation of old questions. In (58), Mrs. Li's question with *dique* indicates that she is seeking an answer to Q 'Where did you go last Friday' (the meaning of a bare question) and presupposes that Q has already been asked by someone, i.e., Mr. Li (the meaning of *dique*). The combination results in an indication that Mrs. Li is showing her agreement with Mr. Li in finding an answer to the question Q.

Having illustrated the presuppositions triggered by *dique*, we are now ready to see the formal analysis of *dique*. As discussed above, *dique*(Q) requires that the question Q has been asked and all the discourse participants share the belief that Q has been asked. These requirements can be formalized based on the notions of Question-Under-Discussion (QUD, Roberts, 1996) and 'public question' (Davis, 2011). Roberts (1996) extends Stalnaker's (1978) possible-world model by proposing a set of questions called the Question Under Discussion along with the CG. The QUD is a set of questions representing contextually salient issues and it is temporarily ordered. The question at the topmost level of the QUD is the question that was asked most recently, and it is also the most immediate question under discussion. Davis (2011) decomposes the QUD into public questions (PQ) of different discourse participants. Each discourse participant is associated with an ordered stack of questions that can be taken as their public questions (PQ).

(61) If $\mathrm{PQ}_x(\mathrm{C})[0]$ = Q, then x is committed to seeking a resolution to question Q.
Notation: $\mathrm{PQ}_x(\mathrm{C})[0]$ indicates the 0th (topmost) element in the stack, i.e., the most immediate public question for x in C. Q is a set of propositions. (Davis 2011: 193)

The QUD is the intersection of the public questions of all the discourse participants in that context, as defined in (62-a). (62-a) says that the i-th element in the QUD of a set of discourse participants equals to the intersection of the i-th public question of each participant in the set. That is to say, if every participant has the question Q at the top of his public questions, then Q is the most immediate question in the QUD of these discourse participants, as shown in (62-b).

(62) a. For a set of discourse participants D(C) = $\{x_1, x_2, \ldots x_n\}$:
$\mathrm{QUD}_{\mathrm{D}}(\mathrm{C})[i] = \mathrm{PQ}_{x_1}(\mathrm{C})[i] \cap \mathrm{PQ}_{x_2}(\mathrm{C})[i] \cap \ldots \cap \mathrm{PQ}_{x_n}(\mathrm{C})[i]$, for all i, C.
b. $\mathrm{QUD}_{\{x,y\}}(\mathrm{C})[0] = \mathrm{PQ}_x(\mathrm{C})[0] \cap \mathrm{PQ}_y(\mathrm{C})[0]$. (Modified from Davis 2011: 205)

Following Roberts (1996) and Davis (2011), we assume that a question Q indicates an update of the speaker's public questions with Q, as defined in (63). The question operator Q is a function from a set of propositions to a context change potential. The '$\oplus$' is the update function which adds a set of propositions onto the top of the public questions. $\mathrm{PQ}_{\mathrm{spkr}}(\mathrm{C}) \oplus Q$ is a context that resembles C, except that $\mathrm{PQ}_{\mathrm{spkr}}(\mathrm{C}) \oplus Q$ contains the set Q at the topmost level of $\mathrm{PQ}_{\mathrm{spkr}}(\mathrm{C})$, i.e., $\mathrm{PQ}_{\mathrm{spkr}}(\mathrm{C})[0] = Q$. (63) says that when a question Q is asked, the set of propositions Q has been added onto the top of the speaker's public questions, i.e., the speaker is committed to solving Q.

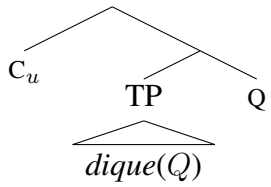
(63) $[\![\mathrm{Q}]\!] = \lambda Q.\lambda \mathrm{C}.\ \mathrm{PQ}_{\mathrm{spkr}}(\mathrm{C}) \oplus Q$

Using the notions introduced above, the two requirements of *dique*(Q) amount to saying that the question Q is at the topmost level of some discourse participant's public questions. The semantics of *dique* in questions is defined as in (64). Here, Q is a set of propositions of type $\langle\langle s,t\rangle,t\rangle$, and *dique* is a modifier of type $\langle\langle\langle s,t\rangle,t\rangle,\langle\langle s,t\rangle,t\rangle\rangle$.

(64) $[\![\textit{dique}]\!] = \lambda Q.Q_{\langle \exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=Q\rangle}$
where $x \in \mathrm{D}(\mathrm{C}_i)$ and $\mathrm{D}(\mathrm{C}_i)$ is a set of discourse participants in the context C_i.

We are now ready to see the semantic composition of a question containing *dique*. The utterance context of a question is C_u, and thus a question containing *dique* has the structure in (65).

(65)



Suppose that Q denotes a set of propositions $\{\mathrm{p}, \mathrm{q}\}$. Following (65), the force head Q takes in the modified set *dique*($\{\mathrm{p}, \mathrm{q}\}$) to form a CCP, i.e., a question containing *dique*. As summarized in (66), a question containing *dique* encodes the meaning of a question, as characterized by the formula $\lambda \mathrm{C}.\mathrm{PQ}_{\mathrm{spkr}}(\mathrm{C}) \oplus \{\mathrm{p}, \mathrm{q}\}$, and carries a presupposition that this question has been asked, as shown by the formula $\exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0] = \{\mathrm{p}, \mathrm{q}\}$.

(66) $[\![\mathrm{Q}(\textit{dique}(\{\mathrm{p}, \mathrm{q}\}))]\!]$
$= [\lambda Q.\lambda \mathrm{C}.\mathrm{PQ}_{\mathrm{spkr}}(\mathrm{C}) \oplus Q](\{\mathrm{p}, \mathrm{q}\}_{\langle \exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=\{\mathrm{p},\mathrm{q}\}\rangle})$
$= \lambda \mathrm{C}.\ \mathrm{PQ}_{\mathrm{spkr}}(\mathrm{C}) \oplus \{\mathrm{p}, \mathrm{q}\}_{\langle \exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=\{\mathrm{p},\mathrm{q}\}\rangle}$

The formula Q(*dique*($\{\mathrm{p}, \mathrm{q}\}$)) is defined if $\{\mathrm{p}, \mathrm{q}\}_{\langle \exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=\{\mathrm{p},\mathrm{q}\}\rangle}$ is defined. According to the definition of presupposition in (34) and the structure in (65), $\{\mathrm{p}, \mathrm{q}\}_{\langle \exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=\{\mathrm{p},\mathrm{q}\}\rangle}$ is defined only if the presupposition $\exists x.\mathrm{PQ}_x(\mathrm{C}_u)[0] = \{\mathrm{p}, \mathrm{q}\}$ is satisfied in the context set $\mathrm{CS}(\mathrm{C}_u)$, as shown in (67). That is, a question containing *dique* is defined if every discourse participant in the utterance context share the belief that this question has been asked in the utterance context. When defined, the speaker's public questions is updated with this question.

(67) $[\![\{\mathrm{p}, \mathrm{q}\}_{\langle \exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=\{\mathrm{p},\mathrm{q}\}\rangle}]\!]$ is defined with respect to $\mathrm{CS}(\mathrm{C}_u)$ iff
$\mathrm{CS}(\mathrm{C}_u) \subseteq \lambda w.\exists x.\mathrm{PQ}_x(\mathrm{C}_u)[0] = \{\mathrm{p}, \mathrm{q}\}$ at w.

The working of (66) can be illustrated with (58), repeated here as (68). Suppose that the question Q 'Where did you go last Friday?' has three answers p, q and r. The question containing *dique* used by Mrs. Li indicates that Mrs. Li adds Q onto the topmost level of her public questions ($\mathrm{PQ}_{\mathrm{Mrs.Li}}(\mathrm{C}_u) \oplus \{\mathrm{p}, \mathrm{q}, \mathrm{r}\}$). At the same time, this question presupposes that some participant, i.e., Mr. Li, also added this question onto the top of his public questions, as shown by $\mathrm{PQ}_{\mathrm{Mr.Li}}(\mathrm{C}_u)[0] = \{\mathrm{p}, \mathrm{q}, \mathrm{r}\}$. Since the question Q is at the top of both participants' public questions, Q is at the topmost level of the QUD ($\mathrm{QUD}(\mathrm{C}_u)[0] = \mathrm{PQ}_{\mathrm{Mr.Li}}(\mathrm{C}_u)[0] \cap \mathrm{PQ}_{\mathrm{Mrs.Li}}(\mathrm{C}_u)[0]$). In other words, both Mr. Li and Mrs. Li are committed to seeking an answer to 'Where did you go last Friday?'. This accounts for the intuition that questions containing *dique* indicate the speaker's confirmation of the old question and the speaker's agreement with the intention of the previous asker.

(68) Context: Mr. and Mrs. Li are talking with Xiaoli:
Mr. Li: Shang zhouwu ni qu naer le?
'Where did you go last Friday?'
Mrs. Li: *Dique*, qu naer le?
'Indeed, where did you go?'

As can be seen from the above discussions, the contribution of *dique* is consistent between assertions and questions. The semantics of *dique* in assertions and questions are summarized in (69). The adverb *dique* modifies a proposition by introducing a presupposition that this proposition has been suggested, and modifies a set of propositions by introducing a presupposition that this set has been added onto some participant's public questions.

(69) The semantics of *dique*:

a. $[\![\textit{dique}]\!] = \lambda p.p_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(p)>0.5\rangle}$ if the sister constituent of *dique* denotes a semantic object of type $\langle s,t\rangle$.

b. $[\![\textit{dique}]\!] = \lambda Q.Q_{\langle \exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=Q\rangle}$ if the sister constituent of *dique* denotes a semantic object of type $\langle\langle s,t\rangle,t\rangle$.
where $x \in \mathrm{D}(\mathrm{C}_i)$ and $\mathrm{D}(\mathrm{C}_i)$ is the set of discourse participants in the context C_i.

4.2 *Zhende* in questions

Section 2.2 mentioned an intuition that an assertion containing *zhende* indicates an emphasis on truth. A question containing *zhende* also indicates an emphasis on truth, but in a slightly different way from assertions containing *zhende*, as stated in (70).

(70) By using *zhende* in a question, the speaker is emphasizing that the question should truly be solved.

(70) can be illustrated by (71). By using a question containing *zhende*, the speaker Mrs. Li is emphasizing that the addressee Xiaoli should truly solve the question Q 'Where did you go last Friday?' asked by Mr. Li. Mrs. Li finds it necessary to emphasize this, because she believes that the answer Xiaoli provided does not solve the question Q.

(71) Context: Mr. and Mrs. Li just had a meeting with the teacher of their son Xiaoli. The couple are talking with Xiaoli:

Mr. Li: Shang zhouwu ni qu naer le?
last Friday you go where PERF
'Where did you go last Friday?'

Xiaoli: Wo zai xuexiao.
I at school
'I was at school.'

Mrs. Li: Women zhidao ni bu zai xuexiao. *Zhende*, ni qu naer le?
we know you not at school really you go where PERF
'We know that you were not at school. Really, where did you go?'

Motivated by this intuition, we analyze *zhende* used in questions as a presupposition trigger. A question Q containing *zhende*, represented as *zhende*(Q), imposes the following three requirements on the previous context.

(72) Requirements of *zhende*(Q) on the previous context:

a. The question Q has been asked by some discourse participant x.

b. All of the discourse participants believe that Q has been asked, and recognize that

they share this belief.

c. Some discourse participant y has provided an answer to Q, but the speaker of *zhende*(Q) believes that this answer does not solve Q.

Like *dique*(Q), *zhende*(Q) requires that Q has been asked in the prior context and all of the discourse participants share the belief that Q has been asked. For example, in (71), the first two requirements of *zhende*(Q) are both met: the question Q 'Where did you go last Friday?' has been asked by Mr. Li and every participant recognizes this. If no one had asked the question Q, it would be infelicitous to use *zhende*. In (73), Q is a new question and should be expressed without *zhende*:

(73) Context: Mr. and Mrs. Li just had a meeting with the teacher of their son Xiaoli. After the meeting, Mrs. Li asks Xiaoli:

Mrs. Li: #*Zhende*, shang zhouwu ni qu naer le?
really last Friday you go where PERF
'Really, where did you go last Friday?'

In addition to the requirements shared with *dique*(Q), *zhende*(Q) imposes a third requirement on the prior context: *zhende*(Q) requires that some participant y has provided an answer to Q, but that the speaker of *zhende*(Q) believes this answer does not solve Q. As in (71), Mrs. Li believes that Xiaoli's answer does not solve the question Q asked by Mr. Li. If Mrs. Li believed that Xiaoli's answer solved the question, as in (74), the use of *zhende* would also be unacceptable. This is because the third requirement of *zhende*(Q) would not be met.

(74) Context: Mr. and Mrs. Li just had a meeting with the teacher of their son Xiaoli. The couple are talking with Xiaoli:

Mr. Li: Shang zhouwu ni qu naer le?
last Friday you go where PERF
'Where did you go last Friday?'
Xiaoli: Wo qu wangba le.
I go internet-bar PERF
'I went to an internet bar.'
Mrs. Li: Mingbai le. #*Zhende*, ni qu naer le?
understand PERF really you go where PERF
'I see. Really, where did you go?'

These requirements of *zhende*(Q) account for the intuition in (70), i.e., questions containing *zhende* indicate an emphasis on truth. In (71), the question containing *zhende* indicates that Mrs. Li is seeking an answer to the question Q (the meaning of a bare question) and presupposes that Mrs. Li did not take the answer provided by Xiaoli as a true resolution to Q (the meaning of *zhende*). The combination results in an indication that Mrs. Li is emphasizing that Xiaoli should provide an answer that truly solves this question.

Now, let us turn to the formal analysis of *zhende* in questions. As discussed above, *zhende*(Q) has a requirement that some participant y has committed himself to some proposition p in order to answer Q but the speaker of *zhende*(Q) believes that p does not solve Q. Given that the speaker is asking the question Q and the speaker believes that p does not solve Q, p cannot be a possible answer to Q. In other words, y has committed himself to a proposition that is not a member of the

set denoted by Q, and the set of y's public beliefs thus has no intersection with the denotation of Q, $\mathrm{PB}_y(\mathrm{C}_i) \cap Q = \varnothing$.

The semantics of *zhende* in questions is defined in (75). According to (75), *zhende* is a modifier which takes in a set of propositions Q and returns a modified set $Q_{\langle(\exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=Q)\wedge(\exists y.\mathrm{PB}_y(\mathrm{C}_i)\cap Q=\varnothing)\rangle}$. This modified set carries a presupposition that Q has been asked by some discourse participant x ($\exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0] = Q$) and another participant y does not solve Q ($\exists y.\mathrm{PB}_y(\mathrm{C}_i) \cap Q = \varnothing$).

(75) $[\![\textit{zhende}]\!] = \lambda Q.Q_{\langle(\exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=Q)\wedge(\exists y.\mathrm{PB}_y(\mathrm{C}_i)\cap Q=\varnothing)\rangle}$

According to (75), *zhende* combines with a set of propositions (e.g., $\{\mathrm{p}, \mathrm{q}\}$) to form a modified set, which is then taken by the question force head to yield a question containing *zhende*:

(76) $[\![\mathrm{Q}(\textit{zhende}(\{\mathrm{p}, \mathrm{q}\}))]\!] = \lambda \mathrm{C}.\ \mathrm{PQ}_{\mathrm{spkr}}(\mathrm{C}) \oplus \{\mathrm{p}, \mathrm{q}\}_{\langle(\exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=\{\mathrm{p},\mathrm{q}\})\wedge(\exists y.\mathrm{PB}_y(\mathrm{C}_i)\cap\{\mathrm{p},\mathrm{q}\}=\varnothing)\rangle}$

$\mathrm{Q}(\textit{zhende}(\{\mathrm{p}, \mathrm{q}\}))$ is defined if $\{\mathrm{p}, \mathrm{q}\}_{\langle(\exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=\{\mathrm{p},\mathrm{q}\})\wedge(\exists y.\mathrm{PB}_y(\mathrm{C}_i)\cap\{\mathrm{p},\mathrm{q}\}=\varnothing)\rangle}$ is defined, and this is defined only if the context set $\mathrm{CS}(\mathrm{C}_u)$ satisfies the presupposition $(\exists x.\mathrm{PQ}_x(\mathrm{C}_u)[0] = \{\mathrm{p}, \mathrm{q}\}) \wedge (\exists y.\mathrm{PB}_y(\mathrm{C}_u) \cap \{\mathrm{p}, \mathrm{q}\} = \varnothing)$, as in (77). That is, a question containing *zhende* is defined only if all the discourse participants in the utterance context share the belief that this question has been asked but some participant has failed to solve this question in the utterance context.

(77) $\{\mathrm{p}, \mathrm{q}\}_{\langle(\exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=\{\mathrm{p},\mathrm{q}\})\wedge(\exists y.\mathrm{PB}_y(\mathrm{C}_i)\cap\{\mathrm{p},\mathrm{q}\}=\varnothing)\rangle}$ is defined with respect to $\mathrm{CS}(\mathrm{C}_u)$ iff $\mathrm{CS}(\mathrm{C}_u) \subseteq \lambda w.(\exists x.\mathrm{PQ}_x(\mathrm{C}_u)[0] = \{\mathrm{p}, \mathrm{q}\}$ at $w) \wedge (\exists y.\mathrm{PB}_y(\mathrm{C}_u) \cap \{\mathrm{p}, \mathrm{q}\} = \varnothing$ at $w)$.

To illustrate how (76) works, let us return to the example (71), repeated here as (78). Suppose that the question Q 'Where did you go last Friday?' has three answers p, q and r. Mrs. Li's use of the question modified by *zhende* indicates the update of Mrs. Li's public questions with the question Q ($\mathrm{PQ}_{\mathrm{Mrs.Li}}(\mathrm{C}_u) \oplus \{\mathrm{p}, \mathrm{q}, \mathrm{r}\}$) and presupposes that some discourse participant (here, Mr. Li) has asked the question Q ($\mathrm{PQ}_{\mathrm{Mr.Li}}(\mathrm{C}_u)[0] = \{\mathrm{p}, \mathrm{q}, \mathrm{r}\}$) but some other participant (Xiaoli) has failed to solve this question ($\mathrm{PB}_{\mathrm{Xiaoli}}(\mathrm{C}_u) \cap \{\mathrm{p}, \mathrm{q}, \mathrm{r}\} = \varnothing$). Since Mrs. Li is seeking an answer to the question Q and Xiaoli has failed to solve it, the question containing *zhende* indicates that Mrs. Li is emphasizing that Xiaoli should truly solve this question.

(78) Context: Mr. and Mrs. Li just had a meeting with the teacher of their son Xiaoli. The couple are talking with Xiaoli:

Mr. Li: Shang zhouwu ni qu naer le?
'Where did you go last Friday?'

Xiaoli: Wo zai xuexiao.
'I was at school.'

Mrs. Li: Women zhidao ni bu zai xuexiao. *Zhende*, ni qu naer le?
'We know that you were not at school. Really, where did you go?'

As can be seen from the above discussion, the contribution of *zhende* is consistent between assertions and questions, as in (79). The adverb *zhende* modifies a proposition p by introducing a presupposition that p has been suggested by x but some participant y remains uncommitted to p. *Zhende* modifies a set of propositions Q by introducing a presupposition that some discourse participant x is committed to solving Q but some participant y has failed to solve Q.

(79) The semantics of *zhende*:

a. $[\![\textit{zhende}]\!] = \lambda p.p_{\langle(\exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(p)>0.5)\wedge(\exists y.p\notin\mathrm{PB}_y(\mathrm{C}_i))\rangle}$ if the sister constituent of *zhende* denotes a semantic object of type $\langle s,t\rangle$.

b. $[\![\textit{zhende}]\!] = \lambda Q.Q_{\langle(\exists x.\mathrm{PQ}_x(\mathrm{C}_i)[0]=Q)\wedge(\exists y.\mathrm{PB}_y(\mathrm{C}_i)\cap Q=\varnothing)\rangle}$ if the sister constituent of *zhende* denotes a semantic object of type $\langle\langle s,t\rangle,t\rangle$.
where x, $y \in \mathrm{D}(\mathrm{C}_i)$, $x \neq y$, and $\mathrm{D}(\mathrm{C}_i)$ is the set of discourse participants in context C_i.

4.3 Summary

The semantic contributions of *dique* and *zhende* in questions parallel the ones in assertions. *Dique* adds to a question Q a presupposition that Q has already been asked, and *zhende* adds another presupposition that Q has been asked and some participant has failed to solve Q.

5 *Dique* and *zhende* as presupposition triggers: Evidence from embedded clauses

The previous sections proposed an analysis of *dique* and *zhende* as presupposition triggers. One well-recognized feature of presuppositions is their projection behavior. Presuppositions can be projected up from certain embeddings but are blocked from projecting from others. Therefore, these embedding environments can be adopted to test if *dique* and *zhende* are truly presupposition triggers. In this section, we will examine the behaviors of *dique* and *zhende* when embedded under attitude verbs (Section 5.1) and conditional structures (Section 5.2). It is shown that the meanings contributed by *dique* and *zhende* are projected up in the same way as presuppositions, supporting the proposal that these adverbs are presupposition triggers.

5.1 *Dique* and *zhende* embedded under attitude verbs

This section discusses the behaviors of *dique* and *zhende* when they are embedded under attitude verbs. In these environments, the presuppositions triggered by *dique* and *zhende* are relativized to the attitude-holder. Typical presupposition triggers exhibit the same behaviors as *dique*/*zhende* when embedded under attitude verbs. We also demonstrate how the dynamic approach to presupposition presented in Section 3 captures the meaning of embedded presuppositions.

The adverbs *dique* and *zhende* can be embedded under propositional attitude verbs like *xiangxin* 'believe', as in (80):[5]

(80) Zhang xiangxin Li *dique* chuguo le.
Zhang believe Li indeed go-abroad PERF
'Zhang believes that Li indeed went abroad.'

Before showing the behaviors of the adverbs embedded under attitude verbs, let us have a look at the behaviors of typical presupposition triggers embedded under attitude verbs. As observed by Kartunnen (1973, 1974), presuppositions embedded under attitude verbs exhibit a particular pattern of projection behavior: If the complement of an attitude verb presupposes p, then the whole

[5]We use *dique* as an example. *Zhende* has the same behaviors as *dique* when embedded under attitude verbs.

sentence containing the attitude verb presupposes that the attitude-holder believes p. For example, in (81), the possessive noun phrase *his cello* triggers a presupposition that Patrick owns a cello, and thus (81) carries this presupposition.[6]

(81) Patrick sells his cello. ≫ Patrick has a cello.

When *sells his cello* is embedded under the attitude verb *want*, the presupposition that Patrick owns a cello is not inherited by the whole sentence, as (82) shows:

(82) Patrick wants to sell his cello. ~≫ Patrick has a cello.

(82) presupposes 'Patrick believes that he owns a cello' rather than 'Patrick owns a cello'. This is shown by the fact that (82) can occur in a context like (83). The second clause in (83) carries the presupposition that Patrick believes that he owns a cello, and this presupposition is satisfied by the context created by the first clause. Therefore, the conjunction of these two clauses does not carry the presupposition that Patrick believes that he owns a cello.

(83) Patrick is under the misconception that he owns a cello, and he wants to sell his cello.

In the previous sections, we hypothesized that the adverbs *dique* and *zhende* are presupposition triggers. This hypothesis predicts that *dique* and *zhende* should exhibit the same behaviors as typical presupposition triggers like *his cello* when embedded under attitude verbs. This prediction turns out to be correct. To see this, let us move on to the behaviors of *dique* and *zhende* embedded under attitude verbs. According to our analysis, the assertion containing *dique* in (84) carries a presupposition that the proposition p 'Li went abroad' has been suggested.

(84) Li *dique* chuguo le.
Li indeed go-abroad PERF
'Li indeed went abroad.'
≫ 'Li went abroad' has been suggested.

However, an assertion where *dique* is embedded under an attitude verb, such as (80), repeated here as (85), does not carry this presupposition. The presupposition of (85) is that the attitude-holder Zhang believes that p has been suggested, not that p actually has been suggested.

(85) Zhang xiangxin Li *dique* chuguo le.
Zhang believe Li indeed go-abroad PERF
'Zhang believes that Li indeed went abroad.'
≫ Zhang believes that 'Li went abroad' has been suggested.

This can be shown by the fact that (85) is felicitous in the discourse in (86). The second clause in (86-a) carries the presupposition that Zhang believes that p 'Li went abroad' has been suggested, and this presupposition is satisfied in the local context created by the first clause. Therefore, the conjunction of these two clauses does not carry this presupposition anymore. (86-a) can be used at the beginning of a discourse.

[6] 'A ≫ B' indicates that A presupposes B, and 'A ~≫ B' indicates that A does not presuppose B.

(86) Context: Wu and Zhang are talking about what Li has been up to over the phone, but Zhang cannot hear Wu very clearly due to the bad signal.

a. Zhang wu yiwei Wu shuo Li chuguo le. Zhang xiangxin Li *dique*
Zhang mistake think Wu say Li go-abroad PERF Zhang believe Li indeed
chuguo le.
go-abroad PERF
'Zhang mistakenly thinks that Wu said that Li went abroad. Zhang believes that Li indeed went abroad.'

The presupposition triggered by embedded *dique* is relativized to the attitude-holder. That is, *dique* exhibits the same behaviors as typical presupposition triggers when embedded under attitude verbs. This is correctly predicted by the hypothesis that *dique* is a presupposition trigger.

Now, let us see how the dynamic approach to presupposition captures the projection behaviors of presuppositions triggered by the adverbs. First, we need a semantic analysis for attitude verbs. We adopt the formal definition of attitude verbs from Heim (1992), who proposes that a sentence like (87) is true in a context C if and only if it is raining in every world w that is doxastically accessible for Zhang to C. A world w is doxastically accessible for a participant x to a context C if and only if w is compatible with the beliefs that x holds in C.

(87) Zhang believes that it is raining.

For instance, the relation of doxastic accessibility for Zhang corresponds to the function $\mathrm{Dox}_{\mathrm{Z,C}}$ ('Z' for 'Zhang'), as shown in (88). $\mathrm{Dox}_{\mathrm{Z,C}}$ represents the worlds that are doxastically accessible for Zhang to C. To put simply, $\mathrm{Dox}_{\mathrm{Z,C}}$ represents Zhang's belief worlds in C.

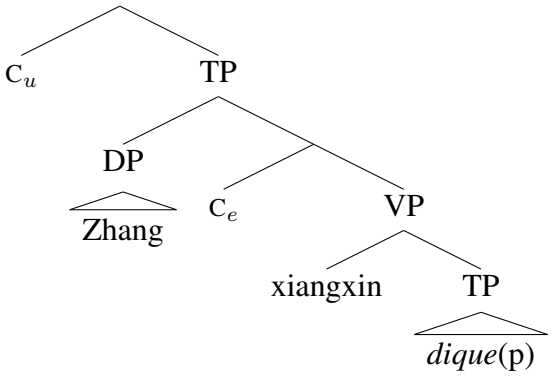
(88) $\mathrm{Dox}_{\mathrm{Z,C}}$= $\{w \mid w$ conforms to what Zhang believes in the context C.$\}$

On the basis of (88), the semantics of *xiangxin* 'believe' is defined as in (89). The attitude verb *xiangxin* takes in a proposition p and an entity x to yield a context change potential λC. $\mathrm{Dox}_{x,\mathrm{C}}$ + p. This says that the utterance of a sentence containing *xiangxin* changes the context by updating x's belief worlds in the context C with the p worlds.

(89) $[\![$*xiangxin*$]\!] = \lambda p.\lambda x.\lambda$C. $\mathrm{Dox}_{x,\mathrm{C}} + p$

We are now ready to see the syntactic structure of sentences containing attitude verbs. Consider (90), which represents the structure of (85):

(90)



As can be seen from (90), there are two contexts in the structure. The utterance context C_u occupies a higher position, and the embedded context C_e is lower. The nearest context to *Li dique chuguo le* (i.e., the modified proposition *dique*(p)) is the embedded context C_e rather than C_u.

Following this structure, the attitude verb *xiangxin* takes in the modified proposition *dique*(p) and the entity Zhang to yield a context change potential, as shown in (91).

(91) $[\![$*xiangxin*(*dique*(p))(Zhang)$]\!]$
$= (\lambda p.\lambda x.\lambda \mathrm{C}.\ \mathrm{Dox}_{x,\mathrm{C}} + p)\ (\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle})(\mathrm{Z})$
$= \lambda \mathrm{C}.\ \mathrm{Dox}_{\mathrm{Z,C}} + \mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$ p = 'Li went abroad'

The formula *xiangxin*(*dique*(p))(Zhang) is defined if $\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$ is defined. According to the definition of presupposition in (34), $\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$ is defined with respect to a set of worlds σ only if σ satisfies the presupposition $[\![\exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p}) > 0.5]\!]^{g[\mathrm{C}_{local}/\mathrm{C}_i]}$. According to (90), the local context C_{local} to the TP (i.e., the modified proposition *dique*(p)) is the embedded context C_e, and thus the context variable C_i is bound by C_e, as shown in (92).

(92) $\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$ is defined with respect to a set of worlds σ iff $\sigma \subseteq \lambda w.\exists x.\mathrm{Cred}_{x,\mathrm{C}_e}(\mathrm{p}) > 0.5$ at w.

Now we need to know what set of worlds satisfies the presupposition $\lambda w.\exists x.\mathrm{Cred}_{x,\mathrm{C}_e}(\mathrm{p}) > 0.5$ at w. According to (91), *xiangxin*(*dique*(p))(Zhang) updates Zhang's belief worlds $\mathrm{Dox}_{\mathrm{Z,C}_u}$ with the proposition p, and thus the presuppositions carried by p are requirements imposed on $\mathrm{Dox}_{\mathrm{Z,C}_u}$ and must be satisfied in $\mathrm{Dox}_{\mathrm{Z,C}_u}$. That is, σ refers to $\mathrm{Dox}_{\mathrm{Z,C}_u}$:

(93) $[\![\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}]\!]$ is defined with respect to $\mathrm{Dox}_{\mathrm{Z,C}_u}$ iff $\mathrm{Dox}_{\mathrm{Z,C}_u} \subseteq \lambda w.\exists x.\mathrm{Cred}_{x,\mathrm{C}_e}(\mathrm{p}) > 0.5$ at w.

(93) says that for (85) to be defined, all the worlds in $\mathrm{Dox}_{\mathrm{Z,C}_u}$ are worlds in which p has been suggested in C_e. In other words, (85) is defined only if the attitude-holder Zhang believes that p has been suggested by some discourse participant in the embedded context C_e. When defined, the set of Zhang's belief worlds in the utterance context is updated with the proposition 'Li went abroad'. This is the correct interpretation of the presuppositions embedded under attitude verbs.

To summarize, when *dique* and *zhende* are embedded under attitude verbs, the presuppositions triggered by these adverbs are relativized to the attitude-holder. This is a typical behavior of presupposition triggers, and is therefore predicted on an analysis whereby *dique* and *zhende* are presupposition triggers.

5.2 *Dique* and *zhende* embedded under conditionals

This section discusses another type of embedding, the embedding of *dique* and *zhende* under conditional structures. We show that the adverbs *dique* and *zhende* exhibit the same behaviors as typical presupposition triggers when embedded under conditionals. We also illustrate how the projection behavior of embedded presuppositions is captured by the dynamic approach to presupposition and the Stalnaker-Lewis-Heim analysis of English conditionals.

Before showing the behaviors of *dique* and *zhende* embedded under Mandarin conditionals, let us have a look at the general behaviors of presupposition triggers embedded under conditionals. In the study of presupposition projection, a conditional structure is considered to be a *filter* (Karttunen,

1973, 1974). This is because the presuppositions of the constituents can only be projected up to the entire conditional under certain conditions. For example, in all three sentences in (94), the phrase *Jack's children* triggers a presupposition that Jack has children. This presupposition is inherited by the entire conditionals in (94-a) and (94-b), but not inherited by the conditional in (94-c).

(94) a. If baldness is hereditary, then all of Jack's children are bald.
b. If all of Jack's children are bald, then baldness is hereditary.
c. If Jack has children, then all of Jack's children are bald. (Karttunen 1973: 177)

Karttunen (1973) summarizes this projection behavior as a filtering condition for conditional structures, as shown in (95). (95) says that the presuppositions of the consequent that are entailed by the antecedent will be blocked from projecting up.

(95) Filtering Condition for a conditional in the form of 'if p, then q':
The presuppositions of the parts will be inherited by the whole conditional unless q presupposes r and p entails r. (Modified from Karttunen 1973: 178)

(95) can be illustrated by (94). In (94-c), the presupposition of the consequent that Jack has children is entailed by the antecedent 'Jack has children', and this presupposition is not inherited by the whole conditional. In (94-a) and (94-b), by contrast, the presupposition that Jack has children is inherited by the whole conditional.

Now, consider what happens when *dique* is embedded in a conditional. We have hypothesized that *dique* is a presupposition trigger. This hypothesis, together with the filtering condition in (95), predicts that the presupposition triggered by *dique* in the antecedent can always be projected up. This is a correct prediction. For example, the antecedent of (96) presupposes that the proposition p 'It will rain tomorrow' has been suggested, and so does the whole conditional.

(96) Ruguo mingtian *dique* xiayu, wo hui dai zai jiali.
if tomorrow indeed rain I will stay at home
'If it indeed rains tomorrow, I will stay at home.'

This is shown by the fact that (96) is felicitous in the discourse in (97), where p has been suggested by A and the presupposition of (96) is therefore satisfied. If the proposition 'It will rain tomorrow' had never been suggested, (96) would be infelicitous.

(97) A: Mingtian hui xiayu.
tomorrow will rain
'It will rain tomorrow.'
B: Ruguo mingtian *dique* xiayu, wo hui dai zai jiali.
if tomorrow indeed rain I will stay at home
'If it indeed rains tomorrow, I will stay at home.'

The hypothesis that *dique* is a presupposition trigger also predicts that when the presupposition triggered by *dique* in the consequent is entailed by the antecedent, this presupposition will not project. This prediction is also correct, as (98) shows. The consequent of (98) presupposes that 'It will rain tomorrow' has been suggested. This presupposition is entailed by the antecedent, and the whole conditional does not carry this presupposition. (98) is felicitous even when 'It will rain tomorrow' has never been mentioned in the prior context.

(98) Ruguo tianqiyubaoyuan shuo mingtian hui xiayu, na mingtian *dique* hui xiayu.
if weather-reporter say tomorrow will rain then tomorrow indeed will rain
'If the weather reporter says that it will rain tomorrow, then it will indeed rain tomorrow.'

In order to capture the projection behavior of presuppositions embedded in conditionals, we adopt the Stalnaker-Lewis-Heim analysis for Mandarin conditionals. According to Stalnaker (1968) and Lewis (1973), a conditional 'if p, q' indicates that the worlds that are most similar to the world of evaluation in which p is true are worlds where q is true. To characterize the similarity among worlds, Heim (1992) adopts a selection function Sim_w, which is defined in (99-a). The function Sim_w maps each proposition p to the set of p-worlds that are maximally similar to w. The definition of conditionals is given in (99-b) on the basis of (99-a). (99-b) says that when a context *c* (i.e., the context set) is updated with a conditional 'if ϕ, ψ', all the ϕ-worlds in *c* that are maximally similar to w are ψ-worlds.

(99) a. $\mathrm{Sim}_w(\mathrm{p}) = \{w' \in \mathrm{W}: w' \in \mathrm{p}$ and w' resembles w no less than any other world in $\mathrm{p}\}$
b. c + if ϕ, $\psi = \{w \in c : \mathrm{Sim}_w(c + \phi) + \psi = \mathrm{Sim}_w(c + \phi)\}$ (Heim 1992: 195-196)

We propose that the word *ruguo* 'if' in Mandarin conditionals represents a conditional operator CON, and CON takes in two propositions (denoted by the antecedent and the consequent) to yield one proposition. Based on Heim's (1992) formalization in (99-a) and (99-b), the semantic definition for the conditional operator is given in (100). CON(p)(q) denotes a set of possible worlds w in the context set, such that all p-worlds maximally similar to w are worlds where q is true.

(100) $[\![\mathrm{CON}]\!] = \lambda p.\lambda q.\ \lambda w \in \mathrm{CS(C)}.[\mathrm{Sim}_w(\mathrm{CS(C)} + p) + q = \mathrm{Sim}_w(\mathrm{CS(C)} + p)]$

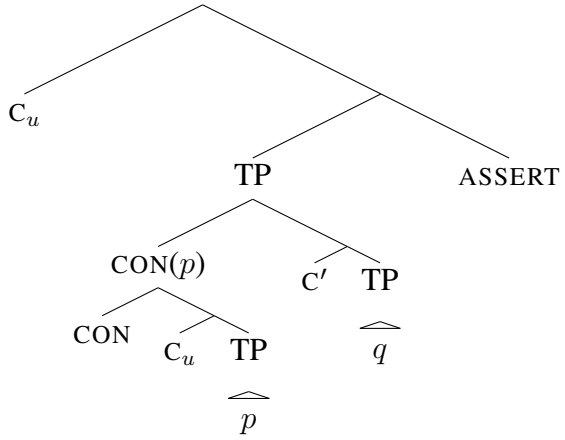
(100) shows that a conditional involves a two-step update procedure. As stated in (101-a), the first update is that the context set is updated with the antecedent p to create a set of p-worlds, as characterized by 'CS(C) + p' in (100). The second update, as shown in (101-b), is that the set of p-worlds that are most similar to w in the context set is updated with the consequent q, as characterized by 'Sim_w(CS(C) + p) + q' in (100).

(101) Two-step update of conditionals:
a. The context set is updated with p:
CS(C) + p
b. The set of p-worlds that are most similar to w is updated with q:
Sim_w(CS(C) + p) + q

Based on this two-step update, we propose that the syntactic structure of a conditional 'If p, q' is as in (102). A conditional is a declarative sentence and hence an assertion. Thus, the ASSERT morpheme occupies the head position of the ForceP and the utterance context C_u occupies the highest position. The fist step in the semantic update is that the antecedent p updates the utterance context. In order to implement this update, we assume that there exists a context between the conditional operator CON and p in the structure in (102), and this context is bound by the utterance context C_u. Suppose the utterance context C_u is updated with the antecedent p to create a temporary context C′. The second step, then, is that the temporary context C′ is updated with the consequent q. This update is syntactically realized as follows: There is a syntactic position for the context C′, which c-commands the consequent q in (102). The context C′ is like the context C_u in every respect,

except that $\text{CS}(\text{C}')$ is a set of p-worlds that are most similar to w in $\text{CS}(\text{C}_u)$.

(102)



The definition of the conditional operator in (100) and the structure in (102) correctly predict that the presupposition triggered by *dique/zhende* in the antecedent is inherited by the whole conditional. Take (96), repeated here as (103), as an example.

(103) Ruguo mingtian *dique* xiayu, wo hui dai zai jiali.
'If it indeed rains tomorrow, I will stay at home.'

The conditional operator takes in a modified proposition *dique*(p) and another proposition q to yield a proposition CON(*dique*(p))(q), which is then taken by the assertive operator to yield a CCP:

(104) $[\![\text{ASSERT}(\text{CON}(\textit{dique}(\text{p}))(\text{q}))]\!]$
= $\lambda\text{C}.\ \text{CS}(\text{C})$ + $[\lambda w \in \text{CS}(\text{C}).\ [\text{Sim}_w(\text{CS}(\text{C})$ + $\text{p}_{\langle\exists x.\text{Cred}_{x,\text{C}_i}(\text{p})>0.5\rangle})$ + q = $\text{Sim}_w(\text{CS}(\text{C})$ + $\text{p}_{\langle\exists x.\text{Cred}_{x,\text{C}_i}(\text{p})>0.5\rangle})]]$
p = 'It will rain tomorrow', q = 'I will stay at home'

As can be seen from (104), ASSERT(CON(*dique*(p))(q)) is defined if $\text{p}_{\langle\exists x.\text{Cred}_{x,\text{C}_i}(\text{p})>0.5\rangle}$ is defined, and $\text{p}_{\langle\exists x.\text{Cred}_{x,\text{C}_i}(\text{p})>0.5\rangle}$ is defined if a set of possible worlds σ satisfies $[\![\exists x.\text{Cred}_{x,\text{C}_i}(\text{p}) > 0.5]\!]^{g[\text{C}_{local}/\text{C}_i]}$. According to the structure in (102), the local context to *dique*(p) is the utterance context C_u, and thus the context variable C_i is bound by C_u, as shown below:

(105) $\text{p}_{\langle\exists x.\text{Cred}_{x,\text{C}_i}(\text{p})>0.5\rangle}$ is defined with respect to a set of worlds σ iff $\sigma \subseteq \lambda w.\exists x.\text{Cred}_{x,\text{C}_u}(\text{p}) > 0.5$ at w.

Now we need to know the value of σ. Since the antecedent p updates the context set of the utterance context $\text{CS}(\text{C}_u)$, the presuppositions carried by p are requirements imposed on $\text{CS}(\text{C}_u)$ and must be satisfied in $\text{CS}(\text{C}_u)$. That is, σrefers to $\text{CS}(\text{C}_u)$:

(106) $\text{p}_{\langle\exists x.\text{Cred}_{x,\text{C}_i}(\text{p})>0.5\rangle}$ is defined with respect to $\text{CS}(\text{C}_u)$ iff $\text{CS}(\text{C}_u) \subseteq \lambda w.\exists x.\text{Cred}_{x,\text{C}_u}(\text{p}) > 0.5$ at w.

That is to say, (103) is defined only if p has been suggested in the Common Ground of the utterance context. (103) inherits the presupposition of its antecedent.

Now, how about the cases in which presuppositions are blocked from projecting up? For example, in (98), repeated here as (107), the presupposition of the consequent, that 'It will rain

tomorrow' has been suggested, is not inherited by the whole conditional.

(107) Ruguo tianqiyubaoyuan shuo mingtian hui xiayu, na mingtian *dique* hui xiayu.
'If the weather reporter says that it will rain tomorrow, then it will indeed rain tomorrow.'

In (107), the semantics of the antecedent *tianqiyubao shuo mingtian hui xiayu* is defined in (108), where WR denotes the individual 'The weather reporter'.

(108) $[\![$*tianqiyubao shuo mingtian hui xiayu*$]\!]$ = say(p)(WR) p = 'It will rain tomorrow'

Then, the semantics of (107) is given in (109).

(109) $[\![$ASSERT(CON(say(p)(WR))(*dique*(p)))$]\!]$
= λC. CS(C) + [$\lambda w \in$ CS(C). [Sim_w(CS(C) + say(p)(WR)) + $\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$ = Sim_w(CS(C) + say(p)(WR))]] p = 'It will rain tomorrow'

(109) shows that the conditional ASSERT(CON(say(p)(WR))(*dique*(p))) is defined if a set of worlds σ satisfies $[\![\exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p}) > 0.5]\!]^{g[\mathrm{C}_{local}/\mathrm{C}_i]}$. Since the local context to the consequent *dique*(p) is the temporary context C′, the context variable C_i is bound by C′:

(110) $\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$ is defined with respect to σ iff $\sigma \subseteq \lambda w.\exists x.\mathrm{Cred}_{x,\mathrm{C}'}(\mathrm{p}) > 0.5$ at w.

Since the consequent updates the context set of the temporary context CS(C′), presuppositions carried by the consequent are requirements imposed on CS(C′) and must be satisfied in CS(C′), as shown in (111). That is to say, if the presupposition [$\lambda w.\exists x.\mathrm{Cred}_{x,\mathrm{C}'}(\mathrm{p}) > 0.5$ at w] is satisfied in CS(C′), the whole conditional is defined and does not inherit the presupposition of the consequent.

(111) $\mathrm{p}_{\langle \exists x.\mathrm{Cred}_{x,\mathrm{C}_i}(\mathrm{p})>0.5\rangle}$ is defined with respect to CS(C′) iff CS(C′) $\subseteq \lambda w.\exists x.\mathrm{Cred}_{x,\mathrm{C}'}(\mathrm{p}) > 0.5$ at w.

Now, let us see whether the presupposition [$\lambda w.\exists x.\mathrm{Cred}_{x,\mathrm{C}'}(\mathrm{p}) > 0.5$ at w] is satisfied in CS(C′). It is reasonable to assume that if a discourse participant x says a proposition p in a context C, then x is biased towards p in this context, as shown in (112).

(112) $\lambda w.\mathrm{say}(p)(x)(w) \subseteq [\lambda w.\mathrm{Cred}_{x,\mathrm{C}}(p) > 0.5$ at $w]$

As mentioned above, the temporary context C′ is like the context C_u in every respect, except that CS(C′) is a set of worlds that are most similar to w in CS(C_u) where the antecedent holds. Therefore, in (107), CS(C′) is a set of worlds where say(p)(WR) is true:

(113) CS(C′) $\subseteq \lambda w.$ say(p)(WR)(w)

Since the weather reporter says p in the context C′, the weather reporter is biased towards p in this context. This in turn entails that there exists at least one participant who is biased towards p:

(114) $\lambda w.$ say(p)(WR)(w) $\subseteq [\lambda w.\mathrm{Cred}_{\mathrm{WR},\mathrm{C}'}(\mathrm{p}) > 0.5$ at $w]$
$[\lambda w.\mathrm{Cred}_{\mathrm{WR},\mathrm{C}'}(\mathrm{p}) > 0.5$ at $w] \subseteq [\lambda w.\exists x.\mathrm{Cred}_{x,\mathrm{C}'}(\mathrm{p}) > 0.5$ at $w]$

(113) and (114) derive that CS(C′) entails the presupposition carried by *dique*:

(115) $\text{CS}(\text{C}') \subseteq [\lambda w.\exists x.\text{Cred}_{x,\text{C}'}(\text{p}) > 0.5 \text{ at } w]$

According to (111), when the presupposition $[\lambda w.\exists x.\text{Cred}_{x,\text{C}'}(\text{p}) > 0.5 \text{ at } w]$ is satisfied in $\text{CS}(\text{C}')$, the whole conditional is defined and does not inherit the presupposition of the consequent.

Finally, let us discuss the contribution of the discourse adverbs in conditionals. Intuitively, a conditional containing *dique* (or *zhende*) expresses that the speaker is doubtful of the proposition denoted by the antecedent or the consequent. Take (116) as an example.

(116) Context: A calls B, the customer service representative for a translation company.

A: Nimen gongsi zuo de fanyi cuowulianpian.
you company do GEN translations full-of-mistakes
'The translations that your company did are full of mistakes.'

B: Ruguo *dique* you cuowu, fanyimen yiding hui gaizheng.
if indeed have mistake translators surely will correct
'If there are indeed mistakes, the translators will surely correct them.'

In (116), A is proposing to add p into the CG by using an assertion, but B responds to A's proposal by uttering a conditional, showing that B remains uncommitted to p. The combination results in an indication that B doubts the suggested p and needs more evidence before committing himself to p. This intuition can be explained by the formal analysis presented above. The meaning of doubtfulness is a discourse effect resulting from the combination of the conditional meaning and the presupposition triggered by *dique*. By using a conditional, the speaker is claiming that all the worlds in which p 'There are mistakes in the translations' is true that are maximally similar to w are worlds where q 'The translators will surely correct them' is true. The speaker does not say whether the world of evaluation w is a world in which p is true or not, i.e., the speaker is not publicly committed to the truth of p. Now, the presupposition $\text{Cred}_{\text{A},\text{C}_u}(\text{p}) > 0.5$ indicates that p has been suggested by A, i.e., A is proposing to add p into the CG. B uses a conditional, which indicates that B is not committed to p even after A has proposed to add it to the CG. This gives rise to a discourse effect that B has refused to accept A's proposal and B doubts the truth of p.

To summarize, the presupposition triggered by *dique*/*zhende* is inherited by the whole conditional, unless the presupposition is triggered in the consequent and entailed by the antecedent. This is consistent with the hypothesis that *dique* and *zhende* are presupposition triggers. The projection behavior of embedded presuppositions is explained by the Stalnaker-Lewis-Heim analysis and the dynamic approach to presupposition: The presupposition of the consequent will not be projected up because it is satisfied in the local context created by the antecedent. The adverb *dique*/*zhende* introduces a presupposition that p has been suggested, but the speaker responds to this suggestion by using a conditional indicating his uncommitment to p. This gives rise to a discourse effect that the speaker doubts the old information p.

5.3 Section summary

This section examined the behaviors of *dique* and *zhende* in embedded clauses. We showed that the adverbs *dique* and *zhende* exhibit the same behaviors as typical presupposition triggers when embedded under attitude verbs and conditional structures, which is consistent with the hypothesis that *dique* and *zhende* are presupposition triggers.

6 Syntactic analysis of *dique* and *zhende*

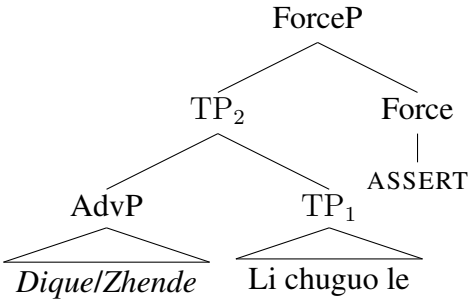
The previous sections discussed the semantic contributions of *dique* and *zhende* in matrix clauses and embedded clauses. Now we are ready to see the syntactic analysis of these discourse adverbs. This section specifies the syntactic positions of *dique* and *zhende* based on the semantic computation presented in Section 3. The proposal regarding the syntactic structure of an assertion containing *dique*/*zhende* is summarized in (117).

(117) a. The assertive operator ASSERT is the head of a Force Phrase (ForceP).
b. *Dique* and *zhende* are TP adjuncts.
(i) First, *dique* or *zhende* attaches to TP_1 to form TP_2.
(ii) Then, TP_2 combines with the assertive operator ASSERT.

For example, (118) has the structure in (119).

(118) *Dique/Zhende*, Li chuguo le.
indeed/really Li go-abroad PERF
'Indeed/Really, Li went abroad.'

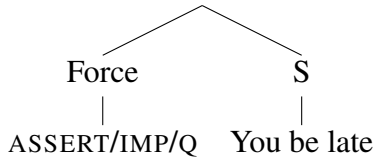
(119)



Let us explain the proposals in (117). (117-a) says that ASSERT is the head of a Force Phrase. We assume that sentential forces are realized syntactically by operators like ASSERT and Q (Sadock & Zwicky, 1985; König & Siemund, 2007). For example, the three sentences in (120) denote the same proposition, i.e., 'You be late', but contain different force markers: the assertive operator ASSERT, the command operator IMP and the question operator Q, as depicted in (121).

(120) a. You are late. b. Be late! c. Are you late? (Lewis 1970: 55)

(121) (Modified from Lewis 1970: 55)



These force markers are generally located at a high position in the structure, typically at the highest head position in the CP domain (Rizzi, 1997) or the IP domain (Cinque, 1999).

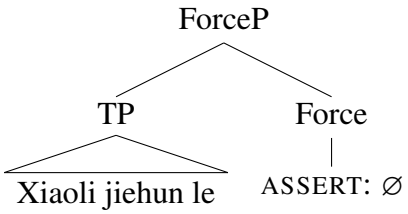
The next question is how these force operators are represented in Mandarin, that is, what element occupies the head of ForceP. In Indo-European languages, sentential force most often manifests as an affix on the verb (Cinque, 1999: 84). Such affixes occupy the head position of ForceP in these languages. Mandarin lacks inflectional morphology and uses sentence-final

particles to mark the force of an utterance (Lü, 1982: 257). These particles occupy the head position of ForceP in Mandarin. For example, a question can be marked by the particles *ma* or *ne*, which we can take to be the overt manifestation of the Q operator that heads ForceP. Assertion and command in Mandarin are not overtly marked. We assume that ASSERT and COM are phonologically null operators in Mandarin, occupying the same position as *ma*/*ne*. Following Gasde & Paul (1996), ForceP is analyzed as head-final, since the particles that mark questions and commands occur in sentence-final position in Mandarin. For example, the assertion in (122) has the structure in (124), where the ForceP is headed by the covert operator ASSERT. The question in (123) has the structure in (125), with the ForceP headed by the operator Q, which manifests overtly as *ma*.

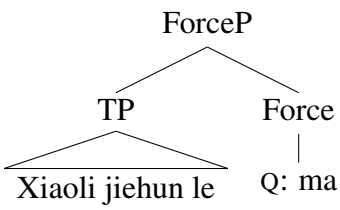
(122) Xiaoli jiehun le.
Xiaoli get-married PERF
'Xiaoli got married.'

(123) Xiaoli jiehun le ma?
Xiaoli get-married PERF Q
'Did Xiaoli get married?'

(124)



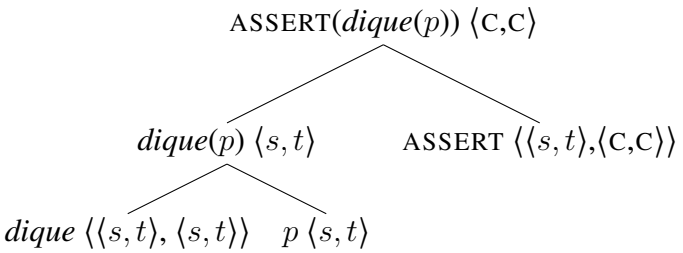
(125)



(117-b) says that *dique* and *zhende* are adjuncts, as illustrated in (119). *Dique* and *zhende* are analyzed as adjuncts because these two adverbs are not lexically selected by any predicate and are therefore syntactically optional in a sentence. This analysis also corresponds to the traditional analysis of adverbs as adjuncts (Zubizarreta, 1982; Sportiche, 1988).

(117-b) also says that *dique* or *zhende* is first adjoined to a TP, and then the modified TP combines with ASSERT. This order is mandated by the two-step semantic computation discussed in (56), repeated as (126). The first step is the combination of *dique*/*zhende* with a proposition p. The proposition p is represented syntactically by a TP. Thus, as stated in (117-b-i), *dique* and *zhende* are TP adjuncts. The second step is the combination of *dique*(p)/*zhende*(p) with ASSERT. Thus, ASSERT must take the modified TP as its complement, as in (117-b-ii). Syntactic composition and semantic computation are performed in parallel, in accordance with the Principle of Compositionality.

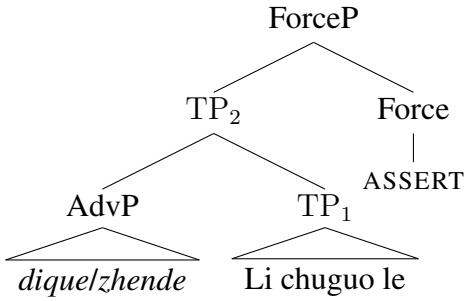
(126)



The syntactic analysis of *dique* and *zhende* as TP adjuncts corresponds to the semantic computation. However, when *dique* or *zhende* follows a noun phrase, the surface structure appears to be inconsistent with the semantic computation. Under the proposal in (127), a noun phrase can occur before *dique* or *zhende*. Following (117), (127) has the structure in (128), which corresponds to the semantic computation in (126).

(127) Li *dique*/*zhende* chuguo le.
Li indeed/really go-abroad PERF
'Li indeed/really went abroad.'

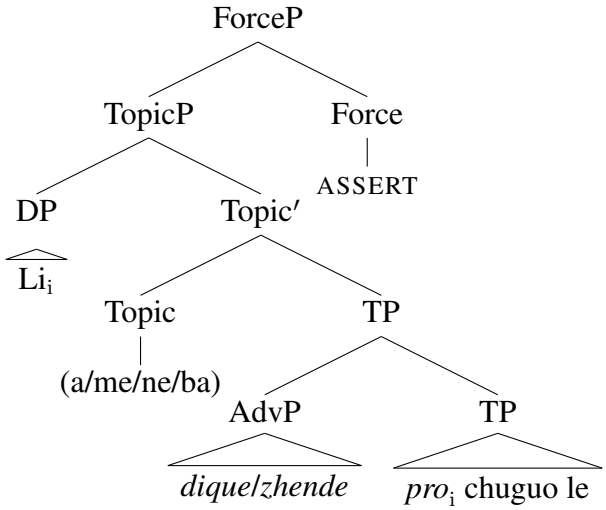
(128)



However, the surface structure of (127) appears to be inconsistent with the semantic computation. According to the surface structure in (127), it appears that *dique* or *zhende* does not combine with TP, *Li chuguo le*, but combines with VP, *chuguo le*. In the semantic computation, however, *dique* or *zhende* must combine with the entire proposition 'Li went abroad'.

To explain the discrepancy between syntax and semantics, we propose that the DP position preceding *dique*/*zhende* is a topic position. The structure of (127) is revised as in (129). The four particles *a*/*me*/*ne*/*ba* in (129) are topic markers (Li & Thompson, 1981: 86), which separate the topic from the rest of the sentence. Topic markers are optional and thus do not appear in (127).

(129)



According to (129), the noun phrase preceding the adverbs occupies the specifier position of a topic phrase. There is a covert pronoun (*pro*) inside the TP which is co-indexed with the noun phrase (Huang, 1984). For example, in (129), a *pro* inside the TP is co-indexed with the topic *Li*. Thus, '*pro* chuguo le' '(Li) went abroad' is still a proposition. This syntactic structure is consistent with the semantic combination of *dique*/*zhende* with the proposition p.

In order to verify that the DP position preceding *dique*/*zhende* is a topic position, we will briefly review previous work on Chinese topic in Section 6.1, and then show that noun phrases preceding *dique* or *zhende* exhibit topic properties in Section 6.2.

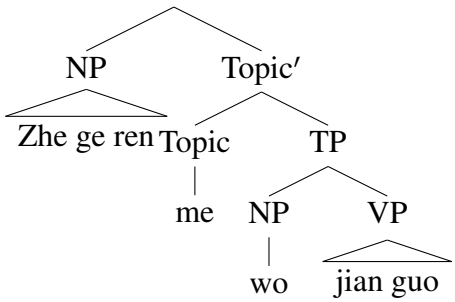
6.1 The structure and properties of Chinese topics

The notion of 'topic' has different interpretations. Some have argued that topichood corresponds to a syntactic position, while others review it as a pragmatic notion that has no representation in syntax. Since we argue that the DP position preceding *dique*/*zhende* is a syntactic topic position, we adopt Gasde & Paul's (1996) analysis of topic and subject as two syntactic positions.

Gasde & Paul (1996) treat both topic and subject as notions in syntax. In this structure, the subject is the specifier of the TP. Topic position is the specifier of a Topic Phrase (noted here as TopicP), and topic markers like *a*, *me*, *ne* and *ba* occupy the head position of this topic phrase. Therefore, the structure of (130) is as in (131).

(130) Zhe ge ren me, wo jian guo.
this CL person TM I see EXP
'As for this person, I have already met him.' (Gasde & Paul 1996: 268)

(131) (modified from Gasde & Paul 1996: 268)



If a position is a topic position, the noun phrase in the position is expected to have topic properties. In order to see whether this is true of noun phrases preceding *dique* and *zhende*, let us summarize the properties of topic that have been discussed in past studies.

Since researchers have characterized the notion of topichood from various perspectives, many different properties of topics have been discussed. Here, we focus on the following properties:

(132) Properties of Chinese topics
- a. A topic can be followed by a pause or pause particles (i.e., topic markers).
- b. Topics cannot be focalized.
- c. There is a strong tendency for topics to be definite.

Let us illustrate these three properties. The first property was discussed by Li & Thompson (1981). In Chinese, a topic can be followed by topic markers, as we have seen in (130).

The second property is that topics cannot be focalized. Topics generally express old information, whereas focus conveys new and prominent information. Sgall et al. (1986: 175, 216) consider topic and focus to be in complementary distribution in a sentence. Büring (1999) holds a similar view that topic is a part of non-focal material.

Shi (2001) shows that Chinese topics cannot be focalized. One way to focalize a noun phrase in Chinese is to add a focus marker *shi* in front of it. Shi (2001) shows that the focalization of topic DPs in this way fails in Chinese. As shown in (133-b), the topic *shu* cannot be marked by *shi*. The sentence-initial DP is generally interpreted as a topic when the DP is the patient of an action that is represented by the predicate and no passive marker appears in the sentence (Chao, 1968;

Li & Thompson, 1981; Xu & Liu, 1998; Shi, 2001).

(133) a. Shu Xiaowang kan wan le.
book Xiaowang read finish PERF
'As for the book, Xiaowang finished reading (it).'
b. *Shi shu Xiaowang kan wan le.
is book Xiaowang read finish PERF
'It is the book that Xiaowang finished reading.' (Shi 2001: 85)

The third property is that topics tend to be definite. Chao (1968) points out that subjects tend to be definite and objects tend to be indefinite. Since Chao (1968) analyzes all Chinese subjects as topics, Chao's (1968) claim amounts to saying that topics tend to be definite. In (134-a), the bare noun *shu* 'book' in object position has an indefinite referent, i.e., it does not refer to any specific book. When *shu* occurs in the topic position in (134-b), it has a definite referent, i.e., the speaker refers to a particular book.

(134) a. Wo kan wan shu le.
I read finish book PERF
'I have finished reading (for example, bedtime reading, of any book).'
b. Shu kan wan le ma?
book read finish PERF Q
'Have you finished reading the book (I lent you, you said you wanted to read, etc.)?'
(Chao 1968: 76)

In summary, topic and subject are two distinct positions. Noun phrases occupying topic position share the properties in (132). The next section shows that the DP position preceding *dique*/*zhende* has these properties.

6.2 The DP position before *dique*/*zhende* is a topic position

In this section, we argue that the DP position preceding *dique*/*zhende* is a topic position by showing that noun phrases in this position exhibit the three properties of topic in (132).

First, noun phrases preceding VP-initial *dique*/*zhende* can be followed by a pause or a topic marker. For example, *Xiaoli* in (135-a) can be marked by any of the four topic markers, as in (135-b).

(135) a. Xiaoli *dique*/*zhende* shi ge hao ren.
Xiaoli indeed/really is CL good person
'Xiaoli is indeed/really a nice person.'
b. Xiaoli a/me/ne/ba, *dique*/*zhende* shi ge hao ren.
Xiaoli TM indeed/really is CL good person
'As for Xiaoli, (he) is indeed/really a nice person.'

Second, noun phrases preceding *dique*/*zhende* cannot be focalized. As shown in (136) and (137), without *dique*/*zhende*, *Li* in the subject position can be focalized by adding a focus marker *shi* before *Li*.

(136) Li mei zou.
Li not leave
'Li didn't leave.'

(137) Shi Li mei zou.
is Li not leave
'It is Li who didn't leave.'

However, when preceding *dique*/*zhende*, the DP *Li* cannot be marked by *shi*:

(138) Li *dique*/*zhende* mei zou.
Li indeed/really not leave
'Li indeed/really didn't leave.'

(139) *Shi Li *dique*/*zhende* mei zou.
is Li indeed/really not leave
'It is Li who indeed/really didn't leave.'

Furthermore, other focalized constituents, such as structures associated with *zhiyou* 'only', cannot appear before *dique*/*zhende*, as shown in (140). This also indicates that the DP preceding *dique*/*zhende* is a topic, which cannot be focalized.

(140) a. *Dique*, [zhiyou zui nuli de ren] neng chenggong.
indeed only most hard-working GEN person can succeed
'Indeed, only the most hard-working people can succeed.'
b. *[Zhiyou zui nuli de ren] *dique* neng chenggong.
only most hard-working GEN person indeed can succeed
'Only the most hard-working people indeed can succeed.'

Finally, non-referential indefinite noun phrases cannot occur in the DP position preceding *dique*/*zhende*. As discussed in Section 6.1, indefinite DPs tend not to occur in the topic position. These indefinite DPs include modified numerals, quantificational indefinites and some quantified noun phrases. Let us illustrate them one by one.

First, modified numerals are excluded from the DP position preceding *dique*/*zhende*. For example, in (141), the DP *chaoguo liushi ge xuesheng* 'more than sixty students' can occur in sentence-initial position in A's utterance, or after *dique* in C1. This is because these two positions are subject positions, which impose no restrictions on indefinite noun phrases. However, *chaoguo liushi ge xuesheng* cannot occur in the DP position in front of *dique*, as shown in C2. This can be explained by the fact that this position is a topic position, which is incompatible with the indefinite DP.

(141) chaoguo + numeral (N) 'more than N'
A: Chaoguo liushi ge xuesheng zhuce le zhe men ke.
more-than sixty CL student register PERF this CL course
'More than sixty students registered in this course.'
B: Shi ma?
is Q
'Is it?'
C1: *Dique*, chaoguo liushi ge xuesheng zhuce le.
indeed more-than sixty CL student register PERF
'Indeed, more than sixty students got registered.'
C2: *Chaoguo liushi ge xuesheng *dique* zhuce le.
more-than sixty CL student indeed register PERF
'More than sixty students indeed got registered.'

Similarly, other modified numerals cannot precede *dique* and *zhende*, as shown in (142) and (143).

(142) zhishao + numeral 'at least N'

a. *Zhende*, zhishao sanshi ge yuedui canjia le zheci yanchu.
really, at-least thirty CL band attend PERF this performance
'Really, at least thirty bands attended this performance.'

b. *Zhishao sanshi ge yuedui *zhende* canjia le zheci yanchu.
at-least thirty CL band really attend PERF this performance
'At least thirty bands really attended this performance.'

(143) zuiduo + numeral 'at most N'

a. *Dique*, zuiduo liang ge xuesheng mei jige.
indeed at-most two CL student not pass
'Indeed, at most two students failed.'

b. *Zuiduo liang ge xuesheng *dique* mei jige.
at-most two CL student indeed not pass
'At most two students indeed failed.'

Second, referential indefinites can precede *dique* and *zhende*, whereas quantificational indefinites cannot. Fodor & Sag (1982) propose that indefinite noun phrases are semantically ambiguous. For example, *a student* in (144) can be interpreted in two ways. The first is that some particular student, e.g., John, cheated on the final exam. With this reading, *a student* is called a referential indefinite, as it is interpreted as a referring expression. On the second interpretation, there exists a student who cheated, i.e., the set of students in the syntax class who cheated is not empty. Here, *a student* is a quantificational indefinite, since it is interpreted as a quantified expression.

(144) A student in the syntax class cheated on the final exam. (Fodor & Sag 1982: 355)

Quantificational indefinites obey normal scope constraints: When a quantificational indefinite and another quantified DP co-occur in a sentence, the preferred reading is the one on which the first quantifier takes wide scope over the second (Fodor & Sag, 1982: 365). However, when co-occurring with a quantified DP, referential indefinites only have wide scope readings. For example, if *a student* is interpreted referentially in (145), the sentence only means that there is a certain student who every professor met.

(145) Every professor met a student in the syntax class. (Fodor & Sag 1982: 355)

Chinese indefinite noun phrases exhibit the same kind of ambiguity. In (146), the indefinite *san ge xuesheng* can be interpreted referentially, in which case it refers to three particular students which the speaker can identify. It can also have a quantificational interpretation, where all we know is that the set of students who cleaned the classroom has three members.

(146) San ge xuesheng dasao le jiaoshi.
three CL student clean PERF classroom
'Three students cleaned the classroom.'

When the indefinite DP *san ge xuesheng* occurs in front of *dique* or *zhende*, it can only have the referential interpretation, as in (147-a). Interpretation (147-b) is not available. In other words, quantificational indefinites cannot occur before *dique*/*zhende*.

(147) San ge xuesheng *dique*/*zhende* dasao le jiaoshi.
three CL student indeed/really clean PERF classroom
a. 'Three (particular) students indeed/really cleaned the classroom.'
b. Unavailable: 'There exist three students who indeed/really cleaned the classroom (, but I don't know which).'

Furthermore, modifiers like *certain*, *particular* and relative clauses favor the referential interpretation (Fodor & Sag, 1982: 361-362). Thus, *san ge xuesheng* in (147) can be replaced with *zuobian de san ge xuesheng* 'the three students sitting on the left'. In contrast, modifiers like *altogether* or *exactly* emphasize the quantity of the referents, and thus favor the quantificational interpretation. As a result, replacing *san ge xuesheng* with *yi gong san ge xuesheng* 'altogether three students' or *zhenghao san ge xuesheng* 'exactly three students' would make the sentence ungrammatical (see (148)), as predicted by the analysis.

(148) *Yigong san ge xuesheng *dique*/*zhende* dasao le jiaoshi.
altogether three CL student indeed/really clean PERF classroom
'Altogether three students indeed/really cleaned the classroom.'

In short, referential indefinites can occur before *dique* or *zhende*, but quantificational indefinites cannot. This is because the DP position preceding the adverbs is a topic position, which favors definite noun phrases. Referential indefinites resemble definites in that they are both referring expressions, and can therefore occupy the topic position. On the other hand, quantificational indefinites do not denote specific referents and are thus excluded from the topic position.

Third, noun phrases with the quantifier *meiyou* 'no' or *henshao* 'few' cannot occur before *dique* or *zhende*, as in (149-b). This is because these quantified noun phrases do not denote specific referents. Therefore, they are excluded from the position in front of *dique*/*zhende*.

(149) a. *Dique*, meiyou ren / henshao ren neng shuo shi zhong yuyan.
indeed no person / few person can speak ten CL language
'Indeed, nobody/few people can speak ten languages.'
b. *Meiyou ren / Henshao ren *dique* neng shuo shi zhong yuyan.
no person / few person indeed can speak ten CL language
'Nobody/few people indeed can speak ten languages.'

In summary, the fact that noun phrases occurring before *dique*/*zhende* show the properties of topic is predicted by the proposal that the DP position preceding *dique*/*zhende* is a topic position.

6.3 Section Summary

This section presented a syntactic analysis for *dique* and *zhende* that corresponds to the semantic analysis. *Dique* and *zhende* are TP adjuncts. The DP position before *dique*/*zhende* is a topic position, which ensures consistency between semantics and syntax. This syntactic analysis correctly predicts that noun phrases exhibiting no topic properties cannot occur before the adverbs.

7 Naturalness rating experiment

Sections 2 to 5 concluded that *dique* and *zhende*, as presupposition triggers, impose different requirements on the previous discourse. In order to validate these conclusions, this section reports a naturalness rating experiment on assertions containing *dique* and *zhende* (See Schütze (1996) and Cowart (1997) for why such an experiment can validate the conclusions).

In Section 2, it is hypothesized that an assertion containing *dique*, i.e., *dique*(p), requires the context to be one in which p has been suggested, whereas *zhende*(p) requires the context to be one in which p has been suggested and some participant is uncommitted to p. Based on this hypothesis, we make the predictions in (150), which will be tested in the experiment.

(150) Predictions:

a. *Dique*(p) is judged to be more natural in a context where p has been suggested than in a context where p has not been suggested.

b. *Zhende*(p) is judged to be more natural in a context where p has been suggested and some participant is uncommitted to p, than in a context where p has not been suggested.

c. *Zhende*(p) is judged to be more natural in a context where p has been suggested and some participant is uncommitted to p, than in a context where p has been suggested and all participants are committed to p.

Method In this experiment, the participants judged the naturalness of assertions containing *dique*/*zhende* in different contexts. For *dique*, each stimulus consists of a context and a target sentence, i.e., an assertion containing *dique*. There are two conditions in this part of the experiment, suggested and unsuggested. Each condition has 10 items, and thus 20 target stimuli were created. A suggested context refers to a context where the prejacent of *dique* has been suggested, while an unsuggested context is where the prejacent has not been suggested before. As in (151), the proposition p 'Xiaolan went out for jogging' has not been suggested in the unsuggested context, but has been suggested by Mr. Lan in the suggested context. According to the predictions in (150), the target sentence *Dique, Xiaolan qu paobu le* in the suggested context should be judged more natural than in the unsuggested context.

(151) Target Sentence: *Dique, Xiaolan qu paobu le.* 'Indeed, Xiaolan went out for jogging.'

a. Unsuggested Context:
Mr. Lan arrives home and finds that his son Xiaolan is not at home. Mrs. Lan tells Mr. Lan:

b. Suggested Context:
Mr. Lan arrives home and finds that his son Xiaolan is not at home. He sees that Xiaolan's sneakers are not in the shoe cabinet, so he says to Mrs. Lan: 'I suppose Xiaolan went out for jogging?'. Mrs. Lan answers:

As for *zhende*, each stimulus also consists of a context and a target sentence, i.e., an assertion containing *zhende*. In this part of the experiment, there are three conditions: *unsuggested*, *suggested and agreed*, and *suggested and opposed*. Each condition has 10 items, and thus 30 target stimuli were created. A suggested and agreed context refers to a context where the prejacent of *zhende*

has been suggested and all the discourse participants are committed to it, while a suggested and opposed context is where the prejacent has been suggested but not all the participants accept it. As in (152), the proposition p 'There was an earthquake last night' has not been suggested in the unsuggested context. In the suggested and agreed context, p has been suggested by A and all discourse participants are committed to p. In the suggested and opposed context, p has been suggested by A's roommate and A is uncommitted to p. According to the predictions in (150), the target sentence *Zuowan zhende dizhen le* in the suggested and opposed context should be judged more natural than in the other two contexts.

(152) Target Sentence: *Zuowan zhende dizhen le.* 'There was really an earthquake last night.'

a. Unsuggested Context:
Waking up in the morning, A's roommate says to A:

b. Suggested and Agreed Context:
Waking up in the morning, A tells his roommate 'There was an earthquake last night.' A's roommate says to A:

c. Suggested and Opposed Context:
Waking up in the morning, A's roommate tells A 'There was an earthquake last night.' A doesn't believe it and says 'Are you sure? I didn't feel anything.' A's roommate says to A:

Thus, 50 stimuli (20 of *dique* and 30 of *zhende*) and 50 fillers were added to the experiment. The 50 stimuli and 50 fillers, all in Chinese characters, were presented to the participants in an anonymous questionnaire in Qualtrics.[7] The questionnaire was organized into ten blocks, each block containing 5 stimuli and 5 fillers. The order of the 10 items within each block was randomized by Qualtrics, ensuring that no minimal pair stimuli appeared together. Each participant completed the questionnaire on a laptop, accompanied by an assistant. The participants were required to judge how natural the target sentences were in the contexts by ticking the numbers on a 5-point scale: completely natural, somewhat natural, undecidable, somewhat unnatural, completely unnatural. 20 native Mandarin speakers, 10 male and 10 female, were paid 80 Hong Kong dollars to participate in the experiment. All participants were undergraduate or postgraduate students from the City University of Hong Kong, 6 of which major in linguistics. The ratings were converted to numerical values as follows: completely natural=5, somewhat natural=4, undecidable=3, somewhat unnatural=2, completely unnatural=1. The t-values and p-values were calculated by the statistical software package SPSS (IBM, 2011).

Results The average naturalness ratings of the 10 assertions containing *dique* are presented in Figure 1. Figure 1 shows that native speakers judged *dique*(p) in the context where p has been suggested as much more natural than in the context where p has not been suggested (t = -14.289, $p < .001$). The average ratings of the 10 assertions modified by *zhende* are presented in Figure 2. Figure 2 shows that native speakers judged *zhende*(p) as more natural in the context where p has been suggested but not all participants were committed to it, than in the context where p has not been suggested at all (t = -24.715, $p < .001$). Figure 2 also shows that native speakers judged *zhende*(p) as more natural in the context where a participant remained uncommitted to p after p has

[7]Qualtrics is a web-based system that conducts online surveys. Version 45634 of the Qualtrics Research Suite. Copyright©2013 Qualtrics. http://www.qualtrics.com.

been suggested, than in the context where all participants accepted p (t = -12.309, p < .001).

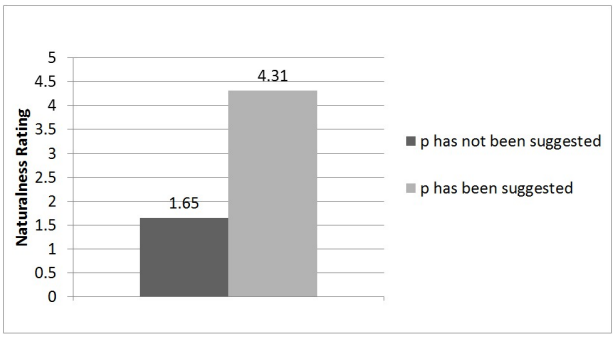


Figure 1: Average naturalness ratings of assertions modified by *dique*

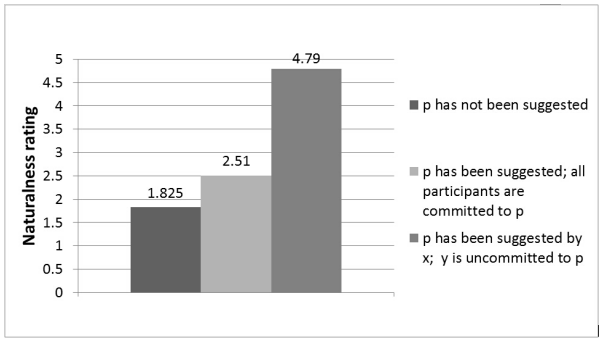


Figure 2: Average naturalness ratings of assertions modified by *zhende*

The results support the predictions in (150) about the specific presuppositions that *dique* and *zhende* add to assertions. *Dique* adds to an assertion of p a presupposition that p has been suggested, whereas *zhende* adds another presupposition that p has been suggested and some participant is uncommitted to p.

8 Conclusion

Human languages adopt various discourse markers to mark the relationship between the utterance and the context. In this study, we have seen that the discourse adverbs *dique* and *zhende* mark different relationships between the utterance containing them and the previous discourse. *Dique* marks the information as old, while *zhende* marks the information as old and challenged. These relationships between the utterance and the context are also marked in other languages. For example, English *indeed* marks the information as old (Zeevat, 2003) and English *man* at sentence-final position marks the information as challenged (McCready, 2008). Discourse adverbs convey information about the previous discourse, and this semantic property is captured by the presuppositional analysis presented in this study.[8] *Dique* and *zhende* are analyzed as presupposition triggers, which modify an utterance by introducing different presuppositions.

On the basis of empirical data and a naturalness rating experiment, we show that *dique* adds to an assertion of p a presupposition that p has been suggested, and adds to a question of Q a presupposition that Q has been asked. Therefore, assertions and questions containing *dique* always indicate a confirmation of old information. In contrast, *zhende* adds to an assertion a presupposition that p has been suggested but some participant remains uncommitted to p, and adds to a question a presupposition that Q has been asked but some participant has failed to solve Q. Therefore, assertions and questions containing *zhende* indicate an emphasis on truth. The semantic analysis of *dique* and *zhende* as presupposition triggers is also supported by the behaviors of these adverbs when embedded under attitude verbs and conditional structures.

Our study shows how discourse adverbs mark various relationships between the utterance and the previous discourse, and demonstrates how discourse adverbs modify assertions and questions

[8]See more discussions about analyzing discourse items as presupposition triggers in Karagjosova (2004), McCready & Zimmermann (2011) and Kaufmann & Kaufmann (2012).

by contributing to presuppositional contents. The presuppositional analysis adopted in this study can be extended to the semantic study of other discourse items.

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Appendix A The principle of MAXIMIZE PRESUPPOSITION

In Section 2, we analyzed *dique* and *zhende* as presupposition triggers, and concluded that *zhende* triggers a more informative presupposition than *dique*. Following the principle of MAXIMIZE PRESUPPOSITION (Heim, 1991), our semantic analysis predicts that *zhende* is preferred to *dique* in contexts where the presuppositions of *zhende* are satisfied. We show that this is a correct prediction in this appendix.

The principle of MAXIMIZE PRESUPPOSITION (Heim, 1991) requires that the speaker choose from a set of competitors the logical form that carries the most informative presupposition. For example, (153-a) carries a presupposition that p 'It rained last night' is true, while (153-b) does not carry this presupposition. That is, (153-a) has a more informative presupposition than (153-b). In a context where the presupposition of (153-a) is satisfied, i.e., when p is true, the speaker will choose (153-a) instead of (153-b) in order to be maximally informative.

(153) a. John knows that it rained last night.
b. John thinks that it rained last night.

As discussed in Section 2, the presupposition of *dique*, that p has been suggested and all the participants recognize that they know about this suggestion, is one of the presuppositions of *zhende*. That is, *zhende* triggers a more informative presupposition than *dique*. This predicts that *zhende* will be preferred to *dique* when the presuppositions of *zhende* are met. For example, in (154), the presuppositions of *zhende* are satisfied: the proposition p 'It rained last night' has been suggested by A and some participant, i.e., B, was uncommitted to p. The principle of MAXIMIZE PRESUPPOSITION predicts that B is preferred to B′. This turns out to be a correct prediction. We presented (154) to ten Mandarin native speakers and asked them which one, B or B′, they would use. Nine participants chose B, while only one participant chose B′.

(154) A: *Zuowan xiayu le*.
'It rained last night.'
(B is not sure. He opens the window and sees that the ground is wet.)
B: *Zhende* xiayu le.
'It really rained.'
B′: *Dique* xiayu le.
'It indeed rained.'

Native speakers' clear preference for B in (154) shows that the use of *zhende* is preferred to *dique* when presuppositions of *zhende* are satisfied. This supports our analysis of these two adverbs as presupposition triggers.