

Plurality, maximality and scalar inferences: A case study of Mandarin *Dou*

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Abstract The Mandarin functional morpheme *dou* appears to have been interpreted, among other things, as a distributor, focus marker *even*, or *already*. This paper aims at providing a unified semantic account for these different uses. I argue that the semantic core of these different usages is the same: *dou* is simply a maximality operator. It gives rise to different meanings by applying maximality to a contextually determined plural set. This could be a set of covers, a set of focus-induced alternatives, or a set of degrees ordered on a scale. This analysis also connects *dou* in these contexts with *dou* in environments that license polarity items, as discussed in Giannakidou and Cheng (J Semant 23: 135–183, 2006).

Keywords *Dou* · Maximality · Distributivity · Plurality · Scales · Focus · Degree constructions

1 Introduction

The Mandarin morpheme *dou* has been the topic of much discussion. At issue is how to account for the seeming diversity of meanings. In one use, *dou* indicates distribution of a predicate over a plural noun phrase preceding it (Lee 1986; Liu 1990; Lin 1998). For instance, in the examples below, the presence of *dou* in (1) makes the collective reading in (1b) unavailable, in contrast to the ambiguity in (2).

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- (1) Tamen dou chi-le yi-ge pingguo pai
 They dou eat-Perf one-Cl apple pie
 a. 'They each ate an apple pie.'
 b. *'They ate an apple pie (together)'
- (2) Tamen chi-le yi-ge pingguo pai
 They eat-Perf one-Cl apple pie
 a. 'They each ate an apple pie.'
 b. 'They ate an apple pie (together)'

However, in many circumstances, *dou* also seems to contribute to scalar interpretations. One often cited example is the *lian...dou* construction, which is roughly equivalent to *even* in English.

- (3)a. Lian shagua dou zhidao zhege.
 Lian idiot dou know this
 'Even idiots know this.'

In addition to the *lian...dou* construction, there are many other cases where *dou* seems to give rise to some sort of scalar interpretation. For instance, in (4), although *dou* is glossed as *already*, I will show in Sect. 5 that the sentence is emphasizing that a maximally unexpected event is true.

- (4) Yizhuanyan, haizi dou da le.
 in a blink, child dou grown Perf
 '(time flies!) In a blink of time, the child/children has/have already grown up.'

In (5), the predicate following *dou* is describing a very high degree of anger on an anger scale.

- (5) Mali qi de dou ku le
 Mary upset de dou cry Perf.
 'Mary was so upset that she broke into tears.'

These examples all express the end point of a contextually determined scale. But it is not clear if *dou* is the underlying source of the scalar meaning or if it only operates on the scale provided by some other sources. Furthermore, it is also not clear whether there is any relationship between *dou* in the scalar context and *dou* in the distributive context.

Based on data like (1), *dou* has often been treated as having universal quantification power (Cheng 1995; Wu 1999). Portner (2002) analyzed *dou* in (3) in a way very similar to the English *even*, which makes *dou* have some inherent scalar semantics. In the current paper, instead of postulating a different meaning of *dou* for each different context, I provide a unified analysis for various uses of *dou*. I will propose that *dou* is simply a maximality operator. It operates on any plural set and outputs a maximal plural individual. The critical thread that joins the seemingly

different uses of *dou* is the context sensitivity of this plural set. It can be a set of covers over a plural noun phrase, in which case the covers themselves are context sensitive, or it can be a set of alternative degrees determined by a contextually defined scale. This analysis extends the critical insight in Giannakidou and Cheng (2006), where *dou* is discussed in the context of licensing polarity items, which is another very common usage of *dou*.

The paper is organized as follows: I will describe the various interpretations of *dou* in Sect. 2. In Sects. 3 and 4, I focus on the distributive context and argue that *dou* is best understood as a maximality operator. This analysis converges nicely with the analysis in Giannakidou and Cheng (2006), which is proposed based on a completely independent domain, namely, the licensing of polarity items. In Sect. 5, I extend this analysis to the various kinds of scalar context.

2 The distribution of *dou*

As shown in the introduction, I will focus on the distributivity context and the scalar context in which *dou* can participate. Distributivity is probably the most discussed property of *dou*. It obligatorily distributes the predicate over the argument to its left, as shown in (6). This is in contrast with the non-*dou* counterpart in (7), which is ambiguous between a distributive and a non-distributive (collective) reading.

- (6) Tamen dou chi-le yi- ge- pingguo pai
 They dou eat-Perf one-Cl apple pie
 a. 'They each/all ate an apple pie.'
 b. *'They ate an apple pie (together)'

- (7) Tamen chi-le yi- ge- pingguo pai
 They eat-Perf one-Cl apple pie
 a. 'They each/all ate an apple pie.'
 b. 'They ate an apple pie (together)'

Since *dou* is used as a distributor, the argument it distributes over has to be distributable. This explains the ungrammaticality of (8).

- (8) *Ta dou chi-le yi- ge- pingguo pai
 he Dou eat-Perf one-Cl apple pie
 'he each ate an apple pie.'

Among the scalar contexts, the *lian...dou* construction has been given a similar analysis to English *even* (Portner 2002). On the surface, the morpheme *lian* is optional, but given the same meaning of the version without *lian*, I will assume that *lian* is always present, explicitly or implicitly.

- (9)a. (Lian) shagua dou zhidao zhege.
 (lian) idiot dou know this
 ‘Even idiots know this.’
- b. (Lian) Zhangsan dou qu-le.
 (lian) Zhangsan dou go-Perf
 ‘Even Zhangsan went.’
- c. Ta (lian) zhoumo dou zai gongzuo.
 he (lian) weekend dou Prog work
 ‘He even works on weekends.’

In the literature, *even* is associated with a focused element. Following Rooth (1985), focus evokes alternatives. For instance, when we abstract over the focused noun phrase *John*, the sentence *John_f was invited* evokes the set of propositions of the form *x was invited*. *Even* is also associated with presuppositions (Horn 1969; Karttunen and Peters 1979). It presupposes that among the set of alternative propositions that are introduced by the focus, the proposition that contains the *even*-related argument is the least likely one. The following examples illustrate this point.

- (10) Even [John]_f was invited.
 Presuppose: among all the guests (Mary, Bill, Chris...), John was the least likely to be invited.
 Assert: John was invited.

Comparing the *lian...dou* construction with English *even*, the two seem to share similar kind of semantics such that the least likely event is true. Let's take (9a) as an example. (9a) presupposes that there is a scale that orders our expectations of different people to solve the problem. Idiots would be the least expected to solve the problem and they stay at the bottom of the expectation scale. Since (9a) asserts the least expected proposition is true, it implies that the problem at hand is an easy one, and everybody else is able to solve it. The other two examples evoke the same kind of presuppositions and implicatures. In (9b), *Zhangsan went* is the least expected among the propositions of the form *x went*, and in (9c) *working on weekends* is the least expected among alternative working schedules.

The *lian...dou* construction is a representative example of the scalar context in which *dou* can participate. I will introduce more examples in Sect. 5. Examples of this sort seem to suggest a separate semantics that distinguish *dou* in these contexts from *dou* in the distributive contexts. But in this paper I will argue that there is an underlying core for different usages of *dou*.

3 Plurality and maximality

In this section, I will examine the conventional claim that *dou* can serve as a distributor. I will show that if *dou* is a distributor, it has to be a very *sloppy* one, since the set of individuals that *dou* is distributing over is often fixed by context.

I propose that *dou* is simply a maximality operator. It operates on a set that has been partitioned by covers and picks out the maximal plural individual. This analysis inherited some important insight from previous analyses that treat *dou* as a generalized distributor (Lin 1998) and sum operator (Huang 1996), but I will show that they are eventually inadequate to cover the full range of data.

3.1 Distributing into non-atoms

As shown earlier, *dou* is often considered as a distributor because it does not have a collective reading when the predicate can be distributed into individual members. The following data is repeated from (6) and (7):

- (11) Tamen dou chi-le yi-ge pingguo pai
 They dou eat-Perf one-Cl apple pie
 a. 'They each ate an apple pie.'
 *b. 'They ate an apple pie (together)'
- (12) Tamen chi-le yi-ge pingguo pai
 They eat-Perf one-Cl apple pie
 a. 'They each ate an apple pie.'
 b. 'They ate an apple pie (together)'

However, as noted in the literature, *dou* doesn't behave exactly like the English distributor *each* (Lin 1998). A critical difference is that as a *strict* distributor, *each* can't distribute collective predicates, presumably because *each* distributes down to the atomic individual members of a plural DP, but the collective predicate on the other hand can't be true for a single individual. *Dou*, however, is compatible with collective predicates. The following examples demonstrate this contrast:

- (13)a. Tamen **dou** shi pengyou.
 they dou be friend
 'They (all of them) are friends.'
 b. *they **each** are friends.
- (14)a. Tamen **dou** jian-guo-mian
 they dou meet-Perf-face
 'They all met before.'
 b. *They **each** met before.

3.2 The sum operator analysis

Huang (1996) analyzed *dou* as a sum operator on events, as demonstrated below:

- (15) $DOU(e, Pred) = \cup\{ePRED1, ePRED2, ePRED3, \dots\}$
 e is an event of minimum size consistent with the semantics of the PRED.

The events of minimal size refer to events that involve minimal number of arguments required by the predicate. For example, *dance* only requires minimally one member for its argument, but a collective predicate such as *meet* will require minimally two members for its argument. Under this analysis, *dou* is sensitive to the lexical semantics of the predicate, and the difference between *dou* and *each* follows naturally.

However, this analysis over-generalizes. It predicts that *dou* always asserts that the maximal plural event is true, which is not the case. Consider the example in (16):

- (16) Tamen dou mai-le fangzi
 they dou buy-Perf house
 a. 'They each bought a house/houses.'
 b. 'They bought houses.'

This sentence couldn't mean that all the people bought a house together. In other words, there has to be some kind of distributivity involved. But it is ambiguous as to how to distribute the house-buying event. It could have a strong distributive reading such that each individual bought houses separately, as shown in (16a). But it could also mean something vague like (16b). Essentially (16) only says that each individual participated in some house-buying event, but we don't know who bought a house by himself, and who bought a house/houses with other people collectively. The exact distribution of house buying is underspecified. For instance, one can imagine a context where there are some couples in the set of people under consideration, and then each couple can jointly buy a house, and the rest of the people can each buy a house.

The second reading in (16b) is unpredicted by the sum operator analysis. A minimal house-buying event only requires one individual, since *house-buying* is not a collective predicate. Under the sum operator analysis, (16) will only assert a plural event with maximal number of minimal house-buying events, namely, each individual bought his own house. This is certainly too strong a claim.

Therefore, although *dou* indeed triggers distributivity, it doesn't specify how the predicate is distributed over a plural set of individuals. This flexibility makes the generalized distributor analysis very attractive (Lin 1998). The original motivation of using generalized distributors (Schwarzschild 1996) is exactly to account for the vagueness problem in the interpretation of plurals. In next section, I will first lay out the general background in the literature, and then examine Lin's analysis that treats *dou* as a generalized distributor.

3.3 Covers and generalized distributor

It has long been observed that distributivity and collectivity are connected. The utterance in (17) is ambiguous between a distributive reading and a collective reading. Under the distributive reading, each person bought a house. The collective reading, on the other hand, only contains one atomic event, namely, the buying of a house that involves three agents at the same time.

- (17) Mary, John and Bill bought a house.
 Mary, John and Bill each bought a house. (distributive)
 Mary, John and Bill bought a house together. (collective)

Interestingly, intermediate readings exist that are not completely distributive or completely collective. (18) is a classical example from Gillon (1987).

- (18) The men wrote musicals.

Suppose the DP *the men* denotes the set containing Rodgers, Hammerstein, and Hart. There is at least one reading that (18) is true if Rodgers and Hammerstein wrote musicals together, and Rodgers and Hart collaborated together. Under this interpretation, there is no strict distributivity that each of the three people wrote musicals independently, and there is also no strict collectivity that three people collaborated to write musicals.

Gillon (1987), Higginbotham (1981) and Schwarzschild (1996) discuss the idea of a cover to account for all three readings above. A cover is a partition of the plurality P if and only if the following criteria are met (Schwarzschild 1996, p. 64):

- (19) C is a cover of P if and only if:
- (i) C is a set of subsets of P
 - (ii) Every member of P belongs to some set in C.
 - (iii) \emptyset is not in C

For example, if P is a set that contains four members: John, Matt, Bill and Chris, we could have different ways to partition this set into smaller subsets. In other words, we could have different covers. The following are some possibilities:

- (20) C1: {{J, M, B, C}}
 C2: {{J, M}, {B, C}}
 C3: {{J}, {M, B, C}}

 Cn: {{J}, {M}, {B}, {C}}

Moreover, Schwarzschild proposed the following interpretive principle (revised from Gillon 1987; Higginbotham 1981):

- (21) [_S NP_{plural} VP] is true iff there is a cover C of the plurality P denoted by NP such that VP is true for every element in C. (p. 64)

According to (21), how we interpret the sentence *the men wrote musicals* depends on how we choose the cover C. If we choose C1, we are taking the group of men as one plural object. Since there is only one element in C1, by applying (21), the predicate *wrote musicals* is true for this plural object. The sentence would mean that John, Matt, Bill and Chris collaborated to write musicals. This is the collective

reading. On the other hand, if we choose Cn as our cover, there are four elements in Cn, and the predicate *wrote musicals* is true for each of the four elements, then we end up having a distributive reading that each person wrote musicals independently. The intermediate readings arise if we choose intermediate covers. As shown in (20), there are many possibilities of intermediate readings because there are different ways to partition the set of four men. If we choose C2 as our cover, the sentence is true if John and Matt are collaborating and Bill and Chris are collaborating. If we choose C3, the sentence is true if John is working by himself, and Matt, Bill and Chris are collaborating, and so on and so forth. Notice that under this analysis, all these interpretations involve universal quantification, which is restricted to the contextually determined covers over the domain instead of the domain itself. To give a more general analysis to all these interpretations, we can adopt the generalized D-operator proposed by Schwarzschild. Supposing that α is a variable over predicates, D is a distributive operator, x and y are variables over the relevant domain in the discourse, the claim in (21) suggests the following analysis:

$$(22) \quad x \in \llbracket D(\text{Cov})(\alpha) \rrbracket \text{ iff} \\ \llbracket \text{Cov} \rrbracket \text{ is a cover of } x \wedge \forall y [y \in \llbracket \text{Cov} \rrbracket \rightarrow y \in \llbracket \alpha \rrbracket] \quad (\text{Schwarzschild 1996})$$

The cover $\llbracket \text{Cov} \rrbracket$ is a set of sets, and its value is assigned by contextual (including non-linguistic) factors. The generalized distributor D doesn't operate directly on the atomic individuals in the domain; instead it operates on the members of the cover set.

3.4 Against *dou* as the generalized distributor

Now let's turn to the analysis of *dou*. Lin (1998) analyzed *dou* as a generalized distributor because in the context of collective predicates, *dou* doesn't distribute down to the atomic individuals in the domain. One of his examples is given below:

$$(23) \quad \begin{array}{l} \text{Naxie ren} \quad \text{dou shi fuqi} \\ \text{those people} \quad \text{dou be husband-and-wife} \\ \text{Those people are all couples.} \end{array}$$

Suppose now the set *those people* has a denotation of Mary, Bill, Ann and Chris. Because the predicate *being a couple* can only be true for a pair of people, it can't be distributed over each single member of the set. The set has to be partitioned first, i.e., we need a cover to work on. Supposing our cover contains pairs {M, B} and {A, C}, *dou* as a generalized distributor can distribute the predicate *being a couple* into each member of the cover. In this respect, *dou* is different from the real distributor *each* in English. *Each* is incompatible with collective predicates, because its inherent distributive property makes it operate upon atomic members of the set, not the covers.

Dou as a generalized distributor can also explain why sometimes *dou*-sentences have intermediate readings that are not strict distributive or strict collective but something in the middle. The following example is repeated from (16).

- (24) Tamen dou mai-le fangzi
 they dou buy-Perf house
 They bought houses.

However, the original motivation to propose a generalized distributor is because plurals are vague among having distributive, intermediate and collective readings. Therefore, if *dou* is an explicit spell-out of the generalized distributor, it should also demonstrate the three-way ambiguity. Unfortunately, as we have shown earlier, *dou* never demonstrates collective readings, which is the most frequently quoted distinction between a *dou*-sentence and its non-*dou* counterpart. The following is such an example. With *dou* present, (25) only has a distributive reading, which says each person bought a car. Without *dou*, (26) is ambiguous between a distributive and a collective reading.

- (25) Zhangsan he Lisi dou mai-le yi-liang-che.
 Zhangsan and L. dou buy-Perf one-Cl-car
 ‘Zhangsan and Lisi each bought a car’.
- (26) Zhangsan he Lisi mai-le yi-liang-che.
 Zhangsan and L. buy-Perf one-Cl-car
 a. ‘Zhangsan and Lisi each bought a car’.
 b. ‘Zhangsan and Lisi bought a car together’.

The claim that *dou* disallows the single-cover reading might seem to be anti-intuitive in the presence of a collective predicate. On the surface, a collective predicate does seem to give rise to the single-cover reading, even when *dou* is present. But I will argue that the desired reading can be derived from multiple covers as well. Consider the earlier example from (13), repeated below:

- (27)a. Tamen **dou** shi pengyou.
 they dou be friend
 ‘They (all of them) are friends.’

Let’s suppose that the relevant set of people in the context is {a, b, c}. We can derive the right interpretation of (27) if we only has one cover that covers all three individuals, and the collective predicate *being-friends* is applied to this cover so that the three people are friends with each other. But we can also derive the same interpretation through multiple covers. Consider the multiple-cover partition in the following way:

- (28) {{a, b}, {b, c}, {a, c}}

When the predicate *being-friends* is applied to these three covers, we get the interpretation that *a* and *b* are friends, *b* and *c* are friends, and *a* and *c* are friends, and therefore all three people are also friends.

To summarize, the generalized distributor analysis of *dou* captures the critical insight that the distributive reading of *dou* is vague and depends a lot on contextual factors and the lexical semantics of the predicate. However, this analysis makes the wrong prediction that *dou* should generally allow the single-cover/collective readings.

4 *Dou* as a maximality operator

4.1 *Dou* imposes maximality/exhaustivity

It is known that although definite descriptions generally denote the maximal plural individual, and hence should be exhaustive, strict maximality doesn't always hold. Brisson (1998) discusses the following case:

(29) The boys are building a raft.

This sentence is ambiguous between a collective reading and a distributive reading. But in its distributive reading, it is still vague in terms of how distributive it could be. One obvious distributive reading is that each boy is building a raft, so that the property of building a raft applies to each boy in the plural set in an exhaustive fashion. However, a non-exhaustive distributive reading is also possible. In a context where there is a very large group of boys, if most boys are building their rafts, and one or two boys are doing something else, the sentence is still true. In other words, although the predicate *building a raft* holds for a plural individual that consists of most of the boys, it does not hold for the maximal set of boys. Also note that since (29) does involve an implicit generalized distributor, it suggests that maximality is not an inherent feature of the generalized distributor.

Now let's turn to the case of Mandarin *dou*. It turned out that *dou* gives rise to strict exhaustivity. Consider the pair of sentences below:

(30) Haizimen qu-le gongyuan
Children go-Perf Park
The children went to the park.

(31) Haizimen **dou** qu-le gongyuan
Children **dou** go-Perf park
The children **all** went to the park.

Like the English sentence in (29), (30) doesn't require strict maximality. The sentence could be true if for a large group of children, most of them went to the park, but one or two didn't. However, when *dou* is used, as shown in (31), the sentence can only be true when every child went to the park.

Therefore, *dou* forces strong maximality. The concept of covers is needed in interpreting plural nouns. *Dou*, as a maximality operator, operates at the level of a set of covers and outputs a maximal plural individual that consists of all the covers.

In the case of (31), this ensures that every individual in the set is included. I will also suggest that being a maximality operator, *dou* has a plural presupposition, such that the domain on which it operates has to contain more than one cover. It is this presupposition that in general rules out the single-cover reading, as shown by the contrast between (25) and (26).

One advantage to associate *dou* with a maximality operator is that it makes a tighter connection between *dou* in the distributive context and *dou* in other context, as I will discuss in Sect. 5. But before I visit those cases, in the next section I will introduce a proposal that analyzed *dou* as a maximality operator based on evidence from a completely different domain: licensing free choice items.

4.2 Maximality and FCI licensing

Giannakidou and Cheng (2006) discussed the contribution of *dou* in licensing Chinese free choice items (FCIs). They have two critical insights. First, *dou* by itself doesn't directly license FCIs. Rather, it operates on an intensionalized domain. For example, in an episodic context (32), the wh-FCI *which-student* is not licensed even with the presence of *dou*, but the combination of *dou* and a modal context in (33) meets the licensing condition.

(32) *Na-ge xuesheng dou jinlai-le
Which-Cl student dou enter-Perf
'Every/any student entered.'

(33) Na-ge xuesheng dou keyi jinlai
Which-Cl student dou can enter.
'Every/any student can enter.'

The second observation is that *dou* contributes to the maximality and exhaustivity of the FCIs, which is confirmed by the contrast of the following two examples:

(34)a. Ta bu xiang mai na-ben-shu
He not want buy which-Cl-book
He doesn't want to buy any book (in particular)
b. Ta na-ben-shu **dou** bu xiang mai.
He which-Cl-book dou not want buy
He doesn't want to buy any book (at all)

(34b) has a much stronger exhaustive reading such that for a contextually determined set of books 'he absolutely doesn't want any of them'. But for (34a), the speaker is talking about a more general fact and there isn't a contextually salient set that is exhaustively evaluated.

Giannakidou and Cheng (2006) propose that *dou* is a maximality (iota) operator, as shown in (35).

(35) $[[\text{dou}]] = \lambda P \iota(\lambda x \cdot P(x))$

In the context of FCI licensing, *dou* takes an intensionalized property as its input and returns a maximal plural individual. This analysis converges nicely with the current analysis of *dou* in the distributive context, and I will therefore adopt this formalization. The only difference in the distributive context is that now the input to *dou* is a set of covers that partition a plural noun rather than an intensionalized property.

The semantic core of *dou* in (35) can be generalized to other contexts as well. In the rest of this paper, I will show that when *dou* is used in other contexts, especially the scalar ones, it also imposes maximality to a set of degrees and return the maximal degree on a contextually determined scale.

5 Maximality and scalar inferences

5.1 The scalar inferences of *dou*-sentences

As discussed in the introduction, *dou* seems to be able to contribute to a scalar meaning that is similar to English *even*. The *lian...dou* construction is as an often cited example of this sort. In this section I will discuss two more contexts where *dou* seems to add a flavor of *even*-sense to the interpretation. First let's consider the following examples, where *dou* can be roughly translated as *already*:

(36) Dou ji dian ne? ni zenme hai mei shui.
 dou what time Q you how still not sleep
 'What time is it already? How come you haven't gone to bed yet!'

(37) Yizhuanyan, haizi dou da le.
 in a blink, children dou grown Perf
 'Time flies! In a blink of time, the children have already grown up.'

(38) Liuyue dou guo wan le. Zenme hai zheme leng.
 June dou pass finish Perf How still this cold
 'It is the end of June already. How come it is still this cold!'

Although the translations with *already* are acceptable, they don't exactly capture the meaning of *dou* here for two reasons. First, in all the examples above, one can add an explicit *already* to it. One example is given in (39). If *dou* already means *already*, it is not clear why an extra *already* is allowed.

(39) Dou **yijing** ji dian ne? ni zengme hai mei shui.
 dou **already** what time Q you how still not sleep
 'What time is it already? How come you haven't been to bed yet!'

Second, all the examples above need to occur in particular contexts, which don't constrain *already* as much. For example, based on the translation *what time is it already*, the speaker of (36) seems to ask a simple question and expect an answer of a certain time. But this is not what (36) means. It is true that the hearer could answer

two o'clock in the morning; however, asking a question is not the point for the speaker. It might well be the case that the speaker knows exactly what time it is, or he doesn't care about the exact answer. The message that the speaker tries to convey is simply that *it is very late now, and you should have gone to bed. It is very unexpected at this time to see you awake*. For (37), if we just say that *the children have already grown up*, it could be a simple statement of fact. By adding *dou* to the sentence, the speaker again expresses surprise about the unexpectedly rapid passing of time such that even the next generation has grown up. The last example (38) also expresses a high degree of unexpectedness. Normally one expects the weather to start getting warm at the end of March and to start getting hot at the end of May. By using *dou*, the speaker expresses a strong emotion of surprise or disappointment.

Therefore, the use of *dou* in these context does not simply state the ready existence of an event. Rather, the presence of *dou* adds a very strong sense of maximal surprise or unexpectedness from the speaker's point of view.

The other scalar context in which *dou* can appear is the *de*-degree construction. I call it the *de*-construction because in this construction a degree modification on the predicate is introduced after the functional morpheme *de*.

(40) Ta qi-de dou feng-le.
 she angry-Ext dou crazy-Perf
 She is so angry that she went crazy.

(41) Ta shou-de dou zhi shengxia gutou le.
 She thin-Ext dou only leave bone Perf
 She is so skinny that she only has bones on her.

In these examples, there is a scale defined by the gradable predicate. In (40), it is a scale of angry-ness, and in (41), it is a scale of skinniness. The degree of these gradable predicates is open to many alternative possibilities, but the functional morpheme *de* introduces the extent of the degree, such that the person in (40) is angry to the degree of being crazy, and the person in (41) is skinny to the degree of being bony.

Note that *dou* is not obligatory in the degree constructions, but its presence makes some subtle differences in meaning. A degree construction without *dou* simply describes a degree of the predicate, but the same sentence with *dou* emphasizes the upper-bound of the maximal degree. The contrast could be subtle, but one can see it more clearly in cases where the degree description is normal for the predicate under average standards.

(42)(a) Ta shangxin-de ku le.
 she sad-Ext cry Perf
 She is sad and she cried.
 (b) Ta shangxin-de dou ku le.
 she sad-Ext dou cry Perf
 She is so sad that she cried.

Being sad to the degree that one starts crying is not uncommon under average circumstances. (42a) simply describes a fact. We do not know from this sentence if the woman's crying signals an unexpected degree of sadness, or if she is crying just like any sad person would. However, (42b) adds an implication that crying in this context is actually a sign of very deep grief. A more accurate translation of (42b) is one that uses *even*, such as *she is so sad that she even cried*. The contrast is made clearer in the following pair:

- (43) Ta bushi hen shangxin...
 she not very sad...
 She is not very sad
- (a) Ta zhibuguo ku-le
 She only/just cry-Perf
 She only cried.
- * (b) Ta zhibuguo dou ku-le
 she only/just dou cry-Perf
 She only even cried.

In this example, a context is set up such that the person isn't very sad. The use of *only/just* emphasizes the non-maximal degree of sadness, and that is not compatible with *dou*.

What kind of semantics of *dou* can account for these scalar interpretations? There are two logical possibilities. One is that *dou* is scalar in nature and directly leads to scalar interpretations. The other one is that the surface scalarity is simply a by-product of a more general semantic core of *dou*. A preliminary sign that suggests *dou* itself is probably not scalar comes from the observation that the scales with which *dou* associates are largely context-dependent. It could be about a likelihood scale or any scales a gradable predicate defines. In the following sections, I will argue that in the scalar contexts *dou* only contributes to maximality, rather than scalarity, and the various scalar meanings are provided elsewhere in the sentence. Since the *lian...dou* construction is the most often discussed example as being similar to English scalar particle *even*, I will start from a more detailed examination of this case.

5.2 *Dou* imposes exhaustivity on alternatives

In Mandarin Chinese, there are a few other ways to express the truth of a low-likelihood event. *Juran* or *jingran* are the two examples, for instance. Consider the following sentence in the context that Jane is the best student in class:

- (44) Zhe-ci kaoshi hen jiandan, henduo ren de A,
 this-Cl exam very easy many people get As
 This test is very easy and many people got As.
- Keshi *juran/jingran* Jane bu jige
 but even Jane not pass
 but Jane didn't even pass.

This sentence only says that a very low-likelihood event, e.g., Jane failed the test, is true, but it doesn't imply anything about the students that under normal circumstances are more likely to fail. In fact, in this small discourse we set up, other students probably all got As. In sharp contrast to this sentence, given the same discourse, the *lian...dou* construction is not allowed.¹

- *(45) keshi *lian* Jane *dou* bu jige
 but *lian* Jane *dou* not pass
 but even Jane didn't pass.

(45) is not acceptable exactly because it implies that more people have failed the test, including those that are more likely to fail under normal circumstances, which conflicts with the information in the discourse. But (45) becomes acceptable if the discourse context is different such that the test is very difficult for everybody.

- (46) Zhe-ci kaoshi hen nan, henduo ren mei guo,
 this-CL exam very difficult many people not pass
 This test is very difficult and many people didn't pass,

lian Jane *dou* bu jige
lian Jane *dou* not pass
 even Jane didn't pass.

This set of examples suggests that the focus of the *lian...dou* construction is not only that the least likely event is true; rather it emphasizes that the alternatives to the least likely event, namely, the more likely ones, are also true. In other words, the *lian...dou* construction imposes strong exhaustivity requirement on the set of alternatives.

The English *even* also seems to require exhaustivity. In a scenario like (44), English speakers also cannot put the focus on *Jane*, and hence the following sentence is contradictory:

¹ One anonymous reviewer pointed out that the contrast between (44) and (45) could also be due to the syntactic differences between *jurán/jingrán* and *lian*, such that *jurán/jingrán* could syntactically modify the VP, instead of the DP. This is a genuine possibility, especially given the alternative word order below (cf. example 44):

- (i) keshi Jane *jurán/jingrán* bu jige
 but Jane even not pass
 but Jane didn't even pass.

However, the word order in (44) also suggests that *jurán/jingrán* could modify the whole CP. Also note that one can add *dou* or *lian...dou* to (44), as shown below:

- (ii) keshi *jurán/jingrán* (*lian*) Jane *dou* bu jige
 but even (*lian*) Jane *dou* not pass
 but even Jane didn't pass.

Syntactically, this example suggests that *jurán/jingrán* could indeed modify a CP. Semantically speaking, with the presence of *dou*, (2) again implies strong exhaustivity and is not appropriate in the context of (44) anymore. Since the syntax of *jurán/jingrán* and *dou* is not the focus of the current paper, I will not further pursue this issue in the current discussion.

*(47) This test is very easy and many people got As. But even Jane failed.

For *even*, the implication about the set of alternatives is standardly considered as part of the lexical semantics of *even*. But we can break down the *lian...dou* construction further and find out the contribution of each morpheme.²

I will suggest that *lian* sets up the set of alternatives and *dou* imposes maximality on the set, which leads to strong exhaustivity. *Lian* literally acts as a conjunction roughly meaning *together*, *with* or *and*, as shown below:

(48) Ta xi yifu shi lian beizi yiqi xi le
 He wash cloth time with quilt together wash Perf
 When he washed the clothes, he washed the quilt together.

In the *lian...dou* construction, *lian* is often analyzed as a focus marker (Shyu 2004; Paris 1998). Being a focus marker, *lian* naturally evokes a set of alternatives (Rooth 1985). It is this set of alternatives on which *dou* can operate. Modeled from English *even*, the lexical entry of *lian* is given below:

(49) The lexical entry of *lian*:

- (i) $[[\textit{lian}(x)(P)]] = 1$ iff $P(x) = 1$
- (ii) $\exists y[y \neq x \wedge C(y) \wedge P(y)]$ (C is the alternative set)
- (iii) All the alternatives are (partially) ordered on a likelihood scale such that:
 $\forall y [y \neq x \rightarrow \text{likelihood}(P(y)) > \text{likelihood}(P(x))]$

As a maximality operator, *dou* should pick out the maximal degree from the set of likelihood degrees. One immediate question arises. Like the English *even*, the *lian...dou* construction asserts that the least likely event is true, rather than the most likely one. How could the maximality operator pick out the smallest likelihood degree? One solution is to rethink what kind of scale *lian* introduces. We have assumed so far that similar to *even*, *lian* introduces a likelihood scale, but this does not necessarily need to be the case. *Lian* could introduce a scale about unexpectedness and *dou* pick out the maximal degree on this scale. The modified lexical entry of *dou* is demonstrated below:

(50) The lexical entry of *lian*:

- (i) $[[\textit{lian}(x)(P)]] = 1$ iff $P(x) = 1$
- (ii) $\exists y[y \neq x \wedge C(y) \wedge P(y)]$ (C is the alternative set)
- (iii) All the alternatives are (partially) ordered on a scale about unexpectedness such that: $\forall y [y \neq x \rightarrow \text{unexpected}(P(x)) > \text{unexpected}(P(y))]$

² I would like to thank one of the anonymous reviewers for pointing out the contribution of *lian* and *dou* should be separated, such that *lian* provides scalarity, and *dou* is only a maximality operator. The reviewer also provided ideas on the exact semantic meaning of *lian*. The comments and encouragement from this reviewer are deeply appreciated.

On a scale of unexpectedness, when the most unexpected degree is true for some event, the rest of the alternatives (i.e., the less unexpected ones) are entailed to be true as well, and this guarantees the exhaustivity.

The strong exhaustivity requirement of *dou* becomes clearer when we compare *lian...dou* with the very similar combination *lian...ye*. The morpheme *ye* by itself simply means *also* or *too*:

- (51) Nǐ du-guo na-ben-shu, wo ye du-guo.
 You read-Perf that-CL-book, I also read-Perf
 You read that book. I read it too.

As shown by this example, *ye* simply states that some alternatives are true. When used together with *lian*, however, the *lian...ye* combination is almost exchangeable with the *lian...dou* combination on some occasions.

- (52) Ta qi wan le, lian zaofan ye/dou mei chi.
 he get-up late Perf lian breakfast ye/dou not eat
 He got up late, (so) he didn't even eat breakfast.

Both *ye* and *dou* imply there might be other things the person has skipped in addition to the breakfast. The fact that *lian...ye* expresses a similar meaning to *lian...dou*, and *ye* by itself is unambiguously referring to alternatives, further confirms that *dou* makes reference to alternatives as well. The subtle difference between the two, crucially but unsurprisingly, is that *lian...dou* has a much stronger exhaustivity implication. In situations where the speaker intends to emphasize exhaustivity, the *lian...dou* combination is preferred. Consider an earlier example again, repeated below:

- (53) Lian shagua dou zhidao zhege.
 lian idiot dou know this
 'Even idiots know this.'

Speakers can accent on the word *idiot* to emphasize on the intended message that everybody knows how to do it. When the noun is stressed, the *lian...dou* combination will be much more preferred.

The difference could be subtle, because the *lian...dou* combination requires a stronger condition to be met, and hence whenever *lian...dou* can be used, the context almost always licenses the weaker *lian...ye* combination. But not all the *lian...ye* contexts can easily accommodate *lian...dou*. One can find context where the speaker simply emphasizes the fact that some alternatives are true, with no obvious intention for exhausting a whole set of alternatives. *Lian...ye* fits more naturally in this kind of situation. (54) provides such a context. In this example, the speaker only expresses that there is an extra thing that is done, but there is not a presupposed set of things the speaker wants to exhaust.

- (54) wo zhi rang ta dasao fangjian, dan ta lian fan
 I only ask him clean room but he lian meal
 ye shao-hao-le.
 ye cook-done-Perf
 I only asked him to clean the room, but he also cooked the meal.

5.3 Other scalar contexts

So far I have shown that under the proposal that *dou* is a maximality operator, we can explain the semantic contribution of *dou* in both the distributivity context and in the *lian...dou* construction. In a distributive context, the partition of a domain defined by the plural noun phrase provides a set of covers upon which maximality can operate. In the *lian...dou* construction, the input to the maximality operator is the alternative degrees ordered on a scale about unexpectedness. In the latter case, because of the scalar inferences, maximality also leads to strong exhaustivity.

We see the maximality function of *dou* in other scalar contexts as well. The following example is repeated from (38):

- (55) Liuyue dou guo wan le. Zenme hai zheme leng.
 June dou pass finish Perf. How still this cold
 'It is the end of June already. How come it is still this cold!'

This sentence emphasizes the maximal degree of surprise about the fact that the weather is cold at the end of June. The speaker could be implicitly comparing the cold weather in June with the cold weather in January or February, and the latter cases are less surprising.

In the degree constructions, the gradable predicate introduces an (partially) ordered scale, which contains a set of degrees. From this set of degrees, the predicate following *de* provides the specific description of the degree that the subject individual is mapped to. The following example is repeated from (40):

- (56) Ta qi-de dou feng-le.
 she angry-Ext dou crazy-Perf
 She is so angry that she went crazy.

Recall that in the degree constructions, the presence of *dou* also picks out the maximal degree for the gradable predicate. Because of this, *dou* is incompatible with *only/just*, although the same degree construction without *dou* is acceptable, as shown in (43).

Therefore, similar to the *lian...dou* construction, *dou* in these other scalar contexts also picks out the maximal degree from a scale. As an extension of the the maximality (iota) analysis of *dou* in (35), the maximality over degrees is demonstrated in (57):

- (57) D is a set of ordered degrees,
 $\text{dou}(D) = \text{id}(d \in D \wedge \forall d' \in D (d \geq d'))$

The exact scale and the degrees involved are determined by context, and *dou* simply operates on the set of degrees and outputs the maximal one.

6 Conclusions

In this paper I discuss different usages of Mandarin *dou* and provide a unified analysis. I show the semantic core of *dou* is simply a maximality operator. This analysis converges with the analysis in Giannakidou and Cheng (2006), which investigated a different set of phenomena. By assuming the maximality function of *dou*, one can account for a large range of the empirical data, including distributivity, scalar interpretations and polarity licensing.

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