Alternations of logical functions: Mandarin particle *dou* as a pre-exhaustification exhaustifier

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Abstract Semantic variations of logical particles should be either non-existent or very limited, otherwise the logical system of the universal grammar would be too complex to acquire. Nevertheless, a number of functional particles possess various logical uses. Take the Mandarin particle *dou* for example. Varying by the item associated with and the prosodic pattern of the environment appearing in, *dou* can trigger a distributivity effect, license a universal free choice item, or evoke an *even*-like inference. To maintain the simplicity of the universal grammar, it is crucial to figure out which function or functions are primary, what parameters are responsible for the alternations of the logical functions, and how these alternations are conditioned.

In this paper, I argue that the seemingly unrelated functions of *dou* share the same source: *dou* is a pre-exhaustification exhaustifier operating on sub-alternatives. Uniformly, *dou* affirms the truth of its propositional prejacent, negates the exhaustification of each sub-alternative, and presupposes the existence of at least one sub-alternative. Function alternations result from minimal weakening operations on the semantics of sub-alternatives. In particular, sub-alternatives are primarily weaker alternatives, and thus the presupposition of *dou* yields a distributivity effect. Further, when the semantics of sub-alternatives is weakened under particular syntactic or prosodic conditions, *dou* gains its other logical functions.

1. Introduction

The Mandarin particle *dou* is known for its function diversity. As a rough classification, *dou* can be used as a quantifier-distributor, a universal free choice item (∀-FCI) licenser, and a scalar additive operator. This paper presents a uniform semantics of *dou* to capture its seemingly diverse functions. I propose that *dou* is a special exhaustifier with a pre-exhaustification effect. The basic idea of my proposal is as follows. For a *dou*-sentence of the form "*dou*(S_A)" where S is the prejacent clause and A is the associate of *dou*, its meaning is roughly 'S_A and not only $S_{A'}$' where A' is what I call a "sub-alternative" of A, which can be a proper subpart of A, a weak scale-mate of A, or a disjunction of A, and so on. For example, "John and Mary *dou* came" means that John and Mary came, not only John came, and not only Mary came; "it's *dou* five o'clock" means that it's five o'clock, not just four o'clock, not just three o'clock, ... I will argue that function alternations of *dou* come from the variations on what counts a sub-alternative.

The function diversity of *dou* raises two fundament questions for the semantics of natural languages: what is the underlying logical system of the universal grammar (UG), and how is it developed? The underlying logical system of UG is the core system of the semantics of human languages. It is made up of connectives (such as negation, conjunction, disjunction, conditional), quantifiers, and so on. This system should be simple and consistent, otherwise we wouldn't have been able to acquire it so easily (Chierchia 2016). Nevertheless, cross-linguistically, many functional particles possess various basic functions. As Gil (2013) reports, 67% of world's languages possess such multi-functional particles. Typical examples include Mandarin particles *dou* and *ye*, and

Japanese particles *ka* and *mo*,[1] and so on. For each of these particles, its diverse functions should have primarily the same source, otherwise the logical system of UG would be unrecognizable. The alternations of the functions should be triggered by minimal variations, otherwise function diversity would not be cross-linguistic. The Mandarin particle *dou*, with a long history for at least 1800 years (Gu 2015), is an excellent case to study the development of the logical system in UG.

The rest of this paper is organized as follows. Section 2 describes the three basic uses of *dou*, including the quantifier-distributor use, the ∀-FCI licenser use, and the scalar additive operator use. Section 3 discusses the advantages and problems of two representative approaches to the semantics of *dou*, including the distributor approach (Lin 1998) and the maximality operator approach (Giannakidou and Cheng 2006; Ming Xiang 2008). Section 4 starts with Alternative Semantics and the meaning of the canonical exhaustifier *only*. Then it outlines a preliminary treatment for the semantics of *dou* in parallel to that of *only*. Section 5 derives the three basic uses of *dou* and explains the relevant semantic effects. Section 6 discusses the alternations of the functions of *dou*. Appendix I reviews a competing approach suggested by reviewers, which contributes the derivation of FC to recursive exhaustifications. Appendix II reviews the analyses by Liao (2011) and Liu (2016b,c, 2018), which also implement Alternative Semantics and exhaustification.

2. Describing the uses of *dou*

2.1. Quantifier-distributor

In a basic declarative sentence, *dou* is associated with a preceding nominal expression and universally distributes over the subparts of the denotation of its associate, as exemplified in (1). This use of *dou* is similar to the post-nominal use of the English particle *all*. Here and throughout this paper, the associate of *dou* is enclosed in "[•]".

(1) a. [Tamen] **dou** dao -le.
they DOU arrive -ASP
'They all arrived.'

b. [Tamen] **dou** ba naxie wenti da dui -le.
they DOU BA those question answer correct -ASP
'They all correctly answered these questions.'

c. Tamen ba [naxie wenti] **dou** da dui -le.
they BA those question DOU answer correct -ASP
'They correctly answered all of these questions.'

Under the quantifier-distributor use, *dou* brings up three semantic consequences in addition to universal quantification, namely, a "maximality requirement," a "distributivity requirement," and a "plurality requirement." Names of these requirements are quoted because they are used in a descriptive manner. Later, I will argue that both of the latter two requirements are illusions. The "maximality requirement" means that the presence of *dou* forces the predicate denoted by the

[1] There is a rich literature on the semantics of Japanese particles *ka* and *mo*. Representative works in contemporary semantics include: Kratzer and Shimoyama (2002); Mitrović (2014); Slade (2011); Szabolcsi (2010, 2015); Mitrovic and Sauerland (2014), among others.

remnant VP to be applied to the maximal element in the extension of *dou*'s associate (Ming Xiang 2008). For instance, in a discourse that a large group of children, with one or two exceptions, went to the park, the sentence in (2) is acceptable only when *dou* is absent.

(2) [Haizimen] (#**dou**) qu -le gongyuan.
children DOU go -PERF park
'The children (#all) went to the park.'

The "distributivity requirement" says that if a sentence admits both collective and (atomic or non-atomic) distributive readings, then adding *dou* to this sentence blocks the collective reading (Lin 1998). For instance, the presence of *dou* in (3) is infelicitous if the considered individuals all together participated in only one house-buying event.

(3) (Scenario: *The considered individuals all together bought only one house.*)
[Tamen] (#**dou**) mai -le fangzi.
they DOU buy -PERF house
'They (#all) bought house(s).'

The "plurality requirement" says that the associate of *dou*, overt or covert, must be non-atomic. If the prejacent clause of *dou* does not contain an overt non-atomic nominal item, *dou* has to be associated with a covert non-atomic item. For example, in (4), since the overt part of the prejacent clause has no non-atomic item, *dou* is associated with a covert item such as *mei-ci* 'every time.'[2]

(4) Yuehan [(mei-ci)] **dou** qu de Beijing.
John every-time DOU go DE Beijing
'For all of the times, the place that John went to was Beijing.'

2.2. Scalar marker

There are two types of structures where *dou* functions as a scalar additive operator: one is the [*lian* Foc *dou* ...] construction where *dou* is associated with *lian*+Foc, and the other is where *dou* is associated with an in-situ focused scalar item.

First, the [*lian* Foc *dou* ...] construction evokes an *even*-like inference, namely, it implies that the prejacent proposition is less likely than at least some of its contextually relevant alternatives, as exemplified in (5).[3] In the [*lian* Foc *dou* ...] construction, the presence of *lian* is optional, but the associate of *dou* must be stressed.[4]

[2]One might find it appealing to interprete *dou* in (4) as 'only' and associate it with *Beijing*, paraphrasing the sentence as 'for all the times, John only went to Beijing.' However, the following example excludes this possibility: the covert *mei-ci* 'every time' appears under the predicate *xiang* 'want', forcing *dou* to appear within the embedded clause.

(i) Wo (*dou) xiang [(mei-ci)] (dou) qu Beijing.
I DOU want every-time DOU go Beijing.
Intended: 'I want it to be the case that I go to Beijing all the times.'

[3]'$\rightsquigarrow p$' means that the Mandarin sentence implies the inference p. Here and throughout the paper, stressed items are capitalized, and focused items are marked with a subscript '$_F$'.

[4]In many cases, a non-subject associate of *dou* can also be left in-situ, as exemplified in the following:

(5) (Lian) [DUIZHANG]$_F$ **dou** chi dao -le.
LIAN team-leader DOU late arrive -ASP
'Even [the team leader]$_F$ arrived late.'
$\rightsquigarrow$ *The team leader is less likely to arrive late (than a regular team member).*

In particular, an indefinite phrase of the form "one-CL-NP" can be licensed as a minimizer at the focal position in a [*lian* Foc *dou* NEG ...] construction, as shown in (6a). Interestingly, as C.-T. James Huang (pers. comm.) points out, the post-*dou* negation is sometimes optional, as seen in (6b). In the presence of negation, (6b) means that John doesn't want any money; in the absence of negation, (6b) means that John is very greedy and wants to take any money regardless of how little amount that is.

(6) a. Yuehan (lian) [YI$_F$-ge ren] *(**dou**) *(mei) qing.
John LIAN one-CL person DOU NEG invite
'John didn't invite even one person.'

b. Yuehan (lian) [YI$_F$-fen qian] *(**dou**) (mei) yao.
John LIAN one-cent money DOU NEG request
With negation: 'John doesn't want even one cent.'
Without negation: 'Even if it is just one cent, John wants it.'

Second, *dou* can also be associated with an in-situ scalar item. In this case, the presence of *dou* implies that its prejacent proposition ranks relatively high with respect to the contextually relevant measurement. For example, in (7a), *dou* is associated with the numeral phrase *WU-dian* 'five o'clock', and the alternatives are ranked in chronological order. When *dou* takes this use, its associate can stay in-situ but must be focus-marked with stress.[5]

(i) a. Ta (lian) [NANJI]$_F$ **dou** qu -guo -le.
he LIAN Antarctica DOU go -EXP -ASP

b. Ta **dou** qu -guo [NANJI]$_F$ -le.
he DOU go -EXP Antarctica -ASP
'He even has been to Antarctica.'

(ii) a. Ta (lian) [XIAOXUE]$_F$ **dou** mei shang -guo.
he LIAN primary-school DOU NEG go -EXP

b. Ta **dou** mei shang -guo [XIAOXUE]$_F$.
he DOU NEG go -EXP primary-school
'He hasn't even been to primary school.'

But, there are still quite a few exceptions, which seem to be conditioned by the aspectual class of the sentence: to place the focused associate of *dou* in the in-situ position, the prejacent of *dou* has to express an accomplishment. Since the aspectual system of Mandarin is very complex, I will not dive into this puzzle in this paper.

(iii) a. Ta (lian) [ZHUXI]$_F$ **dou** renshi.
he LIAN chair DOU know
'He even knows the chair.'

b. * Ta **dou** renshi [ZHUXI]$_F$.
he DOU know chair

(iv) a. Ta (lian) [NANJI]$_F$ **dou** qu -guo (-le).
he LIAN Antarctica DOU go -EXP -ASP
'He even has been to Antarctica.'

b. Ta **dou** qu -guo [NANJI]$_F$ *(-le).
he DOU go -EXP Antarctica -ASP

[5]Note that the scalar additive operator use of *dou* in (7) is different from the non-scalar use in the following sentences, where *dou* is associated with the main verb, which is clearly non-scalar.

(i) a. Yuehan **dou** [LAI]$_F$ -guo zher yi-ci -le.
John DOU come -EXP here one-CL -ASP
'John has been here once.'

b. Yu **dou** [TING]$_F$ -le.
rain DOU stop -ASP
'The rain has stopped.'

Intuitively, here *dou* suggests a contrast between the status where a change has taken place (such as the status where John has been here, or it starts raining) and the status where this changed hasn't taken place (such as the status where John hasn't been here, or the rain hasn't started yet). So far, I don't have a full story on this use of *dou*.

(7) a. **Dou** [WU$_F$-dian] -le.
DOU five-o'clock -ASP
'It is five o'clock.'
⇝ *It's too late.*

b. Ta **dou** yijing lai -guo zher [LIANG$_F$-ci] -le.
he DOU already come -EXP here two-time -ASP.
'He has already been here twice.'
⇝ *Being here twice is quite a lot (for him).*

2.3. FCI-licenser

As a well-known fact, in Mandarin, pre-verbal *wh*-expressions and *renhe* 'any'-expressions can function as ∀-FCIs when preceding the particle *dou*, as exemplified in (8).

(8) [Shui/ Na-ge-ren/ Renhe-ren] *(**dou**) keyi jiao jichu hanyu.
who/ which-CL-person/ any-person DOU can teach introductory Chinese
'Anyone can teach Intro Chinese.'

More interestingly, in Yimei Xiang (2016b), I observe that associating *dou* with a pre-verbal disjunction also evokes a ∀-FC inference, as shown in (9a). Here, while the prejacent clause is a disjunction, associating the pre-verbal disjunction with *dou* yields a conjunctive inference. [6]

(9) a. [Yuehan huozhe Mali] keyi jiao jichu hanyu.
John or Mary can teach introductory Chinese
'Either John or Mary can teach Intro Chinese.'

b. [Yuehan huozhe Mali] **dou** keyi jiao jichu hanyu.
John or Mary DOU can teach introductory Chinese
Intended: 'Both John and Mary can teach Intro Chinese.'

To license the ∀-FCI use of a pre-verbal disjunction, *dou* has to be followed by an existential modal, such as *keyi* 'can'. If *keyi* is dropped or replaced with a universal modal *bixu* 'must', the presence of *dou* makes the sentence ungrammatical. The following sentences illustrate the case of pre-verbal disjunctions: in an episodic sentence or a universally modalized sentence, associating *dou* with a pre-verbal disjunction causes ungrammaticality.

(10) a. [Yuehan huozhe Mali] (***dou**) jiao -guo jichu hanyu.
John or Mary DOU teach -EXP introductory Chinese

b. [Yuehan huozhe Mali] (***dou**) bixu jiao jichu hanyu.
John or Mary DOU must teach introductory Chinese

Conditions of licensing *wh*/*renhe*-FCIs are hard to generalize. I will discuss them in section 5.2.2.

[6] My own intuition doesn't accept a ∀-FC reading for the without-*dou* sentence (9a). However, in an informal survey, judgments from 52 Mandarin native speakers were divergent: 22 speakers accepted only the simple disjunction reading, 24 accepted only the FC reading, and the rest 6 accepted both readings but their preferences were divergent. Crucially, 4 out of the 6 speakers who accepted both readings reported that they got the FC reading if unconsciously inserting a silent *dou* into the sentence, and that they got the simple disjunction reading if consciously avoiding doing so. Hence, there seems to be two types of speakers: "disjunction speakers" and "FC speakers". FC speakers read sentences like (9a) with a covert *dou*. While disjunction speakers resist a covert *dou*, due to probably the economy principle that a language-specific operator shall not be used covertly if it can be used overtly (Chierchia 1998).

2.4. Disambiguation

If a sentence has multiple items that are eligible to be associated with *dou*, the function of *dou* and the association relation can be disambiguated by stress. Compare the following three sentences with different prosody forms:

(11) a. [Tamen] **DOU/dou** lai -guo liang-ci -le.
they DOU/DOU come -EXP two-time -ASP
'They ALL have been here twice.'

b. (Lian) [TAMEN]$_F$ **dou** lai -guo liang-ci -le.
LIAN they DOU come -EXP two-time -ASP
'Even THEY have been here twice.'
$\rightsquigarrow$ *Compared with some other people, they are less likely to come here twice.*

c. Tamen **dou** lai -guo [LIANG$_F$-ci] -le.
they DOU come -EXP two-time -ASP
'They've been here even TWICE.'
$\rightsquigarrow$ *Being here twice is a lot for them.*

In (11a), where the prejacent of *dou* has no stressed item, *dou* functions as a quantifier-distributor and is associated with the preceding plural term *tamen* 'they'. While in (11b-c), *dou* functions as a scalar additive operator and is associated with the stressed item.

3. Previous studies

There are numerous studies on the syntax and semantics of *dou*. Earlier approaches treat *dou* as an adverb with universal quantification power (Ma 1983; Lee 1986; Cheng 1995; Pan 2006; Jiang 1998; among many others). Huang (1996) and Yuan (2005) treat *dou* as a sum operator operating on the event variable. Portner (2002) analyzes the scalar additive operator use of *dou* in a way similar to the inherent scalar semantics of the English focus sensitive particle *even*. Liao (2011) and Liu (2016b,c, 2018) also define *dou* as *even*, and derive the distributor use of *dou* based on a universal scalar presupposition. Hole (2004) treats *dou* as a universal quantifier over the domain of alternatives. This section will review two representative views on the semantics of *dou*, including the distributor approach by Lin (1998) and the maximality operator approach by Giannakidou and Cheng (2006) and Ming Xiang (2008). Reviews on Liao (2011) and Liu (2016b,c, 2018) are postponed to Appendix II since they involve technicalities to be introduced in later sections.

3.1. The distributor approach

Lin (1998) provides the first extensive treatment of the semantics of *dou*. He treats *dou* as an overt counterpart of the generalized distributor PART in the sense of Schwarzschild (1996), as defined in (12), where x stands for the associate of *dou* and P for the predicate that *dou* combines with.

(12) **Semantics of** *dou* (Lin 1998)
"x dou P" is true iff $\text{PART}_C(P, x) = 1$,
iff $\forall y \in C[y \leq x \rightarrow P(y)]$ where C is a cover of x.

The generalized distributor PART distributes over the cover of the associated item, whose members can be atomic or non-atomic. A cover of an entity X is a set of subparts of X, as defined in (13). The value of a cover is determined by both linguistic and non-linguistic factors.

(13) C is a **cover** of X (formalized as '$Cov(C, X) = 1$') iff
   a. C is a set of subparts of X;
   b. every subpart of X belongs to some member in C.

When a cover is a set of atomic elements, PART distributes down to atoms, yielding an atomic distributive reading. When a cover is a singleton set, distributivity becomes trivial, and applying PART returns a collective reading. In other cases, applying PART gives rise to a non-atomic distributive reading. For example, if the cover of $a \oplus b \oplus c$ is $\{a \oplus b, c\}$, '*abc* **dou** bought houses' means that *ab* together bought a house and *c* alone bought a house.

(14) Possible covers of $a \oplus b \oplus c$ and the corresponding readings of *abc* **dou** bought houses:

$\{a, b, c\}$	Atomic distributive	'*abc* each bought houses'
$\{a \oplus b, c\}$	Non-atomic distributive	
$\{a \oplus b, b \oplus c\}$		
...		
$\{a \oplus b \oplus c\}$	Collective	'*abc* together bought houses'

The distributor approach by Lin only considers the quantifier-distributor use of *dou*. It is unclear how to extend it to the other uses, such as the FCI-licenser use and the scalar additive operator use. Moreover, even for the quantifier use, this approach faces the following challenges.

First, *dou* evokes a distributivity requirement, but the generalized PART-distributor does not. For instance, as seen in (3) and repeated below, the presence of *dou* eliminates the collective reading of the prejacent sentence. As Ming Xiang (2008) argues, if *dou* were a generalized distributor, it should be compatible with a single cover reading (viz., the collective reading). For example, in (15), if *tamen* 'they' denotes the plural individual $a \oplus b \oplus c$, there can be a discourse under which the cover of *tamen* 'they' denotes a singleton set like $\{a \oplus b \oplus c\}$, and then Lin predicts *dou* to trivially distribute over this singleton set, yielding a collective reading, contra fact.

(15) [Tamen] **dou** mai -le fangzi.
   they DOU buy -PERF house
   'They **dou** bought houses.' (#collective)

Second, as shown by the contrast in (16), unlike English distributors like *each* and *all*,[7] Mandarin *dou* can be associated with a distributive expression such as NP-*gezi* 'NP each'.[8]

(16) a. The five investors each (*each/*all) invested in one startup.

[7] Champollion (2015) argues that *all* is a distributor that distributes down to subgroups, while that *each* distributes all the way down to atoms.

[8] Similar arguments have been reached by Cheng (2009) and others, but they mostly draw on the fact that *dou* can be associated with the distributive quantificational phrase *mei*-CL-NP 'every NP', as exemplified in (i). This fact, however, cannot knock down the distributor approach: observe in (i) that stress falls on the distributive phrase *mei*-CL-NP, not the particle *dou*; therefore, here *dou* might function as a scalar additive operator, not a quantifier.

b. [Zhe wu-ge touziren gezi] (**dou**) touzi -le yi-jia chuangye gongsi.
This five-CL investor each DOU invest PERF one-CL startup company
'The five investors each **dou** invested in one startup.' (atomic distributive)

3.2. The maximality operator approach

Another representative approach, initiated by Giannakidou and Cheng (2006) and extended by Ming Xiang (2008), is to treat *dou* as a maximality operator. Briefly, this approach assumes *dou* to have the following semantic characteristics: (i) it operates on a non-singleton cover of its associate and returns the maximal plural element in this cover, and (ii) it presupposes the existence of this maximal plural element. Since their original papers don't have a full formal definition, I schematize this idea as follows:

(17) **Semantics of** *dou* (based on Giannakidou and Cheng 2006 and Ming Xiang 2008)
Let $Cov(C, x) = 1$, then $[\![dou]\!](x) = |C| > 1 \wedge \exists y \in C[\neg \textsc{Atom}(y) \wedge \forall z \in C[z \leq y]]$.
$\iota y \in C[\neg \textsc{Atom}(y) \wedge \forall z \in C[z \leq y]]$
($[\![dou]\!](x)$ is defined only if the cover of x is non-singleton and has a unique non-atomic maximal element; when defined, the reference of $[\![dou]\!](x)$ is this maximal element.)

The maximality operator approach of *dou* is similar to the standard treatment of the definite determiner *the* (Sharvy 1980, Link 1983): *the* picks out the unique maximal element in the extension of its NP-complement and presupposes the existence of this maximal element.

(18) $[\![the]\!](P_{\langle \alpha,t \rangle}) = \exists x_\alpha[x \in P \wedge \forall y \in P[y \leq x]].\iota x_\alpha[x \in P \wedge \forall y \in P[y \leq x]]$
($[\![the]\!](P_{\langle \alpha,t \rangle})$ is defined only if there is a unique maximal object x such that $P(x)$ is true; when defined, the reference of $[\![the]\!](P_{\langle \alpha,t \rangle})$ is this maximal element.)

The maximality operator approach has two advantages over the distributor approach. First, it captures the maximality requirement. Second, it can be extended to the scalar use of *dou* (see Ming Xiang 2008). Nevertheless, this approach still faces several conceptual or empirical problems. First, it predicts no distributivity effect at all. Under this approach, "[x] **dou** did f" only asserts that the maximal element in the cover of x did f, not that each element in the cover of x did f. For instance, in (19) (repeated from (15)), if the cover of *tamen* 'they' is $\{a \oplus b, a \oplus b \oplus c\}$, then the asserted inference predicted by the maximality operator approach would simply be '$a \oplus b \oplus c$ bought houses,' which says nothing as to whether $a \oplus b$ bought houses.

(19) [Tamen] **dou** mai -le fangzi.
they DOU buy -PERF house
'They **dou** bought houses.' (#collective)

Second, the plurality requirement comes as a stipulation on the presupposition of *dou*: *dou* presupposes that the selected maximal element is non-atomic. It is unclear why this is so, because

(i) a. [MEI-ge ren] **dou** you youdian.
every-CL person DOU have advantage
'Everyone **dou** has some advantages.'

b. ?? [Mei-ge ren] **DOU** you youdian.
every-CL person DOU have advantage

the definite article *the* does not trigger such a plural presupposition. Moreover, as we will see in section 5.1.2, the so-called "plurality requirement" is illusive. This plural presupposition is neither sufficient nor necessary for accounting for the relevant facts.

4. Defining *dou* as a special exhaustifier

This section will start with Alternative Semantics and the meaning of the canonical F-sensitive exhaustifier *only*, and then will define the particle *dou* as a special exhaustifier in parallel to *only*.

4.1. Alternative Semantics

Rooth (1985) assumes that a meaningful linguistic expression α is associated with a set of focus (F-)alternatives 'F-ALT(α)' (also called the focus value of α and written as '$[\![\alpha]\!]_F$'). F-alternatives of a simple expression are derived by replacing the focused item with meanings of the same semantic type, as in (20a). The F-alternative set grows point-wise (Hamblin 1973, Rooth 1992), as in (20b).

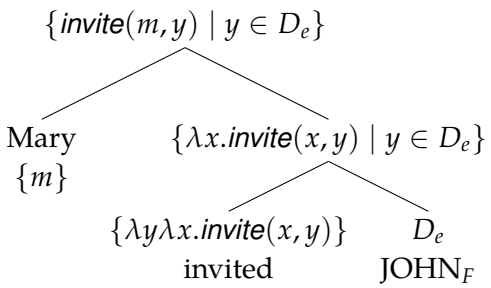
(20) **F-alternatives**

a. For any lexical entry α, $\text{F-ALT}(\alpha) = \begin{cases} D_{\text{type}([\![\alpha]\!])} & \text{if } \alpha \text{ is focused} \\ \{[\![\alpha]\!]\} & \text{otherwise} \end{cases}$

b. $\text{F-ALT}(\beta(\alpha)) = \{b(a) \mid b \in \text{F-ALT}(\beta), a \in \text{F-ALT}(\alpha)\}$

The following tree structure illustrates the composition of F-alternatives. This structure is annotated with the set of F-alternatives at every node.

(21) Mary invited JOHN$_F$.



In a simple sentence, focus placement only affects the felicity of this sentence. For example, in answering the question in (22), stressing *Mary* makes the answer infelicitous, but not false or ungrammatical.

(22) Who did Mary invite?

a. Mary invited JOHN$_F$.

b. # MARY$_F$ invited John.

However, in the presence of an exclusive particle *only*, association between focus and *only* has an effect on the truth conditions of a sentence, as seen in (23).

(23) a. John *only* introduced Bill$_F$ to Sue. ⇝ *John didn't introduce anyone to Sue except Bill.*

b. John *only* introduced Bill to Sue$_F$. ⇝ *John didn't introduce Bill to anyone except Sue.*

We call *only* a F-sensitive operator (Jackendoff 1972). Canonical F-sensitive operators also include exclusive particles such as *merely*, *just*, and *exclusively*, as well as additive particles such as *also*, *even*, *additionally*, and *too*.

Rooth (1992, 1996) captures the F-sensitivity effect of *only* through a Focus Condition which constraints the quantification domain of *only*, a pronoun-like contextually determined variable C, namely, $[\![only_C(\mathrm{S})]\!]$ is defined only if $C \subseteq$ F-Alt(S).[9] More generally:

(24) **Focus Condition**
For any F-sensitive operator Θ quantifying over a domain C and combining with a focus-contained expression δ, $[\![\Theta_C(\delta)]\!]$ is defined only if $C \subseteq$ F-Alt(δ).

In addition to F-alternatives, subsequent works of Alternative Semantics discuss another two types of alternatives, namely, scalar (σ-)alternatives of scalar items (Sauerland 2004) and domain (D-)alternatives of disjunctions or existential quantifiers (Kratzer and Shimoyama 2002; Sauerland 2004; Katzir 2007). σ-alternatives are derived by replacing the scalar item with meanings belonging to the same scale, as in (25b). D-alternatives are derived by substituting the existential quantification domain with its subsets, as in (25c), where '$\bigvee D'$' denotes an existential quantification over the set D'. The same as F-alternatives, σ-alternatives and D-alternatives grow point-wise.

(25) For any basic expression α:

a. $$\text{F-Alt}(\alpha) = \begin{cases} D_{\text{type}([\![\alpha]\!])} & \text{if } \alpha \text{ is focused} \\ \{[\![\alpha]\!]\} & \text{otherwise} \end{cases}$$

b. $$\sigma\text{-Alt}(\alpha) = \begin{cases} \{[\![\alpha_1]\!], ..., [\![\alpha_n]\!]\} & \text{if } \alpha \text{ is part of a scale } \langle [\![\alpha_1]\!], ..., [\![\alpha_n]\!] \rangle \\ \{[\![\alpha]\!]\} & \text{if } \alpha \text{ does not belong to a scale} \end{cases}$$

c. $$\text{D-Alt}(\alpha) = \begin{cases} \{\bigvee D' \mid D' \subseteq D\} & \text{if } \alpha \text{ is an } \exists\text{-quantifier over a set } D \\ \{[\![\alpha]\!]\} & \text{otherwise} \end{cases}$$

Following Rooth's idea that F-alternatives are activated by a grammatical feature [F], Chierchia (2006, 2013) assumes that σ- and D-alternatives are activated by the [σ] and [D] feature, respectively. For illustration, the following lists the features and activated alternatives of a nominal disjunction:

(26) a. $[\![\text{Andy or Billy}]\!] = \lambda P.P(a) \vee P(b)$
b. F-Alt$([\text{Andy or Billy}]_F) = D_{\langle et,t \rangle}$
c. σ-Alt$([\text{Andy or Billy}]_\sigma) = \{\lambda P.P(a) \vee P(b), \lambda P.P(a) \wedge P(b)\}$
d. D-Alt$([\text{Andy or Billy}]_D) = \{\lambda P.P(a), \lambda P.P(b), \lambda P.P(a) \vee P(b)\}$

[9] Strictly speaking, F-sensitive operators cannot access F-alternatives directly. Instead, Rooth (1992) assumes that *only* makes reference to F-alternatives indirectly through a focus interpretation operator, written as '$\sim$'. As illustrated in (i), the $\sim$-operator first combines with a contextually determined F-domain variable C and then with the prejacent of *only*, presupposing that C denotes a subset of the F-alternative set F-Alt(S). Further, Rooth (1992, 1996) assumes that *only* directly combines with a quantification domain variable, and that this quantification domain variable is co-indexed with the F-domain variable. In consequence, the quantification domain of *only* is restricted to a set of contextually relevant F-alternatives of the prejacent sentence.

(i) only(C_1) [$\sim C_1$ [S ... X_F ...]] $\quad [\![\sim C_1(\mathrm{S})]\!] = [\![\mathrm{S}]\!]$, defined only if $[\![C_1]\!] \subseteq$ F-Alt(S)

I extend Focus Condition to a more general condition as follows:

(27) **Domain restriction condition**
For any operator Θ quantifying over a domain C and combining with an expression δ, if Θ agrees with an alternative-activating feature $[x]$, $[\![\Theta_C(\delta)]\!]$ is defined only if $C \subseteq x\text{-}\textsc{Alt}(\delta)$.

4.2. Defining *only*

It is standardly assumed that *only* presupposes the truth of its prejacent proposition and asserts an exhaustivity inference (Horn 1969), as exemplified in (28).

(28) Mary only invited JOHN$_F$.
  a. $\rightsquigarrow$ *Mary invited John.* Prejacent presupposition
  b. $\rightsquigarrow$ *Mary didn't invite anyone other than John.* Exhaustivity inference

The exhaustivity inference is derived by negating all the contextually relevant F-alternatives of the prejacent clause that are excludable, as formalized in (29). Standardly, an alternative is excludable iff it is not entailed by the prejacent, as in (30).

(29) **The meaning of** *only* (To be revised in (32))
$[\![only_C]\!] = \lambda p \lambda w : p(w) = 1. \forall q \in \textsc{Excl}(p, C)[p \not\subseteq q \rightarrow q(w) = 0]$

(30) **Excludable (excl-)alternatives** (Standard)
$\textsc{Excl}(p, C) = \{q \mid p \not\subseteq q \wedge q \in C\}$

Note that the definition of F-alternatives in (20) doesn't require F-alternatives to be contextually relevant, while the exhaustivity inference of *only* is only concerned with contextually relevant meanings. Hence, alternatives negated by *only* are chosen out of the domain C, a set of contextually relevant F-alternatives, not out of the entire F-alternative set.

In addition to the prejacent presupposition, I argue that *only* presupposes the existence of at least one excludable (excl)-alternative. Consider (31) for illustration:

(31) Which of John and Mary will you invite?
  a. Only JOHN$_F$, (not Mary / not both).
  b. # Only BOTH$_F$.
  c. BOTH$_F$.

The *which*-question restricts the domain of *only* to the following set: $C = \{\phi_j, \phi_m, \phi_{j \oplus m}\}$ where $\phi_x = I$ *will invite* x. The response in (31b) is infelicitous because the propositional argument of *only*, namely $\phi_{j \oplus m}$, is the strongest proposition in C and has no excl-alternative in C. I call the requirement that the propositional argument of *only* has at least one excl-alternative a "non-vacuity presupposition", as it comes from a general economy condition that an overt operator cannot be applied vacuously (Martin Hackl pers. comm.; compare Al Khatib 2013). In comparison, the response in (31c) is felicitous, although *BOTH* is focused and is associated with a covert exhaustifier. The reason is

that covert exhaustifiers are not subject to the economy condition and do not trigger a non-vacuity presupposition.

To sum up, I define the meaning of *only* as follows: *only* presupposes the truth of its prejacent proposition and the existence of an excl-alternative in its quantification domain; when the presuppositions are satisfied, it negates all the excl-alternatives of its prejacent clause.[10]

(32) **The meaning of** *only* (Final)
$[\![only_C]\!] = \lambda p \lambda w : \underbrace{\exists q \in \textsc{Excl}(p, C)}_{\text{non-vacuity}} \wedge \underbrace{p(w) = 1}_{\text{prejacent}} . \underbrace{\forall q \in \textsc{Excl}(p, C)[q(w) = 0]}_{\text{exhaustivity}}$

a. *Non-vacuity presupposition*: The prejacent has at least one excl-alternative.

b. *Prejacent presupposition*: The prejacent is true.

c. *Exhaustivity assertion*: All the excl-alternatives are false.

4.3. Defining *dou* in analogous to *only*

I treat *dou* as a special exhaustifier, in analogous to the canonical exhaustifier *only*:

(33) **The meaning of** *dou*
$[\![dou_C]\!] = \lambda p \lambda w : \underbrace{\exists q \in \textsc{Sub}(p, C)}_{\text{non-vacuity}} . \underbrace{p(w) = 1}_{\text{prejacent}} \wedge \underbrace{\forall q \in \textsc{Sub}(p, C)[O_C(q)(w) = 0]}_{\text{anti-exhaustivity}}$

a. *Non-vacuity presupposition*: The prejacent has at least one sub-alternative.

b. *Prejacent assertion*: The prejacent is true.

c. *Anti-exhaustification assertion*: The exhaustification of each sub-alternative is false.

On the one hand, the same as *only*, due to the economy principle of overt functional particles, *dou* triggers a non-vacuity presupposition, which requires the existence of an alternative that it operates on. On the other hand, the semantics of *dou* and *only* are contrary in the following two respects.

Contrast I: Excl-alternatives versus sub-alternatives While *only* operates on excl-alternatives, *dou* operates on sub-alternatives, which are complementary to excl-alternatives, as defined in (34).

(34) **Sub-alternatives**
$\textsc{Sub}(p, C) = (C - \textsc{Excl}(p, C)) - \{p\}$
(Alternatives that are non-excludable and distinct from the prejacent)

If excl-alternatives are defined standardly as non-entailed alternatives, as in (30), sub-alternatives are simply alternatives asymmetrically entailed by the prejacent, as in (35).

[10] For simplicity, this paper treats all F-sensitive operators propositional. A cross-categorical semantics of *only* is given in (i), where f and P stand for the left argument (i.e., restrictor) and the right argument (i.e., scope), respectively. By Focus Condition, the quantification domain C is a set of F-alternatives of the left argument.

(i) **Cross-categorical semantics of** *only*
$[\![only_C]\!] = \lambda f_\alpha \lambda P_{\langle \alpha, st \rangle} \lambda w_s : \underbrace{P(f)(w) = 1}_{\text{prejacent pres.}} \wedge \underbrace{\exists f' \in C[P(f) \not\subseteq P(f')]}_{\text{non-vacuity pres.}} . \underbrace{\forall f' \in C[P(f) \not\subseteq P(f') \rightarrow P(f)(w) = 0]}_{\text{exhaustivity assertion}}$

This definition easily extends to other F-sensitive operators.

(35) **Sub-alternatives as weaker alternatives** (By standard excludability)
$\textsc{Sub}(p, C) = \{q \mid p \subset q, q \in C\}$

However, as to be seen in section 5, what counts an excl-alternative is subject to variations, depending on the quantification domain of the F-sensitive operator (namely, whether this domain consists of F-, σ-, or D-alternatives of the prejacent) and the measurement for ordering alternatives (such as logical strength, likelihood, and various contextually determined measurements). Consequently, what counts a sub-alternative is also subject to variations, causing function alternations of *dou.*

Contrast II: Exhaustivity versus anti-exhaustivity While *only* asserts an exhaustivity inference, *dou* asserts an "anti-exhaustivity" inference, derived by negating the exhaustification of each sub-alternative. Hence, we say that *dou* has a "pre-exhaustification" effect (a la Chierchia 2013). In a basic case, the pre-exhaustification effect is realized by applying an *O*-operator (also written as 'Exh') to each sub-alternative.[11] The *O*-operator is a covert counterpart of the exclusive particle *only*, coined by the grammatical view of scalar implicatures (Fox 2007, Chierchia et al. 2012, Fox and Spector 2018, among others). As defined in (36), this *O*-operator affirms the prejacent and negates all the excl-alternatives of the prejacent.[12]

(36) **The *O*-operator** (Chierchia et al. 2012)
$O_C = \lambda p \lambda w : p(w) = 1 \wedge \forall q \in \textsc{Excl}(p, C)[q(w) = 0]$
(The prejacent is true, while all the excl-alternatives are false.)

If excludability is defined standardly as in (30), the prejacent is excludable to its sub-alternatives, and the anti-exhaustivity inference collapses under the prejacent inference (i.e., the anti-exhaustivity inference is true whenever the prejacent is true). [Proof: Whenever p is true, any alternative of p that is weaker than p has a true excl-alternative r, where $r = p$. End of proof.] Hence, the default meaning of *dou* is vacuous in assertion. However, as to be seen in section 5.2, the assertion of *dou* can be non-vacuous under particular definitions of excludability.

Consider (37) and (38) for simple illustration of the proposed definition of *dou* in deriving the quantifier-distributor use. In (37), the meaning of the prejacent clause and the quantification domain of *dou* are schematized as in (37b) and (37c), respectively. In this domain, the two alternatives in

[11] When *dou* is used as a scalar additive operator, the pre-exhaustification effect is realized by applying a scalar exhaustifier ($\approx$ *just*) to each sub-alternative. This change is a logical consequence of redefining excl- and sub-alternatives based on likelihood. See section 5.3.

[12] Note that the *O*-operator is defined based on excludability, and that excl-alternatives are complementary to sub-alternatives. Hence, the semantics of *dou* purely depends what counts a sub-alternative, as seen in the following:

(i) **Defining *dou* based on sub-alternatives**

a. $O_C = \lambda q \lambda w : q(w) = 1 \wedge \forall r \in \textsc{Excl}(q, C)[r(w) = 0]$
$= \lambda q \lambda w : q(w) = 1 \wedge \forall r \in ((C - \textsc{Sub}(q, C)) - \{q\})[r(w) = 0]$ By (34)

b. $[\![dou_C]\!] = \lambda p \lambda w : \exists q \in \textsc{Sub}(p, C).p(w) = 1 \wedge \forall q \in \textsc{Sub}(p, C)[O_C(q)(w) = 0]$
$= \lambda p \lambda w : \exists q \in \textsc{Sub}(p, C).p(w) = 1 \wedge$
$\forall q \in \textsc{Sub}(p, C)[q(w) = 0 \vee \neg \forall r \in ((C - \textsc{Sub}(q, C)) - \{q\})[r(w) = 0]]$ By (i-a)

This paper uses the more intuitive definition in (33). But we should keep in mind that the meaning alternation of *dou* is purely realized by the meaning variation of sub-alternatives.

(37d) are asymmetrically entailed by the prejacent, which are therefore sub-alternatives of the prejacent. The application of *dou* affirms the prejacent and negates the exhaustification of each sub-alternative, yielding the inference in (37e): John and Mary arrived, not only John arrived, and not only Mary arrived. The anti-exhaustification inference given by the *not only*-clauses is entailed by the prejacent and adds nothing new to the truth conditions.[13]

(37) [John and Mary] **dou** arrived.

a. LF: $\textbf{dou}_C$ [$_S$ [John and Mary]$_F$ arrived]

b. $[\![\text{S}]\!] = \textit{arrive}(j \oplus m)$

c. $C = \{\textit{arrive}(x) \mid x_e \text{ is a relevant individual}\}$

d. $\textsc{Sub}(p, C) = \{\textit{arrive}(j), \textit{arrive}(m)\}$

e. $[\![dou_C(\text{S})]\!] = \textit{arrive}(j \oplus m) \wedge \neg O[\textit{arrive}(j)] \wedge \neg O[\textit{arrive}(m)] = \textit{arrive}(j \oplus m)$

In contrast, in (38), *dou* cannot be present and associated with an atomic proper name *John* (unless *John* is stressed): regardless of the context, the prejacent clause has no sub-alternative, failing to satisfy the non-vacuity presupposition of *dou*.

(38) [John] (***dou**) arrived.

a. LF: $\textbf{dou}_C$ [$_S$ John$_F$ arrived]

b. $[\![\text{S}]\!] = \textit{arrive}(j)$

c. $C = \{\textit{arrive}(x) \mid x_e \text{ is a relevant individual}\}$

d. $\textsc{Sub}(p, C) = \varnothing$

e. $[\![dou_C(\text{S})]\!]$ is undefined

[13] One might wonder why *dou* is used even though it does not change the truth conditions. Such uses are observed cross-linguistically. For instance, in (i), the distributor *both* adds nothing to the truth conditions.

(i) John and Mary *both* arrived.

One possibility, raised by the audience at LAGB 2015, is that *dou* and *both* are used as contrast focus in comparison with non-maximality operators like *only part of* or *only one of*. If this is the case, the question under discussion for (37) and (i) would be 'is it the case that John and Mary both arrived or that only one of them arrived?' This idea is supported by the distribution of stress discussed in section 2.4: when *dou* functions as a quantifier-distributor, stress can only assignment to the particle *dou*, not to the associate of *dou*. Moreover, this idea also explains the maximality requirement of *dou* under the quantifier-distributor use. Let me sketch out this idea informally: the assertion of the *dou*-sentence (ii) (repeated from (2)) is identical to the inference in (iiia), which is tolerant of non-maximality; but (ii) also implicates the anti-non-maximality inference (iiib), giving rise to a maximality requirement.

(ii) (Context: *The children, with only one or two exceptions, went to the park.*)

[Haizimen] (#**dou**) qu -le gongyuan.
children DOU go -PERF park
'The children (#all) went to the park.'

(iii) a. The children went to the park.

b. Not [only part of the children went to the park.]

5. Deriving the uses of *dou*

5.1. Deriving the quantifier-distributor use

Recall that, when used as a quantifier-distributor, *dou* has no effect on assertions but evokes three requirements: (i) the "maximality requirement," namely, that *dou* forces maximality with respect to the domain denoted by the associated item; (ii) the "distributivity requirement," namely, that the prejacent sentence cannot take a collective reading; (iii) the "plurality requirement," namely, that the item associated with *dou* must take a non-atomic interpretation. This section will focus on the latter two requirements. (See footnote 13 for a rough idea regarding to the maximality requirement.) I will argue that these two requirements are both illusions. Moreover, I will argue that all the facts that are thought to result from these two requirements actually result from the non-vacuity presupposition of *dou*.

5.1.1. Explaining the "distributivity requirement"

To generate sub-alternatives and satisfy the non-vacuity presupposition of *dou*, the prejacent of *dou* needs to be strictly stronger than some of its alternatives. In case that the associate of *dou* is an entity (of type e), this requirement is satisfied only when the predicate denoted by the remnant VP is (atomically or non-atomically) distributive or divisive.

Consider the *dou*-sentence in (39) for illustration. For simplicity, I follow the well-known cover-based treatment of generalized distributivity by Schwarzschild (1996), ignoring the undesired consequences of this treatment in generating alternatives.[14] To avoid confusion, in this section, I use C for the cover variable and $C_{\text{F-Alt}}$ for the set of contextually relevant F-alternatives that *dou* quantifies over. The prejacent clause of *dou* is interpreted as in (39a), where a generalized distributor Part distributes over the contextually determined cover of $a \oplus b \oplus c$. Alternatives of the prejacent clause are derived by replacing $a \oplus b \oplus c$ with a contextually relevant individual of type e, as in (39b). Sub-alternatives are (roughly) the ones formed based on the sum of a proper subset of C, as in (39c).[15]

(39) **Dou**$_{C_{\text{F-Alt}}}$ [$_{\text{S}}$ $a \oplus b \oplus c$ bought houses]

[14] In the alternatives, the value of C constantly equals to the contextually determined cover of the associated item in the prejacent (viz. the cover of $a \oplus b \oplus c$), and Part only distributes over C. (See Liao 2011: chap. 4.) For example, if $C = \{a, b, c\}$, the alternative $\text{Part}_C(f, d)$ is vacuously a tautology, and the alternative $\text{Part}_C(f, a \oplus b \oplus c \oplus d)$ is logically equivalent to $\text{Part}_C(f, a \oplus b \oplus c)$. These consequences are harmless for now. But, problems arise if we want to characterize an operator that operates on excl-alternatives. For example, to derive the exhaustification inference of (i), 'b bought houses' shall not be a tautology.

(i) Only abc_F bought houses. $\rightsquigarrow$ *d didn't bought houses.*

See a solution in Liu (2016c) based on Link-Landman's approach of encoding distributivity/collectivity distinction. Details regarding to Liu's formal implementations are omitted due to the scope of this paper.

[15] More precisely, under the cover-based account of distributivity, it doesn't matter whether X contains parts that are not members of C, as seen in footnote 14. Thus, more accurately, sub-alternatives shall be formulated as follows:

(i) $\text{Sub}([\![\text{S}]\!], C_{\text{F-Alt}}) = \{\text{Part}_C(f, X) \mid X_e \text{ is contextually relevant and } \{y \mid y \leq X \wedge C(y)\} \subset C\}$

An alternative is a sub-alternative as long as it is based on a contextually relevant individual X such that the set of subparts of X that are members of C is a proper subset of C.

a. $[\![\text{S}]\!] = \textsc{Part}_C(f, a \oplus b \oplus c)$

b. $C_{\text{F-Alt}} = \{\textsc{Part}_C(f, X) \mid X_e \text{ is relevant}\}$

c. $\textsc{Sub}([\![\text{S}]\!], C_{\text{F-Alt}}) = \{\textsc{Part}_C(f, X) \mid X_e \text{ is relevant and } \exists C' \subset C[X = \bigoplus C']\}$

The quantification domain of *dou* is illustrated in the following. For simplicity, I ignore alternatives based on individuals that are not parts of $a \oplus b \oplus c$. Shading marks sub-alternatives, box encloses the prejacent proposition, and arrows indicate entailment relations. If C is non-singleton, the prejacent clause of *dou* takes an atomic or non-atomic distributive reading and does have some weaker/sub-alternatives, which therefore satisfies the non-vacuity presupposition of *dou*. In contrast, if the prejacent clause takes a collective/single-cover reading, it does not have a weaker/sub- alternative, making the use of *dou* undefined.

(39 cont.) Quantification domain of *dou*:

√ **Atomic distributive:** If $C = \{a, b, c\}$, then ...

$$C_{\text{F-Alt}} = \left\{ \begin{array}{ccccc} & & \boxed{\textsc{Part}_C(f, a \oplus b \oplus c)} & & \\ & \swarrow & \downarrow & \searrow & \\ \textsc{Part}_C(f, a \oplus b) & & \textsc{Part}_C(f, a \oplus c) & & \textsc{Part}_C(f, b \oplus c) \\ \downarrow & \searrow\ \swarrow & & \searrow\ \swarrow & \downarrow \\ \textsc{Part}_C(f, a) & & \textsc{Part}_C(f, b) & & \textsc{Part}_C(f, c) \end{array} \right\}$$

$$= \left\{ \begin{array}{ccccc} & & \boxed{f(a) \wedge f(b) \wedge f(c)} & & \\ & \swarrow & \downarrow & \searrow & \\ f(a) \wedge f(b) & & f(b) \wedge f(c) & & f(a) \wedge f(c) \\ \downarrow & \searrow\ \swarrow & & \searrow\ \swarrow & \downarrow \\ f(a) & & f(b) & & f(c) \end{array} \right\}$$

√ **Non-atomic distributive:** If $C = \{a, b \oplus c\}$, then ...

$$C_{\text{F-Alt}} = \left\{ \begin{array}{ccc} \boxed{\textsc{Part}_C(f, a \oplus b \oplus c)} & & \\ \swarrow & \searrow & \\ \textsc{Part}_C(f, a) & & \textsc{Part}_C(f, b \oplus c) \end{array} \right\} = \left\{ \begin{array}{ccc} \boxed{f(a) \wedge f(b \oplus c)} & & \\ \swarrow & \searrow & \\ f(a) & & f(b \oplus c) \end{array} \right\}$$

× **Collective:** If $C = \{a \oplus b \oplus c\}$, then ...
$C_{\text{F-Alt}} = \{f(a \oplus b \oplus c)\}$ and $\textsc{Sub}([\![\text{S}]\!], C_{\text{F-Alt}}) = \varnothing$

In conclusion, the particle *dou* itself is not a distributor, but in certain cases, its non-vacuity presupposition forces the application of a distributor, or the application of any operation that makes the prejacent clause distributive. We can now easily explain why *dou* can be associated with the distributive expression NP-*gezi* 'NP-each'. The presence of the distributor *gezi* 'each' is not redundant; instead, it is required for satisfying the non-vacuity presupposition of *dou*. If *gezi* is not overtly used, there would still be a covert distributor present in the LF.

(40) [Tamen gezi] **dou** you yixie youdian.
They each DOU have some advantage
'They each **dou** has some advantages .'

This account also explains why *dou* can occur in some collective sentences: *dou* can combine with a collective predicate as long as this collective predicate is divisive.

(41) A predicate P is **divisive** iff $\forall x[P(x) \rightarrow \forall y \leq x[y \in \textsc{Dom}(P) \rightarrow P(y)]]$
(Whenever P holds of something x, it also holds of every subpart of x defined for P.)

For instance, *dou* is compatible with divisive collective predicates such as *shi pengyou* 'be friends', *jihe* 'gather', and *jianmian* 'meet', as seen in (42a-c). Consider (42a) for a concrete example. Let *tamen* 'they' denote the sum of three individuals *abc*. The set of sub-alternatives is {*ab* ***are friends***, *bc* ***are friends***, *ac* ***are friends***}. Applying *dou* yields inference that *abc* are friends, not only *ab* are friends, not only *bc* are friends, and not only *ac* are friends. In comparison, *dou* cannot be applied to a collective statement if the predicate is not divisive, as shown in (42d).

(42) a. [Tamen] (**dou**) shi pengyou.
they DOU be friends
'They are (all) friends.'

b. [Tamen] (**dou**) zai dating jihe -le.
they DOU at hallway gather -ASP
'They (all) gathered in the hallway.'

c. [Tamen] (**dou**) jian-guo-mian -le.
they DOU see-EXP-face -ASP
'They (all) have met.'

d. [Tamen] (*__dou__) zucheng -le zhe-ge weiyuanhui.
they DOU form -ASP this-CL committee
'They (*all) formed this committee.'

5.1.2. Explaining the "plurality requirement"

The "plurality requirement" says that the associate of *dou* has to take a non-atomic interpretation. I argue that this requirement is also illusive, and that the related facts all result from the non-vacuity presupposition of *dou*.

On the one hand, the plurality requirement is unnecessary: *dou* can be associated with an atomic item as long as the predicate denoted by the remnant VP is divisive. For instance, in (43a), *dou*'s associate *na-ge pingguo* 'that apple' has only an atomic interpretation. With a divisive predicate λx.***John ate*** x, the prejacent clause of *dou* does have some sub-alternatives formed based proper subparts of ***that apple***, as schematized in (44a), which therefore supports the non-vacuity presupposition of *dou*. In contrast, in (43b), the predicate λx.***John ate half of*** x is not divisive and hence the prejacent of *dou* has no sub-alternative, as shown in (44b), which therefore makes the presence of *dou* deviant.

(43) a. Yuehan ba [na-ge pingguo] (**dou**) chi -le.
John BA that-CL apple DOU eat -PERF
'John ate that apple.'

b. Yuehan ba [na-ge pingguo] (*__dou__) chi -le yi-ban.
John BA that-CL apple DOU eat -PERF one-half
Intended: 'John ate half of that apple.'

(44) a. *John ate that apple* $\Rightarrow$ *John ate* x (x < *that apple*)
SUB (*John ate that apple*) = {*John ate* x | x < *that apple*}

b. *John ate half of that apple* $\not\Rightarrow$ *John ate half of* x (x < *that apple*)
SUB (*John ate half of that apple*) $= \varnothing$

On the other hand, the plurality requirement is insufficient. When applied to a statement with a divisive collective predicate, *dou* requires its associate to denote a group consisting of at least three distinct individuals, as exemplified in (45).

(45) [Tamen -sa/*-lia] **dou** shi pengyou.
they -three/-two DOU be friends
'They three/*two are all friends.'

The proposed non-vacuity presupposition of *dou* also accounts for this fact. As schematized in (46), the proper subparts of a dual-individual (e.g., $a \oplus b$) are atomic individuals, which however are undefined for the collective predicate $\lambda x.$*be-friends*(x). Hence, in (45), if the associate of *dou* denotes only a dual-individual, the prejacent clause of *dou* has no sub-alternative, which therefore leaves the non-vacuity presupposition of *dou* unsatisfied.

(46) [*ab*] (*__dou__) are friends.
a. $[\![$be friends$]\!] = \lambda x : \neg$ATOM(x).*be-friends*(x)
b. SUB$(ab$ *are friends*$) = \varnothing$

5.2. Deriving the ∀-FCI-licenser use

The particle *dou* can license the ∀-FCI uses of pre-verbal polarity items, *wh*-items, and disjunctions. In this section, I argue that the assertion of *dou* turns a disjunctive/existential statement into a conjunctive/universal statement, giving rise to an FC inference. I will also explain why the licensing of a ∀-FCI requires the presence of *dou*, as well as why the licensing of a ∀-FCI disjunction is subject to modal obviation.

5.2.1. Predicting universal FC

As seen in section 4.1, a disjunction or existential quantifier that carries a [D] feature is associated with a set of D-alternatives. Thus in the disjunctive sentence (9b), paraphrased in English in (47), the quantification domain of *dou* consists of the D-alternatives of its disjunctive prejacent, as in (47c). Sub-alternatives of the prejacent are the disjuncts, as in (47d). Applying *dou* affirms the prejacent and negates the exhaustification of each disjunct, yielding a ∀-FC inference, as in (47e). In a word, *dou* turns a disjunction into a conjunction. Contrary to the derivation of the quantifier-distributor use, it is crucial that here *dou* does change the truth condition, because here the prejacent disjunctive inference does not entail the anti-exhaustification inference.

(47) [John or Mary] **dou** can teach Intro Chinese.

a. LF: $\mathbf{dou}_C$ [$_S$ [John or Mary]$_D$ can teach Intro Chinese]

b. $[\![S]\!] = \Diamond\phi_j \vee \Diamond\phi_m$ $\qquad\qquad$ $\phi_x = x$ *teach Intro Chinese*

c. $C = \text{D-ALT}(S) = \{\Diamond\phi_j, \Diamond\phi_m, \Diamond\phi_j \vee \Diamond\phi_m\}$

d. $\text{SUB}([\![S]\!], C) = \{\Diamond\phi_j, \Diamond\phi_m\}$

e. $$\begin{aligned}[\![\mathbf{dou}_C\ (S)]\!] &= [\Diamond\phi_j \vee \Diamond\phi_m] \wedge \neg O_C\Diamond\phi_j \wedge \neg O_C\Diamond\phi_m \\ &= [\Diamond\phi_j \vee \Diamond\phi_m] \wedge [\Diamond\phi_j \rightarrow \Diamond\phi_m] \wedge [\Diamond\phi_m \rightarrow \Diamond\phi_j] \\ &= [\Diamond\phi_j \vee \Diamond\phi_m] \wedge [\Diamond\phi_j \leftrightarrow \Diamond\phi_m] \\ &= \Diamond\phi_j \wedge \Diamond\phi_m\end{aligned}$$

This analysis easily extends to other ∀-FCIs in Mandarin, such as *wh*-items and *renhe* 'any'-items. *Wh*-items and *any*-phrases are commonly treated as existential quantifiers (Karttunen 1977; Krifka 1995; Lahiri 1998; Chierchia 2004, 2006, 2013). Just like disjunctions, Mandarin *wh*-items and *renhe*-items carry a domain feature [D] and are associated with sets of D-alternatives (Liao 2011; Chierchia and Liao 2015).

Now, a problem arises as to why disjuncts count as sub-alternatives of disjunctions. In (35) in section 4.3, sub-alternatives are weaker alternatives by the regular definition of excludability. But, in (47), the disjuncts are stronger than the disjunction, why are they sub-alternatives? This problem can be solved by a minimal change from "(non-)excludability" to "(non-)innocent excludability," a notion coined by Fox (2007) for deriving FC inferences via exhaustifications. As schematized in (48a), an alternative is innocently (I-)excludable iff it is included in every maximal set of alternatives A such that affirming the prejacent is consistent with negating all the alternatives in A.[16] In (47), the disjuncts are not I-excludable to the disjunction: affirming the disjunction and negating both of its disjuncts yield a contradiction (formally, $\{\Diamond\phi_j, \Diamond\phi_m\}^{\neg} \cup \{\Diamond\phi_j \vee \Diamond\phi_m\}$ is inconsistent, because $[\Diamond\phi_j \vee \Diamond\phi_m] \wedge \neg\Diamond\phi_j \wedge \neg\Diamond\phi_m = \bot$). Hence, by the definition in (48b) based on innocent excludability, disjuncts of a disjunction are indeed sub-alternatives of this disjunction.

(48) a. **Innocently (I)-excl-alternatives** (Fox 2007)
$\text{IEXCL}(p, C) = \bigcap\{A \mid A \text{ is a maximal subset of } C \text{ s.t. } A^{\neg} \cup \{p\} \text{ is consistent}\}$,
where $A^{\neg} = \{\neg q \mid q \in A\}$
(The intersection of the maximal sets of alternatives of p in C such that the exclusion of each such maximal set is consistent with p.)

b. **Sub-alternatives** (Based on innocent excludability)
$\text{SUB}(p, C) = (C - \text{IEXCL}(p, C)) - \{p\}$
(The set of alternatives excluding the I-excl-alternatives and the prejacent itself)

Weaker alternatives are clearly not I-excludable: affirming a prejacent and negating a weaker alternative yield a contradiction. Hence, in cases where the associate of *dou* has no D-alternative,

[16] Another commonly seen definition of I-excl-alternatives is as in (i), which is however inadequate. For example, in sentence "EVERY student came," where the prejacent is the strongest among the alternatives and thus has no excl-alternative, the condition underlined in (i) is vacuously satisfied; therefore, the definition in (i) predicts that every alternative of p is I-excludable, which is apparently implausible.

(i) $\text{IEXCL}(p, C) = \{q \mid q \in C \wedge \neg\underline{\exists q' \in \text{EXCL}(p, C)[[p \wedge \neg q] \rightarrow q']}\}$
(The set of alternatives q such that affirming p and negating q does not entail any excl-alternatives)

the innocent excludability-based definition of sub-alternatives in (48b) and the regular excludability-based definition in (35) predict the same set of sub-alternatives.[17]

The following is an interim summary for the semantics of *dou*:

(49) **Semantics of** *dou* (Interim)
$[\![dou_C]\!] = \lambda p \lambda w : \exists q \in \textsc{Sub}(p, C).p(w) = 1 \wedge \forall q \in \textsc{Sub}(p, C)[O_C(q)(w) = 0]$
where $\textsc{Sub}(p, C)$ is defined as in a or b:
a. Def strong (Based on regular excludability)
$\textsc{Sub}(p, C) = (C - \textsc{Excl}(p)) - \{p\}$
b. Def weak (Based on innocent excludability)
$\textsc{Sub}(p, C) = (C - \textsc{IExcl}(p)) - \{p\}$

Compare the two definitions of sub-alternatives: Def strong is only compatible with the quantifier-distributor use of *dou*, while Def weak also extends to the ∀-FCI licenser use. As such, there are two ways to view the semantics of sub-alternatives:

> **The unifying view** Sub-alternatives are uniformly defined based on innocent excludability. Def strong is just a special case where the I-excl-alternatives are excludable.
>
> **The weakening view** Sub-alternatives are primarily defined based on regular excludability. Def weak is available only when non-excludability is weakened to non-I-excludability. This weakening operation is licensed only when the associate of *dou* carries a [D] feature.

These two views yield different predictions with respect to the derivational paths of the uses of *dou*. The unifying view predicts that the quantifier-distributor use and the ∀-FCI licenser use are both primary. In contrast, the weakening view predicts that the quantifier-distributor use of *dou* is primary while the ∀-FCI licenser use is secondary. I argue that the weakening view is more preferable than the uniform view. First, empirically, the quantifier-distributor use of *dou* emerged as early as the Eastern Han Dynasty (25AC-220AC) (Gu 2015), while the other uses came much later. So far, there isn't any reliable evidence showing that *dou* could function as a ∀-FCI licenser or a scalar additive operator before Ming Dynasty. Second, theoretically, the scalar additive operator use of *dou* can be derived easily by weakening the strong definition of sub-alternatives, but not the weak definition in. Hence, it is hard for the uniform view to explain the alternation between the scalar additive operator use and the other two uses. I will return to this point in section 6.

5.2.2. Licensing conditions of Mandarin FCIs

In English, the emphatic item *any* is licensed as a ∀-FCI when preceding an existential modal (e.g., *can*), but not licensed when appearing in an episodic sentence or before a universal modal, as shown

[17] A reviewer raises a concern regarding to disjunctions: in symmetric to treating p as an alternative of $p \vee q$, if $p \vee q$ is an alternative of p, the non-vacuity presupposition of *dou* in $dou(p)$ would be trivially satisfied. For example, the sentence "*[John] **dou** came" would be predicted to be grammatical since the existence of a disjunctive alternative *[John or Mary] came*, which is weaker and more likely than the prejacent, fulfills the non-vacuity presupposition of *dou*.

I argue not to be concerned about this issue — while p is an alternative of $p \vee q$, $p \vee q$ is NOT an alternative to p. Such an "(a)symmetry problem" is widely observed in defining alternatives. In responding to this problem, Katzir (2007) makes the following generalization: the alternatives of p are all the structures that are at most as complex as p. Accordingly, $p \vee q$ is more complex than p and thus not an alternative of p.

in (50). The fact that an existential modal helps to license FCIs is called *Modal Obviation*.

(50) English ∀-FCI *any*-NP
  a. Any guest can come in.
  b. * Any guest must come in.
  c. * Any guest came in.

It is crucial to differentiate between ∀-FCIs and ∃-FCIs. Although they sometimes share the same morphology cross languages, they have different scope patterns and licensing conditions (Chierchia 2013: section 6.4). First, ∀-FCIs appear pre-verbally and take scope above modals, while ∃-FCIs appear post-verbally and take scope below modals. Second, the licensing of ∀-FCI requires the presence of an existential modal, while ∃-FCIs can be licensed under an existential modal or a universal modal. The following exemplifies the distributional patterns of English ∃-FCI *any*-NP and *any*-NumP. When taking scope below a universal modal, *any*-NPs must occur in a supplementary construction, as in (51b), while *any*-NumPs can occur directly under a universal modal, as in (52b) (Dayal 2004).

(51) English ∃-FCI *any*-NP
  a. John can read any book.
  b. John must read a book, any book.
  c. * John read any book.

(52) English ∃-FCI *any*-NumP
  a. John can read any two books.
  b. John must read any two books.
  c. * John read any two books.

Disjunctions can function as ∃-FCIs cross-linguistically. Previous studies on FC disjunctions focus only on the ∃-FCI use, where disjunctions take scope below modals (Alonso Ovalle 2005; Fox 2007; Santorio and Romoli 2017; among others).

(53) a. You can invite Andy or Billy.
  ⇝ *You can invite Andy and you can invite Billy.*
  b. You must invite Andy or Billy.
  ⇝ *You can invite Andy and you can invite Billy; you must invite one of them.*

Interestingly, in Mandarin, disjunctions preceding *dou* can also function as ∀-FCIs (Xiang 2016b). To license the ∀-FCI use of a pre-verbal disjunction, *dou* must present and must be followed by an existential modal, as shown in (54).

(54) a. [Yuehan huozhe Mali] **dou** keyi/*bixu jiao jichu hanyu.
  John or Mary DOU can/must teach intro Chinese
  Intended: 'Both John and Mary can/must teach Intro Chinese.'
  b. [Yuehan huozhe Mali] (***dou**) jiao -guo jichu hanyu.
  John or Mary DOU teach -EXP intro Chinese
  Intended: 'Both Johan and Mary have taught Intro Chinese.'

To license of the ∀-FCI uses of *wh*-items and polarity items (e.g., *renhe*-NP 'any-NP'), *dou* also must be present. But requirements related to modal obviations are quite unclear. For example, Giannakidou and Cheng (2006) claim that the bare *wh*-word *shei* 'who' can be licensed as a ∀-FCI in

an episodic *dou*-sentence like (55a). But, this distributional pattern is very unproductive: the other episodic *dou*-sentence (55b) sounds very odd. Hence, there must be some salvaging effect from the experiential maker *-guo* on FCI-licensing. I leave this puzzle open.

(55) a. [Shei] **dou** jiao -guo jichu hanyu.
who DOU teach -EXP intro Chinese.
'Everyone has taught Intro Chinese.'

b. ?? [Shei] **dou** jinlai -le.
who DOU enter -ASP.
Intended: 'Everyone came in.'

The licensing conditions of *na*-CL-NP 'which-NP' and *renhe*-NP 'any-NP' are even harder to generalize. Giannakidou and Cheng (2006) claim that the ∀-FCI uses of these items are only licensed in a pre-*dou*+◇ position. Their judgements are illustrated in (56). Nevertheless, it is difficult to justice the data because judgements on (56) vary greatly among native speakers.

(56) a. [Na-ge/Renhe -ren] **dou** keyi/??bixu jinlai.
which-CL/any -person DOU can/must enter
Intended: 'Everyone can/must come in.'

b. ?? [Na-ge/Renhe -ren] **dou** shou dao -le yaoqing.
which-CL/any -person DOU get arrive -asp invitation
Intended: 'Everyone got an invitation.'

Given the individual variations in grammaticality judgments and the unproductiveness of ∀-FCIs in sentences without an existential modal, I neglect the licensing conditions of ∀-FCI uses of Mandarin *wh-/any*-expressions related to modal obviations. For other recent studies on Mandarin ∀-FCIs, see Liao (2011), Cheng and Giannakidou (2013), and Chierchia and Liao (2015).

In summary, the licensing of Mandarin ∀-FCIs is subject to (at least) two conditions. First, to license the ∀-FCI use of a pre-verbal *wh/any*-expression, *dou* must be present and associated with this *wh/any*-expression. Second, the licensing of the ∀-FCI use of a pre-verbal disjunction is subject to modal obviation, namely that this use is licensed only in the presence of a post-*dou* existential modal. The rest of this section explains these two conditions. The modal obviation effect in the licensing of the ∀-FCI use of a preverbal *wh/any*-expression is yet unclear and will not be discussed.

I. Why is the presence of *dou* mandatory in a *wh/any*$_{\forall\text{-FCI}}$-declarative?

Following Chierchia and Liao (2015), I assume that the sub/D-alternatives associated with a Mandarin *wh/any*-expression are obligatorily activated when this *wh*-word takes a non-interrogative use, and that these sub/D-alternatives must be used up via employing a c-commanding exhaustifier. Hence, if the particle *dou* is absent, these sub/D-alternatives would be have to used by a basic *O*-exhaustifier, as in (57b). As to be shown in the following, the application of a basic *O*-exhaustifier has an undesired semantic consequence.

(57) [Shei] *(**dou**) can teach Intro Chinese.

a. The LF in presence of *dou*: **dou**$_C$ [shei$_D$ can teach Intro Chinese]

b. The LF in absence of *dou*: O_C [shei$_D$ can teach Intro Chinese]

Compare the computation in (58) with (47). In (47) where *dou* is present, applying *dou* to a disjunction returns a conjunction, yielding a FC inference. While in (58), applying a basic *O*-exhaustifier to a

disjunction affirms this disjunction and negates both of its disjuncts, yielding a contradiction and making the *wh*-declarative ungrammatical.

(58) Consider only two relevant individuals a and b:

a. $[\![\text{S}]\!] = \Diamond\phi_a \vee \Diamond\phi_b$ S = 'shei can teach Intro Chinese'

b. $C = \text{D-Alt}(\text{S}) = \{\Diamond\phi_a, \Diamond\phi_b, \Diamond\phi_a \vee \Diamond\phi_b\}$

c. $\text{Excl}([\![\text{S}]\!], C) = \text{Sub}([\![\text{S}]\!], C) = \{\Diamond\phi_a, \Diamond\phi_b\}$

d. $[\![O_C(\text{S})]\!] = [\Diamond\phi_a \vee \Diamond\phi_b] \wedge \neg\Diamond\phi_a \wedge \neg\Diamond\phi_b = \bot$

The case of disjunctions is different. Unlike those of *wh*/*any*-items, the sub-alternatives of disjunctions are not mandatorily activated (Chierchia 2006, 2013). Hence, in absence of *dou*, a sentence with a pre-verbal disjunction takes a simple (inclusive or exclusive) disjunctive interpretation.

The explanation above faces the following challenge: why it is that the sub-alternatives of a *wh*-declarative cannot be used by a covert pre-exhaustification exhaustifier, such as the O_{DOU}-operator proposed by Xiang (2016c) and Xiang (2016a: chap. 2) for interpreting mention-some questions? A covert O_{DOU}-operator cannot be placed here due to a fundamental principle for the architecture of human languages, roughly, "Language-particular choices win over universal tendencies" or "Don't do covertly what you can do overtly." (Chierchia 1998) We consider an exhaustification over the sub-alternatives of a polarity item as a grammatical operation. Given that *dou* must be associated with a preceding item in most declaratives, we predict the following distributional pattern of covert and covert *dou*, illustrated by the polarity item *renhe* 'any':[18]

(59) a. *Renhe*-NP as a ∀-FCI

Ni [renhe-ren] *(**dou**) keyi jian.
You any-person DOU can meet.
'You can meet anyone.'

a′. $^{\text{OK}}$*dou*/*O_{DOU} [you can meet anyone]

b. *Renhe*-NP as an ∃-FCI

Ni (***dou**) keyi jian [renhe-ren].
You DOU can meet any-person
'You can meet anyone.'

b′. **dou*/$^{\text{OK}}O_{\text{DOU}}$ [you can meet anyone]

If *renhe* appears in or can be overtly raised to a pre-verbal position, the sub-alternatives of *renhe* can be exhaustified by the overt particle *dou*, which therefore blocks the use of a covert O_{DOU}-operator, as exemplified by the ∀-FC sentence (59a). In contrast, when an exhaustification operation cannot be done by *dou* due to other syntactic constraints (such as that *dou* in general cannot be associated with an item appearing on its right side), a covert pre-exhaustification exhaustifier would be feasible, as exemplified by the ∃-FC sentence (59b). In one word, since *dou* is Mandarin-particular, the covert O_{DOU} cannot be used whenever the overt *dou* can be used.

II. Why is the licensing of a ∀-FC disjunction subject to modal obviation?

In the realm of exhaustifications, explanations of the modal obviation effect in ∀-FCI-licensing include Dayal (2009) and Chierchia (2013) on English *any*-phrases, and Xiang (2016b) on Mandarin

[18] When the modal is existential, while derived from different LFs, ∀-FC and ∃-FC inferences are logically equivalent. Hence, the two sentences in (59) have the same English translation.

(i) a. $\textbf{dou}(\Diamond p \vee \Diamond q) = (\Diamond p \vee \Diamond q) \wedge \neg O\Diamond p \wedge \neg O\Diamond q = \Diamond p \wedge \Diamond q$

b. $\textbf{dou}(\Diamond(p \vee q)) = \Diamond(p \vee q) \wedge \neg O\Diamond p \wedge \neg O\Diamond q = \Diamond p \wedge \Diamond q$

pre-verbal disjunctions. Dayal (2009) assumes a *Fluctuation Constraint* to explain the modal obviation effect in English *any*-sentences: in an *any*-sentence of the form [*any* NP VP], the intersection of the restriction (i.e., NP) and the scope (i.e., VP) that verifies the sentence should not be constant across the accessible worlds. However, this analysis requires *any* to be interpreted as a universal quantifier and hence does not extend to ∀-FC disjunctions. I will not dive into the technical details. In what follows, I will first review the explanations proposed by Chierchia (2013) and Xiang (2016b). Both analyses involve some syncategorematic assumptions and heavily rely on mandatorily evoked scalar implicatures. Then I will present a new analysis that is free from these problems.

Chierchia (2013) defines *any*-phrases uniformly as existential indefinites, and derives FC inferences via an exhaustification mechanism similar to (47). His explanation of the modal obviation effect is two fold. First, in responding to the ungrammaticality of ∀-FCI in an episodic sentence, he assumes that an *any*-phrase evoke a scalar implicature, which contradicts the FC inference.

(60) Anyone came.

a. $\rightsquigarrow$ *Everyone came.* FC inference

b. $\rightsquigarrow$ *Not everyone came.* Scalar implicature

Second, Chierchia explains the obviation effect of existential modals by proposing a *Modal Containment Constraint*. He assumes that the FC inference and the scalar implicature are assessed based on different modal bases; in particular, the one for the scalar implicature is a proper subset of the one for the FC inference. To see the idea better, let's assume that the domain restriction of *anyone* is a set consisting of two individuals a and b. The modal base for the FC inference is $M_{\text{FC}} = \{w_1, w_2, w_3\}$ while the modal base for scalar implicature is $M_{\text{SI}} = \{w_1, w_2\}$. We can easily see that the two inferences in (61) are not contradictory. For example, with existential quantifications over the worlds, both inferences are true if ϕ_a is true only in w_1 and ϕ_b is true only in w_3. In contrast, the two inferences with universal modals in (62) are contradictory regardless of the modal containment relation. Hence, existential modals can obviate the ungrammaticality but universal modals cannot.

(61) Consistent if $M_{\text{SI}} \subset M_{\text{FC}}$

a. $\Diamond_{M_{\text{FC}}}\phi_a \wedge \Diamond_{M_{\text{FC}}}\phi_b$ FC inference

b. $\neg[\Diamond_{M_{\text{SI}}}\phi_a \wedge \Diamond_{M_{\text{SI}}}\phi_b]$ Scalar implicature

(62) Contradictory regardless whether $M_{\text{SI}} \subset M_{\text{FC}}$

a. $\Box_{M_{\text{FC}}}\phi_a \wedge \Box_{M_{\text{FC}}}\phi_b$ FC inference

b. $\neg[\Box_{M_{\text{SI}}}\phi_a \wedge \Box_{M_{\text{SI}}}\phi_b]$ Scalar implicature

In Xiang (2016b), I extended Chierchia's explanation about the failure of licensing FC *any* in episodic sentences to the case of Mandarin FC disjunctions. A disjunctive episodic *dou*-sentence yields two inferences contradicting each other, as stated in (63a-b), and hence is ungrammatical. When *dou* is not present, the sub-alternatives of a disjunction are not activated, and then (63) has a simple exclusive disjunction meaning: John or Mary but not both has taught Intro Chinese.

(63) * [Yuehan huozhe Mali] **dou** jiao -guo jichu hanyu.
John or Mary DOU teach -EXP intro Chinese

a. $\rightsquigarrow$ *John and Mary have taught Intro Chinese.* FC inference

b. $\rightsquigarrow$ *Not that both John and Mary have taught Intro Chinese.* Scalar implicature

To explain the contrast between existential modals and universal modals in modal obviation, Xiang (2016b) further proposes that the scalar implicature evoked by a pre-verbal disjunction can be assessed within a circumstantial modal base: the modal base is restricted to the set of worlds where the scalar implicature is satisfied. For instance, the $\Diamond$-sentence (64a) intuitively suggests that the speaker ignores worlds where both John and Mary teach Intro Chinese, and is only interested in cases where exactly one of the considered individuals teaches Intro Chinese.

(64) a. [Yuehan huozhe Mali] **dou** keyi jiao jichu hanyu.
John or Mary DOU can teach intro Chinese
'Both John and Mary can teach Intro Chinese.'

b. * [Yuehan huozhe Mali] **dou** bixu jiao jichu hanyu.
John or Mary DOU must teach intro Chinese

More concretely, assume that the property *teach Intro Chinese* denotes the set of the three world-individual pairs in (65a). For instance, the pair $\langle w_1, \{j\}\rangle$ is read as 'only John teaches Intro Chinese in w_1.' The scalar implicature evoked by the pre-verbal disjunction restricts the modal base M to the set of worlds where **not** both John and Mary teach Intro Chinese. In an existentially modalized context, employing *dou* yields the $\forall$-FC inferences in (65c), true relative to M. In contrast, in a universally modalized context, employing *dou* yields the inference in (65d), which is false under M.

(65) a. $f = \{\langle w_1, \{j\}\rangle, \langle w_2, \{m\}\rangle, \langle w_3, \{j, m\}\rangle\}$
b. $M = \{w_1, w_2\}$
c. $\mathbf{dou}[\Diamond\phi_j \vee \Diamond\phi_m] = \Diamond\phi_j \wedge \Diamond\phi_m$ True under M
d. $\mathbf{dou}[\Box\phi_j \vee \Box\phi_m] = \Box\phi_j \wedge \Box\phi_m$ False under M

Chierchia (2013) and Xiang (2016b) are similar to the extend that they both attribute the obviation effect to a special treatment of scalar implicatures in modalized contexts. However, both analyses involve syncategorematic assumptions. In particular, Chierchia's Modal Containment Constraint abnormally requires the existential modal to have different modal bases in scalar alternatives and in domain alternatives, which is not permitted by the compositional derivation of alternatives in standard Alternative Semantics. Xiang's assumption that scalar implicatures can be assessed within the modal base is also problematic — it requires the scalar implicature to be computed first before a modal verb is interpreted.

Moreover, both Chierchia (2013) and Xiang (2016b) rely on the interactions between FC inferences and scalar implicatures, and hence have to assume that scalar implicatures are mandatory. While this assumption is plausible for polarity items, it is problematic to extend it to regular disjunctions. Example (66) shows that the disjunctive episodic sentence doesn't not trigger a scalar implicature if it occurs in the antecedent of a conditional. Despite so, associating *dou* with the contained disjunction still makes the sentence ungrammatical, as seen in (66b), which shows that the failure or licensing a $\forall$-FC disjunction has nothing to do with scalar implicatures.

(66) a. Ruguo Yuehan huozhe Mali jiao-guo jichu hanyu, wo jiu bu-danxin.
If John or Mary teach-EXP Intro Chinese, I then not-worry
'If John or Mary (~~but not both~~) has taught Intro Chinese, I won't be worried'

b. ?? Ruguo [Yuehan huozhe Mali] **dou** jiao-guo jichu hanyu, wo jiu bu-danxin.
If John or Mary DOU teach-EXP Intro Chinese, I then not-worry

The following presents a new analysis that complies with the convention of semantic composition and is irrelevant to scalar implicatures. I assume that the disjunctive ◇-sentence (64a) has the LF in (67). The only new assumption with this LF is that the modal verb mandatorily embeds a covert *O*-exhaustifier, which checks off the [F] feature of the VP-internal trace of the subject disjunction.[19] Let ϕ_x abbreviate for x *teach Intro Chinese*, then $\Diamond O_{C'}\phi_x$ means that x can teach Intro Chinese alone. Then computation proceeds regularly, yielding the desired FC inference.

(67) $\mathbf{dou}_C$ [$_S$ [John or Mary]$_D$ λx can [$O_{C'}$ [$_{VP}$ x_F teach Intro Chinese]]]

a. $C' = \text{F-ALT(VP)} = \{\phi_x \mid x \in D_e\}$ ϕ_x stands for x *teach Intro Chinese*

b. $[\![S]\!] = \Diamond O_{C'}\phi_m \vee \Diamond O_{C'}\phi_j$

c. $C = \text{D-ALT(S)} = \{\Diamond O_{C'}\phi_m \vee \Diamond O_{C'}\phi_j, \Diamond O_{C'}\phi_m, \Diamond O_{C'}\phi_j\}$

d. $\mathbf{dou}_C([\![S]\!]) = [\Diamond O_{C'}\phi_m \vee \Diamond O_{C'}\phi_j] \wedge \neg O_C\Diamond O_{C'}\phi_m \wedge \neg O_C\Diamond O_{C'}\phi_j$
$= \Diamond O_{C'}\phi_m \wedge \Diamond O_{C'}\phi_j$
(John and Mary can each teach Intro Chinese alone.)

Now consider why the corresponding episodic sentences and universally modalized sentences are ungrammatical. As seen in the following, with a local *O*-exhaustifier, the conjunctive inferences derived by applying *dou* are contradictory:

(68) a. $\mathbf{dou}_C$ [$_S$ [John or Mary]$_D$ λx [$O_{C'}$ [$_{VP}$ x_F teach Intro Chinese]]]
$\mathbf{dou}_C([\![S]\!]) = O_{C'}\phi_j \wedge O_{C'}\phi_m = \bot$ (where $C' = \{\phi_x \mid x \in D_e\}$)

b. $\mathbf{dou}_C$ [$_S$ [John or Mary]$_D$ λx must [$O_{C'}$ [$_{VP}$ x_F teach Intro Chinese]]]
$\mathbf{dou}_C([\![S]\!]) = \Box O_{C'}\phi_j \wedge \Box O_{C'}\phi_m = \bot$ (where $C' = \{\phi_x \mid x \in D_e\}$)

This analysis easily extends to *wh*/*any*-expressions.

5.3. Deriving the scalar operator use

There are two cases where *dou* functions as a scalar operator. One is in a [*lian* ...*dou*] construction, where *dou* is associated with the preceding *lian*-Foc and evokes an *even*-like inference. The other case is where *dou* is associated with an in-situ scalar item. This section starts with the semantics of English *even* (section 5.3.1), and then derives the *even*-like reading of *dou* in the [*lian* Foc *dou* ...] construction based on the proposed semantics of *dou* (section 5.3.2). Section 5.3.3 explains the minimizer-licensing effect of the [*lian* Min *dou* ...] construction. Section 5.3.4 extends to general cases where *dou* is associated with a scalar item.

5.3.1. The semantics of *even*

The English particle *even* is sensitive to focus. As seen in (69), associating *even* with different focus yields different scalar comparative inferences.

[19] This assumption was originally proposed by Xiang (2016c,a) to interpret questions admitting mention-some readings (such as *where can we get gas?*). Since mention-some questions contain an existential modal, and their disjunctive answers receive FC interpretations, it is not surprising that this analysis extends to the Modal Obviation effect in the licensing of ∀-FCIs.

(69) a. Mary **even** introduced BILL_F to Sue.
⇝ Compared with Mary introducing (some of) the others to Sue, it is unlikely/surprising that she introduced Bill to Sue.

b. Mary **even** introduced Bill to SUE_F.
⇝ Compared with Mary introducing Bill to (some of) the others, it is unlikely/surprising that she introduced Bill to Sue.

Due to Focus Condition, the domain of *even* is a subset of F-alternatives of the prejacent clause: $[\![even_C(\text{S})]\!]$ is defined only if $C \subseteq \text{F-ALT}(\text{S})$. However, unlike the case of *only*, excludability for the scalar exclusive particle *even* is defined based on likelihood, not logical strength.

There are two popular views on the semantics of *even*. Both views treat *even* a F-sensitive operator with a vacuous assertion and a scalar presupposition, but they differ with respect to the quantificational force of the scalar presupposition. Karttunen and Peters (1979) assumes that the scalar presupposition of *even* is **universal**: *even* presupposes that the propositional argument of *even* is the less likely than **all** of its contextually relevant F-alternatives.

(70) **Semantics of** *even* (Karttunen and Peters 1979)
$[\![even_C]\!] = \lambda p \lambda w : \forall q \in C[p \neq q \rightarrow q >_{\text{likely}} p].p(w) = 1$
(For any proposition p: $[\![even]\!](p)$ is defined only if p is less likely than *all* of its contextually relevant F-alternatives that are not identical to it; when defined, $[\![even]\!](p) = p$.)

In contrast, Bennett (1982) and Kay (1990) argue that the universal scalar presupposition is too strong and thus define an **existential** scalar presupposition: *even* presupposes that its propositional argument is less likely than **at least one** of its contextually relevant F-alternatives.

(71) **Semantics of** *even* (Bennett 1982; Kay 1990)
$[\![even_C]\!] = \lambda p \lambda w : \exists q \in C[q >_{\text{likely}} p].p(w) = 1$
(For any proposition p: $[\![even]\!](p)$ is defined only if p is less likely than *at least one* of its contextually relevant F-alternatives; when defined, $[\![even]\!](p) = p$.)

I adopt the existential scalar presupposition by Bennett and Kay. As the following sentences show, taken from Kay (1990), *even*-sentences can describe non-extreme cases:[20]

[20] A reviewer points out that the existential scalar presupposition cannot capture the infelicity of the use of *even* in example (i), taken from Greenberg (2016).

(i) (Harry, John and Bill participated in the sports competition.) Harry made it to the finals, John won his first round match, and Bill (??**even**) made it to [the semifinals]F .

However, this sentence involves many confounds. The oddness is not from the scalar presupposition of *even*, but rather a mix of non-semantic conditions. First, due to the Maxim of Manner, the order of the three conjuncts must be compatible with the scale ⟨first rounds, semi-finals, finals⟩. Second, for reasons unknown but clearly independent from semantics, it is strongly preferred to place an additive particle (e.g., *even*, *also*) to only the final conjunct:

(ii) John won his first round match, ...
a. ?? ... Bill **even** made it to the semifinals_F, and Harry (**even**) made it to the finals_F.
b. ?? ... Bill **also** won his first round match, and Harry (**also**) won his first round match.

As such, whenever an extreme case is presented explicitly as a conjunct, there is no feasible way to associate *even* with a non-extreme case. In contrast, in (73), where the extreme case is introduced covertly by the said question, *even* can be felicitously associated with a non-extreme case.

(72) a. Not only did Mary win her first round match, she **even** made it to the SEMI-finals$_F$.
b. The administration was so bewildered that they **even** had [lieutenant colonels]$_F$ making policy decisions.

For example, (72a) is felicitous although the prejacent "Mary made it to the SEMI-finals$_F$" is less extreme than that Mary made it to the finals. One might argue that the most extreme case, that Mary made it to the finals, is not included in the alternative set used by *even*. However, the contrast between *even* and *only* in the following question-answer pair excludes this possibility:

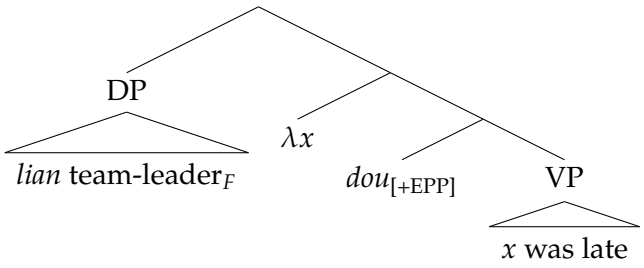
(73) Q: Which rounds did Mary make it to?
A: I'm not entirely sure. To what I know, she **even**/**#only** made it to the SEMI-finals$_F$.

Under the same question and associated with the same answer focus, *even* and *only* shall quantify over the same set of F-alternatives. The infelicity of the use of *only* suggests that this quantification domain includes all the propositions of the form 'Mary made it to round X': *only* exhaustifies over all such propositions, requiring the addressee to be fully knowledgable with the given question, which is contradictory to the previous utterance "I'm not entirely sure".

5.3.2. Deriving the *even*-like inference

The [(*lian*) Foc *dou* ...] construction has an *even*-like reading. I assume a toy surface structure as in (74). In this structure, *dou* selects for the entire VP, and *lian* is a focus marker which takes the focused or focus-containing phrase as its complement. To check off the [+EPP] feature of *dou*, *lian* together with the focused phrase (or the focus-containing phrase) moves to the left edge of VP.

(74) **Lian** [LINGDUI]$_F$ **dou** chidao -le.
LIAN team-leader DOU late -ASP
'Even the team leader was late.'



When *dou* is associated with *lian*-DP, the measurement used for ordering alternatives gets shifted from logical strength to likelihood. This shift brings changes to both the meaning of sub-alternatives as well as the exhaustifier encoded within the lexicon of *dou* used for pre-exhaustification. First, due to the Entailment-Scalarity Principle (Crnič 2011: 15), a proposition that is logically weaker is more likely to be true, and thus sub-alternatives of the prejacent propositional argument of *dou* are the alternatives that are more likely than this prejacent proposition.

(75) **Sub-alternatives as more likely alternatives**
$\textsc{Sub}(p, C) = \{q \mid q \in C \wedge q >_{\text{likely}} p\}$

Second, the pre-exhaustification effect of *dou* is realized by the scalar exhaustifier JUST (not the *O*-exhaustifier). As schematized in (76), analogous to the *O*-operator, JUST affirms the prejacent p and states a scalar exhaustivity condition that no true alternative of p is more likely than p.

(76) $\textsc{just}_C(q) = \lambda w : q(w) = 1 \wedge \forall r \in C[r(w) = 1 \rightarrow q \leq_{\text{likely}} r]$
(q is true, and q is the least likely proposition among its true alternatives in C.)

The *O*-to-JUST change is a consequence of defining sub-alternatives as more likely alternatives:

(77) $O_C(q)$
$= \lambda w : q(w) = 1 \wedge \forall r \in ((C - \textsc{Sub}(q, C)) - \{q\})[r(w) = 0]$
$= \lambda w : q(w) = 1 \wedge \forall r \in ((C - \{r' \mid r' \in C, r' >_{\text{likely}} q\}) - \{q\})[r(w) = 0]$
$= \lambda w : q(w) = 1 \wedge \forall r \in C[r <_{\text{likely}} q \rightarrow r(w) = 0]$
$= \lambda w : q(w) = 1 \wedge \forall r \in C[r(w) = 1 \rightarrow q \leq_{\text{likely}} r]$
$= \textsc{just}_C(q)$

Hence, in a [*lian* Foc *dou* ...] construction, the semantics of *dou* is adapted to (78). Compared with the default lexical entry in (49), the only parameter gets changed is the semantics of sub-alternatives, or more specifically, the measurement of ordering alternatives.

(78) **Semantics of** *dou* (in the [*lian* Foc *dou* ...] construction)
$[\![dou_C]\!] = \lambda p \lambda w : \exists q \in \textsc{Sub}(p, C).p(w) = 1 \wedge \forall q \in \textsc{Sub}(p, C)[\textsc{just}_C(q)(w) = 0]$
where $\textsc{Sub}(p, C) = \{q \mid q \in C \wedge q >_{\text{likely}} p\}$
(For any proposition p: $[\![dou_C]\!](p)$ is defined only if p has at least one sub-alternative in C. When defined, $[\![dou_C]\!](p)$ means 'p, and for any sub-alternative q in C, not just q.')

We can further simplify the assertion of *dou*. The anti-exhaustification condition provided by the *not just*-clause (underlined in (79)) that 'every alternative that is more likely than p is more likely than some true alternative of p,' is asymmetrically entailed by the rest asserted part that 'p is true.' [Proof: Whenever p is true, then any alternative of p that is more likely than p is less likely than some true alternative r, where $r = p$. End of proof.] Hence, the asserted component of *dou* simply affirms its propositional argument, or equivalently, is vacuous. Finally, we get a *dou* semantically equivalent to *even*: the non-vacuity presupposition of *dou* is equivalent to the existential scalar presupposition of *even*, and the assertion is vacuous.

(79) $[\![dou_C]\!]$
$= \lambda p \lambda w : \exists q \in \textsc{Sub}(p, C).p(w) = 1 \wedge \forall q \in \textsc{Sub}(p, C)[\textsc{just}_C(q)(w) = 0]$
$= \lambda p \lambda w : \exists q \in \textsc{Sub}(p, C).p(w) = 1 \wedge \forall q \in \textsc{Sub}(p, C) \exists r \in C[r(w) = 1 \wedge q >_{\text{likely}} r]$
$= \lambda p \lambda w : \exists q \in C[q >_{\text{likely}} p].p(w) = 1 \wedge \underline{\forall q \in C[q >_{\text{likely}} p \rightarrow \exists r \in C[r(w) = 1 \wedge q >_{\text{likely}} r]]}$
$= \lambda p \lambda w : \exists q \in C[q >_{\text{likely}} p].p(w) = 1$
(For any proposition p: $[\![dou_C]\!](p)$ is defined only if p is less likely than at least one of its contextually relevant alternatives; when defined, $[\![dou_C]\!](p) = p$.)
$= [\![even_C]\!]$

Thus, it is plausible to say that the *even*-like interpretation of the [*lian* Foc *dou* ...] construction comes from the non-vacuity presupposition of *dou* (Portner 2002, Shyu 2004, Paris 1998, Liao 2011, Liu 2016c), while that the particle *lian* is simply a focus marker and is present just for syntactic purposes. I define *lian* as follows: it asserts the meaning of its argument, and presupposes that this argument is focused. Following Rooth (1985, 1992, 1996), we say that a focused or focus-containing expression α has at least one F-alternative distinct from itself.

(80) **Semantics of** *lian*
$[\![lian(\alpha)]\!] = [\![\alpha]\!]$, defined only if $\{[\![\alpha]\!]\} \subset$ F-Alt(α).

5.3.3. Minimizer-licensing

Minimizers (including also emphatic weak scalar items such as *YI-ge ren* 'ONE person') can occur at the focal position in the [*lian* Foc *dou*...] construction. Usually, to license a minimizer, a post-*dou* negation must be present, as exemplified in (81). But, there are also cases where the post-*dou* negation is optional, as seen in (82).

(81) Yuehan (lian) [YI-ge ren]$_F$ **dou** *(bu) renshi.
John LIAN one-CL person DOU NEG know
'John doesn't know anyone.'

(82) Yuehan (lian) [YI-fen qian]$_F$ **dou** (bu) yao.
John LIAN one-cent money DOU NEG request
Without negation: 'John doesn't even want one cent.' (≈ 'John doesn't want any money.')
With negation: 'John wants it even if it is just one cent.' (≈ 'John wants any amount of money, however small amount it is.')

Minimizers must be licensed by a non-upward-entailing (i.e., downward-entailing or non-monotonic) operator. An operator is upward-entailing if it preserves the entailment pattern of its argument, downward-entailing if it reverses this pattern, and non-monotonic if it does neither. For instance, *Li is a semanticist* entails *Li is a linguist*. This entailment pattern is preserved in the modalized sentence (83a) and reversed in the negative sentence (83b). We thus say that *might* is upward-entailing while *not* is downward-entailing. In comparison, in the bi-conditional sentence (83c), neither entailment holds, which suggests that *iff* is non-monotonic in its second argument.

(83) a. *Upward-entailing*
i. Li might be a linguist.
⇑
ii. Li might be a semanticist.

b. *Downward-entailing*
i. Li isn't a linguist.
⇓
ii. Li isn't a semanticist.

c. *Non-monotonic*
i. We will invite Li iff she is a linguist.
⇯ ⇓
ii. We will invite Li iff she is a semanticist.

In what follows, I will show that the distributional pattern of Mandarin minimizers in [*lian* MIN *dou*...] constructions mirrors the distributional pattern of English minimizers and emphatic weak scalar items in *even*-sentences. Next, I extend Crnič (2011, 2014a)'s analysis of minimizer-licensing in English *even*-sentences to minimizer-licensing in Mandarin [*lian* ... *dou* ...] constructions.

I. Minimizer-licensing in *even*-sentences: scalar presupposition + operator movement

In English, a minimizer (such as a canonical minimizer like *lift a finger* or an emphatic weak scalar item like *ONE video*) can appear under the scope of *even* only if the propositional complement of

even is downward-entailing or non-monotonic with respect to this minimizer (Crnič 2011, 2014a). Consider the distribution of the emphatic weak scalar item *ONE video* in *even*-sentences for illustration. It is licensed only if the *even*-sentence involves a downward-entailing operator such as negation *n't*, as in (84b), or a non-monotonic predicate such as the desire predicate *hope*, as in (84c).

(84) a. * John made even ONE video.
b. John did**n't** make even ONE video.
c. I **hope** to someday make even ONE video of that quality.

Crnič (2011, 2014a) adopts the semantics of *even* from Bennett (1982) and Kay (1990), repeated below, and argues that the distributional pattern of minimizers in *even*-sentences is a consequence of the existential scalar presupposition of *even*.

(85) **Semantics of** *even* (Bennett 1982; Kay 1990)
$[\![even_C]\!] = \lambda p \lambda w : \exists q \in C[q >_{\text{likely}} p].p(w) = 1$

Further, Crnič bridges logical strength and likelihood with the principle in (86a). To illustrate the relation for different definitions of sub-alternatives, I alternatively use the more specific rule in (86b). According to this principle, to satisfy the existential scalar presupposition of *even*, the propositional prejacent of *even* must have at least one alternative that does not entail the prejacent.[21]

(86) **Entailment and scalarity**
a. If $p \subseteq q$, then $p \leq_{\text{likely}} q$. (Crnič 2011: 15)
(If a proposition p entails a proposition q, then p isn't more likely than q.)
b. If $p \subset q$, then $p <_{\text{likely}} q$.
(If a proposition p asymmetrically entails a proposition q, then p is less likely than q.)

This prediction immediately accounts for the ungrammaticality of (84a). With a focus-mark on the weak scalar item *ONE*, the F-alternatives of the prejacent proposition of *even* are formed by replacing *ONE* with other positive integers: $C = \{\textit{John made } n \textit{ videos} : n \in \mathbb{N}^+\}$. Hence, the existential scalar presupposition of *even* requires the prejacent proposition to be more likely than, and thus not entailed by, at least one of the F-alternatives. Nevertheless, because the prejacent is entailed by all the alternatives in C, this requirement cannot be satisfied, leaving the use of *even* infelicitous and the minimizer unlicensed.

(87) *John made even ONE video. Upward-entailing
a. Even_C [John made one_F video]

[21] Both principles follow basic probability theory. Following Kolmogorov's third axiom, the likelihood of a union of mutually exclusive propositions equals the sum of the likelihoods of the propositions, formally:

(i) For any two propositions p_1 and p_2 that are mutually exclusive, $\Pr(p_1 \cup p_2) = \Pr(p_1) + \Pr(p_2)$

The following is a proof of the principle in (86b). First, by axiom (i), for any two propositions p and q such that $p \subset q$, we have: (ii) $\Pr(q) = \Pr(p \cup (q - p)) = \Pr(p) + \Pr(q - p)$. Second, by the assumption $p \subset q$, $q - p$ is not contradictory, and thus: (iii) $\Pr(q - p) > 0$. Finally, by (ii) and (iii), we have: $\Pr(q) > \Pr(p)$. End of proof.

b. The scalar presupposition is unsatisfied, because the prejacent of *even* is weaker than and hence **more likely** than the other alternatives:

For any n s.t. $n > 1$: John made 1 video $\supset$ John made n videos

As for the grammatical cases in (84b-c), Crnič proposes that the LFs of these sentences involve a covert movement of the F-sensitive operator *even*. This operator movement does not leave a trace, but it makes *even* take a wide scope (e.g., above *not* and *hope*). When *even* is associated with a minimizer across a downward-entailing operator (e.g., *not*), its scalar presupposition gets trivially satisfied: the prejacent is logically stronger than all the other alternatives, and hence is less likely than all the other alternatives.

(88) John did**n't** make even ONE video. Downward-entailing

a. Even$_C$ [**not** [~~even~~$_C$ [John made one$_F$ video]]]

b. The scalar presupposition is satisfied, because the prejacent of *even* is stronger than and hence **less likely** than all the other alternatives:

For any n s.t. $n > 1$: **not** [John made 1 video] $\subset$ **not** [John made n videos]

When *even* is associated with a minimizer across a non-monotonic operator such as the desire predicate *hope* (Heim 1992), the prejacent of *even* is logically independent from other alternatives, and it can be less likely than (at least some of) the other alternatives in proper contexts.

(89) I **hope** to someday make even ONE video of that quality. Non-monotonic

a. Even$_C$ [I **hope** to [~~even~~$_C$ [someday make one$_F$ video of that quality]]]

b. The scalar presupposition can be satisfied, because: The prejacent of *even* is logically independent from all the other alternatives. In a proper context, the prejacent can be **less likely** than (some of) the other alternatives.

For any n s.t. $n > 1$: I **hope** to [... make 1 video ...] $\not\Rightarrow$ I **hope** to [... make n videos ...]
I **hope** to [... make 1 video ...] $\not\Leftarrow$ I **hope** to [... make n videos ...]

II. Minimizer-licensing in [*lian* ... *dou*] constructions: scalar presupposition + F-reconstruction

Similar to the minimizer-licensing condition in English *even*-sentences, in Mandarin, the minimizer in a [*lian* MIN *dou*...] construction is licensed iff the prejacent clause of *dou* is downward-entailing or non-monotonic with respect to this minimizer. Briefly, the post-*dou* negation *bu* in (81) provides a downward-entailing environment, while the desire predicate *yao* 'want' in (82) provides a non-monotonic environment.

Since the Mandarin particle *dou* in a [*lian* ... *dou* ...] construction is semantically identical to English *even*, we can easily extend Crnič's (2011, 2014) analysis of minimizer-licensing in English *even*-sentences to minimizer-licensing in Mandarin [*lian* ... *dou* ...] constructions. Briefly, the minimizer-licensing condition is a logical consequence of the non-vacuity presupposition of *dou*, which requires the propositional argument of *dou* to be less likely than some of the alternatives, and hence not to be weakest proposition among the alternatives. The only difference between my treatment of *dou* and Crnič's of *even* is the following: while Crnič assumes an operator movement of

even over a non-upward-entailing operator, I assume that the minimizer undergoes reconstruction and gets interpreted below the non-upward-entailing operator.

In (81), the non-vacuity presupposition of *dou* forces the minimizer *YI-ge ren* 'one person' to take reconstruction and get interpreted below negation, as shown in (90): *there is at least one person that John didn't invite* is weaker than alternatives of the form *there are at least n people that John didn't invite* where $n > 1$; while *not [John invited at least one person]* is stronger than alternatives of the form *not [John invited at least n people]* where $n > 1$. Hence, without negation or if the minimizer scopes above negation, the propositional argument of *dou* would be logically the weakest among its alternatives, leaving the presupposition of *dou* unsatisfied.

(90) Yuehan (lian) [YI$_F$-ge ren] **dou** *(bu) renshi.
John LIAN one-CL person DOU NEG know
'John doesn't even know ONE person.'

a. * **Dou** [$_{\text{UE}}$ [**lian** (**one**$_F$ **person**)]$_i$ NOT [John knows t_i]] MIN ≫ NEG
for any $n > 1$: $\exists 1x\neg[\textit{know}(j,x)] \supset \exists nx\neg[\textit{know}(j,x)]$

b. **Dou** [$_{\text{DE}}$ NOT [John knows **lian** (**one**$_F$ **person**)]] NEG ≫ MIN
for any $n > 1$: $\neg\exists 1x[\textit{know}(j,x)] \subset \neg\exists nx[\textit{know}(j,x)]$

The focus reconstruction-based analysis is supported by the ungrammaticality of (91): a minimizer cannot be licensed if it cannot be reconstructed to a position below negation. In (91), the minimizer *YI-ge ren* 'one person' serves as the subject, whose surface position and reconstructed position are both higher than negation *bu*, and hence the ungrammaticality of (91) cannot be salvaged by reconstruction.[22]

(91) * (Lian) [YI-ge ren]$_F$ **dou** bu renshi Yuehan.
LIAN one-CL person DOU NEG know John.
Intended: 'No one knows John.'

The optional presence of a post-*dou* negation in (82) can also be accounted for in the same way. The desire predicate *yao* 'want to have' is a non-monotonic operator (Heim 1992, a.o.). Hence, if the minimizer *YI-fen qian* 'one cent' takes scope below *yao*, as in (92b), the alternatives of the propositional argument of *dou* would be semantically independent from each other. In a proper context, such as where John is unlikely to be interested in a small amount of money, the prejacent *John wants to have one cent* would be less likely than alternatives such as *John wants to have two cents*. Therefore, the non-vacuity presupposition of *dou* can be satisfied even in absence of the post-*dou* negation.

(92) a. Yuehan (lian) [YI-fen qian]$_F$ **dou** yao.
John LIAN one-cent money DOU want

[22] Mandarin is highly isomorphic. It doesn't allow scope inversion (for subjects at least). For example:

(i) a. Mei-ge-ren dou mei lai.
every-CL-person DOU NEG come
'Every individual x is such that x didn't come.'
($^{\text{OK}}$EVERY ≫ NEG, $^{\#}$NEG ≫ EVERY)

b. You yi-ge-ren mei lai.
exist one-CL-person NEG come
'Some individual x is such that x didn't come.'
($^{\text{OK}}$SOME ≫ NEG, $^{\#}$NEG ≫ SOME)

'John wants to have even one cent.
(Intended: John wants any money, however little money it is.)'

b. [**dou** [John$_i$ wants$_{\text{NM}}$ [**lian (one$_F$-cent)** λx [e_i has x]]]]

5.3.4. Association with a scalar item

Associating *dou* with a in-situ scalar item implies that the prejacent proposition ranks relatively high with respect to some contextually relevant measurement. A simple way of thought would be to order the alternatives based on the contextually relevant measurement, and to define the sub-alternatives as the ones that rank lower than the prejacent proposition with respect to this measurement. For instance, in (93), sub-alternatives are propositions that rank lower than the prejacent in chronological order. The pre-exhaustification effect of *dou* is realized by the scalar exhaustifier JUST.

(93) **Dou** [WU-dian] -le.
DOU five-o'clock -ASP
'It is **dou** [FIVE] o'clock.' $\rightsquigarrow$ *It's too late.*

a. SUB(*it's five o'clock*, C) = {*it's 4 o'clock*, *it's 3 o'clock*, ...}

b. $[\![\textbf{dou}_C$ [it's FIVE$_\sigma$ o'clock]$]\!]$ = 'it's 5 o'clock, not just 4 o'clock, not just 3 o'clock, ...'

We thus get a definition of *dou* as schematized in (94) for its general scalar additive operator use. Here the quantification domain of *dou* is restricted to a subset of scalar alternatives of its prejacent.

(94) $[\![dou_C]\!] = \lambda p \lambda w : \exists q \in \text{SUB}(p, C).p(w) = 1 \wedge \forall q \in \text{SUB}(p, C)[\text{JUST}_C(q)(w) = 0]$
(For any proposition p: $[\![dou_C]\!](p)$ is defined only if p has at least one sub-alternative in C. When defined, $[\![dou_C]\!](p)$ means 'p, and for any sub-alternative q in C, not just q.')
where:

a. $\text{SUB}(p, C) = \{q \mid q <_\mu p, q \in C\}$
(The set of contextually relevant alternatives of p that rank lower than p w.r.t. μ)

b. $\text{JUST}_C(q) = \lambda w : q(w) = 1 \wedge \forall r \in C[r(w) = 1 \rightarrow r \geq_\mu q]$
(q is true; q ranks the highest w.r.t. μ among its true alternatives.)

To generate sub-alternatives and satisfy the non-vacuity presupposition of *dou*, the prejacent statement needs to be relatively strong among the quantificational statements. For instance, in (95), *dou* can be associated with 'many-NP' but not with 'few-NP'. Likewise, in (96), *dou* can be associated with 'twice' but not with 'once'.

(95) [Duo/*Shao -shu -ren] **dou** lai -le.
many/few -amount -person DOU come -ASP
'Most/*few people **dou** came.'

(96) Ta **dou** yijing lai -guo zher [LIANG/*YI$_F$-ci] -le.
he DOU already come -EXP here two/one-time -ASP.
'He has already been here twice/*once.'

5.4. Interim summary

This section derives the three uses of *dou* based on a uniform semantics. Briefly, for the quantifier-distributor use and the scalar use, the non-vacuity presupposition is responsible for all the observed semantic effects, while the anti-exhaustivity inference collapses under the prejacent inference. For the ∀-FCI-licenser use, the non-vacuity presupposition is trivially satisfied, while the prejacent inference together with anti-exhaustivity inference yields the FC inference.

6. Sorting the parameters

I define *dou* uniformly an exhaustifier that negates pre-exhaustified sub-alternatives, as repeated from (33):

(97) $[\![dou_C]\!] = \lambda p \lambda w : \underbrace{\exists q \in \textsc{Sub}(p, C)}_{\text{non-vacuity}} . \underbrace{p(w) = 1}_{\text{prejacent}} \wedge \underbrace{\forall q \in \textsc{Sub}(p, C)[O_C(q)(w) = 0]}_{\text{anti-exhaustivity}}$

The function of *dou* varies purely by the meaning of sub-alternatives. Among the four variants for the definition of sub-alternatives summarized in Table 1, the first two are based on logical strength, varying with respect to the type of excludability (regular excludability or innocent excludability), the third is based on likelihood, and the last is based on a contextually determined scale. This section focuses on the first three variants.

	Definition of sub-alternatives	Function of *dou*
Def (a)	Alternatives that are **weaker** than the prejacent	Distributor
Def (b)	Alternatives that are **not I-excludable**	∀-FCI-licenser
Def (c)	Alternatives that are **more likely** than the prejacent	EVEN
Def (d)	Alternatives ranked lower than the prejacent w.r.t. a relevant measurement	Scalar marker

Table 1: Definitions of sub-alternatives and the corresponding functions of *dou*

Here arise two non-trivial questions: how are these variants related, and which variant is primary? I argue that Def (a) is primary, while that Def (b) and (c) are derived from (a) by two independent semantic weakening operations, as illustrated in Figure 1.

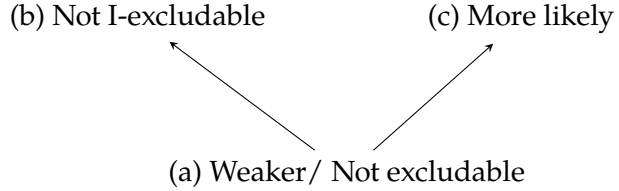


Figure 1: Development path for sub-alternatives

In particular, Def (b) is derived from Def (a) by weakening unexcludability to un-I-excludability. As seen in section 5.2.1, any alternative that is not excludable is not I-excludable, while it is not the

case that every alternative that is not I-excl-alternative is not excludable. For example, in the case of a disjunction, the disjuncts are excludable but not I-excludable. Def (c) is derived from (a) by weakening logical strength to likelihood. Due to Entailment-Scalarity Principle, any alternative that is logically weaker than the prejacent is also more likely than the prejacent, but a less likely alternative is not necessarily logically weaker. For example, as seen in (89), *I hope to someday make two videos of that quality* is logically independent from the prejacent *I hope to someday make one video of that quality*, it can still be more likely (or less likely) than the prejacent.

The proposed derivational path for sub-alternatives yields two predictions. First, the distributor use of *dou* is primary, while the other uses are derived, as illustrated in Figure 2.

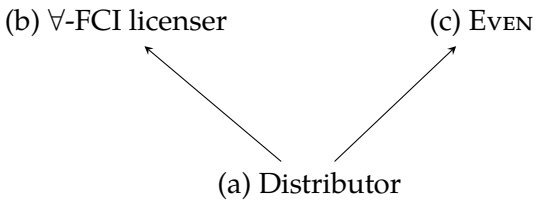


Figure 2: Development path for the uses of *dou*

This prediction is supported by diachronic evidence: the two derived uses emerged much later than the primary use. In particular, the distributor use of *dou* emerged as early as the Eastern Han Dynasty (25-220AC) (Gu 2015), while so far there is no reliable evidence to show that *dou* could function as an *even*-like scalar additive operator or a ∀-FCI licenser before the Ming Dynasty.

Second, the likelihood-based semantics of *dou* (i.e., the one defined based on definition (c) of sub-alternatives) shall be strictly more restrictively used than the logical strength-based semantics of *dou* (i.e., the one defined based on Def (a) of sub-alternatives). More concretely, the logical strength-based semantics should be widely available, while the likelihood-based one is only licensed under particular syntactic or prosodic conditions, such as when *dou* appears in a [(*lian*) ... *dou* ...] construction or is associated with a stressed item.[23] This prediction is supported by the distribution of *dou* in basic declaratives and [(*lian*) ... *dou* ...] constructions, as summarized in the following table:

If the prejacent of *dou* is ...	Can the presupposition of *dou* be satisfied in ...	
	... basic declaratives?	... [(*lian*) ... *dou* ...] constructions?
stronger than some alternative(s)	Yes	Yes
the weakest alternative	No	No
neither	**No**	Yes

Table 2: Distribution of *dou* in declaratives and [*lian* ... *dou* ...] constructions

The table above considers three conditions regarding to the logical strength of the propositional argument of *dou*. Let us go through them one by one, and keep in mind that *dou* presupposes

[23]For the same reason, we expect that the unexcludability-based semantics of *dou* (i.e., the one defined based on definitions (b) of sub-alternatives) is more restrictedly used than the logical strength-based one. For example, the unexcludability-based semantics is licensed only when *dou* is associated with an existential or disjunctive quantifier.

that its propositional prejacent has at least one sub-alternative. First, if the prejacent is logically stronger than one of more of its alternatives, then due to the Entailment-Scalarity Principle, the non-vacuity presupposition of *dou* is satisfied not only under the logical strength-based definition, but also trivially satisfied under the likelihood-based definition. For example, in (98a-b), compared with the prejacent *John can eat up three bowls of rice*, scalar alternatives such as *John can eat up two bowls of rice* are not only more likely but also weaker than the prejacent, making the non-vacuity presupposition of *dou* satisfied under both semantics. In particular, the logical strength-based semantics yields the quantifier-distributor use of *dou* in (98a), and the likelihood-based semantics yields the *even*-like use in (98b).[24]

(98) a. Yuehan [(zhe) san-wan fan] **DOU** chi-de-wan.
John DEM three-bowl rice DOU eat-mod-finish
'John can eat up (these) three bowls of rice.'

b. Yuehan (lian) [SAN$_F$-wan fan] **dou** chi-de-wan.
John LIAN three-bowl rice DOU eat-mod-finish
'John can even eat up THREE bowls of rice.'

Second, if the prejacent is logically weaker than all the other alternatives, *dou* suffers a presupposition failure under both semantics. For example, as seen in (99a), *dou* cannot be associated with the non-emphatic '(the) one person' when functioning as a quantifier-distributor, because the prejacent proposition is the logically weakest alternative. Likewise, as seen in the [(*lian*)...*dou*...] sentence (99b), in absence of a non-upward-entailing operator, *dou* cannot be associated with an emphatic 'one person' and function as an *even*-like minimizer-licenser, because the prejacent proposition of *dou* is the logically weakest as well as the most likely alternative.

(99) a. Yuehan [(zhe) *yi/san-ge ren] **dou** renshi.
John DEM one/three-CL person DOU know
'John knows all the *one/three people.'

b. Yuehan (lian) [YI$_F$-ge ren] **dou** *(bu) renshi.
John LIAN one-CL person DOU NEG know
'John does*(n't) even know ONE person.'

Last and the most important, under the "neither" condition, namely, that the prejacent proposition is neither stronger than any alternative nor the weakest alternative, *dou* can be felicitously used in [*lian* ... *dou* ...] constructions but not in basic declaratives. Consider the following two pairs of sentences:

(100) a. * John **dou** arrived.
b. (Lian) JOHN **dou** arrived.

(101) a. They **dou** bought houses. (#collective, $\surd$distributive)
b. (Lian) THEY **dou** bought houses. ($\surd$collective,$\surd$distributive)

[24]There is a minor difference between the two examples in (98): *san-wan fan* 'three bowls of rice' receives a referential interpretation in the basic declarative (98a) but a generic interpretation in the [(*lian*) ... *dou* ...] sentence (98b).

The basic declarative (100a) is ungrammatical due to a presupposition failure: the prejacent of *dou* has no logically weaker alternative. In contrast, the [(*lian*) Foc *dou* ...] sentence (100b) is grammatical, because propositions of the form "*x* arrived" can be less likely than the prejacent *John arrived* in proper contexts, which therefore makes the presupposition of *dou* satisfied. In (101), although both sentences are grammatical, the prejacent clause *they bought houses* admits a collective reading in the [(*lian*) Foc *dou* ...] sentence (101b) but not in the basic declarative (101a). When taking a collective reading, the prejacent of *dou* is logically independent from all the alternatives, but it can be more likely than some of its alternatives in proper contexts. The above contrasts suggest a crucial prediction: the likelihood-based semantics of *dou*, which allows sub-alternatives to be logically independent from the prejacent, is available in [(*lian*) Foc *dou* ...] constructions but not in basic declaratives. Given that the likelihood-based semantics is weaker than the logical strength-based one, the strictly more restrictive distributional pattern of the likelihood-based semantics suggests that the likelihood-based semantics is derived out of the logical strength-based one.

7. Conclusions

This paper offered a uniform semantics to capture the seemingly diverse functions of the Mandarin particle *dou*, including the quantifier-distributor use, the ∀-FCI-licenser use, and the scalar use. I define *dou* as a special exhaustifier that operates on sub-alternatives and has a pre-exhaustification effect: *dou* presupposes the existence of at least one sub-alternative, asserts the truth of the prejacent and the negation of each pre-exhaustified sub-alternative.

The semantics of *dou* exhibits minimal alternations caused by semantic weakenings on the definition of sub-alternatives, giving rise to different uses. By default, sub-alternatives are the alternatives that are weaker than the prejacent, or equivalently, the ones that are not excludable and distinct from the prejacent. Under this definition of sub-alternatives, *dou* obtains its primary use as a distributor. Further, with a weakening from unexcludability to un-I-excludability, *dou* gains its ∀-FCI licenser use. Alternatively, with a weakening from logical strength to likelihood, *dou* becomes semantically equivalent to English *even* and functions as a scalar additive operator. The derivational path for the functions of *dou* is supported by both diachronic and synchronic evidence.

The anti-exhaustivity assertion of *dou* is responsible for the derivation of universal FC inferences. The non-vacuity presupposition of *dou* explains the distributional pattern of *dou* and many of its semantic consequences, such as the requirements regarding to distributivity and plurality, the *even*-like interpretation of the [*lian* Foc/Min *dou* ...] construction, the distributional pattern of the post-*dou* negation in licensing minimizers, and so on.

Appendix I: Deriving FC with recursive exhaustification

Readers who are familiar with the grammatical view of exhaustifications might find that the proposed meaning of *dou* is similar to the operation of recursive exhaustification proposed by Fox (2007) or to the pre-exhaustification exhaustifier for D-alternatives by Chierchia (2013). This appendix reviews the possibility of using recursive exhaustification to derive the ∀-FCI use of a pre-verbal disjunction in Mandarin. For a detailed comparison of these three operators, especially

on deriving ∃-FC, see Xiang (2016a: chap. 2 Appendix).

Fox's (2007) recursive exhaustification (abbreviated as 'O^R') has two major characteristics. First, exhaustification negates only alternatives that are I-excludable. Second, exhaustification is applied recursively. See (102) for a concrete example for the derivation of an ∃-FC inference. The inner exhaustification negates the I-excludable σ-alternative (i.e., $\Diamond[p \wedge q]$) and F-alternatives (e.g., $\Diamond r$); the D-alternatives are not negated in this round, because they are not I-excludable. The outer exhaustification affirms the exhaustified prejacent and negates the pre-exhaustified D-alternatives.

(102) **Recursive exhaustifications** (Fox 2007)
$O^R\Diamond[p \vee q]$

a. The first exhaustification:
$O_C\Diamond[p \vee q] = \Diamond[p \vee q] \wedge \neg\Diamond[p \wedge q] \wedge \neg\Diamond r$

b. The second exhaustification:
$O'O\Diamond[p \vee q]$
$= O\Diamond[p \vee q] \wedge \neg O\Diamond(p) \wedge \neg O\Diamond(q)$
$= [\Diamond[p \vee q] \wedge \neg\Diamond[p \wedge q] \wedge \neg\Diamond r] \wedge [\Diamond p \rightarrow \Diamond q] \wedge [\Diamond q \rightarrow \Diamond p]$
$= [\Diamond[p \vee q] \wedge \neg\Diamond[p \wedge q] \wedge \neg\Diamond r] \wedge [\Diamond p \leftrightarrow \Diamond q]$
$= \Diamond p \wedge \Diamond q \wedge \neg\Diamond[p \wedge q] \wedge \neg\Diamond r$

For an easier comparison with *dou*, I formulate the semantics of O^R as in (103): O^R affirms the prejacent, negates the exhaustification of each sub-alternative, and negates the I-excl-alternatives.[25]

(103) $O^R_C(p) = \lambda w : p(w) = 1 \wedge \forall q \in \textsc{Sub}(p, C)[O_C(q)(w) = 0] \wedge \forall q' \in \textsc{IExcl}(p, C)[q'(w) = 0]$
where $\textsc{Sub}(p, C) = (C - \textsc{IExcl}(p, C)) - \{p\}$

It can be observed that O^R is stronger than the proposed meaning of *dou*: unlike O^R, *dou* does not negate I-excl-alternatives and thus does not yield an exclusive inference or scalar implicature. For instance, the sentence "John or Mary *dou* can teach Intro Chinese" (English paraphrase of (9b)) does not imply that no one other than John and Mary can teach Intro Chinese. If *dou* is defined equivalent to O^R, we will have to assume that all the I-excludable F-alternatives are pruned.

Two reviewers suggested an alternative analysis for the ∀-FCI licenser use of *dou*, which attributes the derivation of FC to the application of recursive exhaustification, as summarized in the following. First, *dou* is vacuous in assertion but it presupposes that the prejacent has at least one weaker alternative, as in (104b). Second, when *dou* combines with a disjunctive sentence, since its prejacent is the weakest among its alternatives, its presupposition forces the application of recursive exhaustification, which turns the prejacent disjunction into a conjunction.

(104) John or Mary **dou** can teach Intro Chinese.

a. LF: $\textbf{dou}_{C'}$ [O^R_C [$_S$ [John or Mary]$_D$ can teach Intro Chinese]]

b. $[\![\textbf{dou}_{C'}]\!] = \lambda p \lambda w : \exists q \in C[p \subset q].p(w) = 1$

[25] In particular cases, the definition for O^R in (103) yields inferences different from what Fox's proposal would expect: if the exhaustification of a sub-alternative is still not innocently excludable, the exhaustification of this sub-alternative would not be negated by O^R under Fox's original definition. See details in Xiang (2016a: footnote 38).

c. $C = \text{D-ALT(S)}$
$= \{\Diamond\phi_j \vee \Diamond\phi_m, \Diamond\phi_j, \Diamond\phi_m\}$

d. $C' = \{O^R(p) \mid p \in \text{D-ALT(S)}\}$
$= \{O^R_C[\Diamond\phi_j \vee \Diamond\phi_m], O^R_C\Diamond\phi_j, O^R_C\Diamond\phi_m\}$

This analysis is quite appealing, but it faces two problems. First, it requires the D-alternatives of the prejacent disjunction to be used twice: once is by the recursive exhaustifier for deriving FC inference, and the other is by *dou* for fulfilling the presupposition. However, according to the grammatical view of exhaustifications, if an alternative has been used by a local operator, it will become unavailable to global operators. Second, contrary to the expected consequence of this analysis, recursive exhaustification cannot salvage the presupposition failure of *dou*. Consider the recursively exhaustified alternatives in (104d): these alternatives are derived by applying recursive exhaustification point-wise to the D-alternatives of the prejacent disjunction. The domain for recursive exhaustification, as in (104c), is also the set of D-alternatives of the prejacent disjunction.[26] As such, even though recursively exhaustifying the prejacent disjunction yields a desired FC inference, as in (105a), the recursively exhaustified disjuncts (105b-c) contradict this FC inference, leaving the presupposition of *dou* unsatisfied.

(105) The alternatives in (104d) are mutually exclusive:

a. $O^R_C[\Diamond\phi_j \vee \Diamond\phi_m] = \Diamond\phi_j \wedge \Diamond\phi_m$

b. $O^R_C\Diamond\phi_j = O\Diamond\phi_j = \Diamond\phi_j \wedge \neg\Diamond\phi_m$

c. $O^R_C\Diamond\phi_m = O\Diamond\phi_m = \Diamond\phi_m \wedge \neg\Diamond\phi_j$

One might suggest to solve this problem by stipulating that recursively exhaustifying one disjunct does not negate the other disjunct (for example, let $O^R_C\Diamond\phi_j = \Diamond\phi_j$). Then, the domain of *dou* would be pleasantly as follows: $C' = \{\Diamond\phi_j \wedge \Diamond\phi_m, \Diamond\phi_j, \Diamond\phi_m\}$. However, in Fox's (2007) derivation of ∃-FC inferences, it is crucial to let disjuncts be alternatives of each other. More precisely, in computing (102b), if the disjuncts are not alternatives of each other, applying the outer exhaustification yields a contradiction. The following considers two possibilities: (106a) assumes that F-alternatives are pruned, while (106b) assumes that F-alternatives (i.e., $\Diamond r$ and $\Diamond s$) are not pruned.

(106) a. $O'O\Diamond[p \vee q] = O\Diamond[p \vee q] \wedge \neg O\Diamond p \wedge \neg O\Diamond q$
$= \Diamond[p \vee q] \wedge \neg\Diamond[p \wedge q] \wedge \neg\Diamond p \wedge \neg\Diamond q$
$= \bot$

b. $O'O\Diamond[p \vee q] = O\Diamond[p \vee q] \wedge \neg O\Diamond p \wedge \neg O\Diamond q$
$= \Diamond[p \vee q] \wedge \neg\Diamond[p \wedge q] \wedge \neg[\Diamond r \vee \Diamond s] \wedge [\Diamond p \rightarrow \Diamond r \vee \Diamond s] \wedge [\Diamond q \rightarrow \Diamond r \vee \Diamond s]$
$= \Diamond[p \vee q] \wedge \neg\Diamond[p \wedge q] \wedge \neg[\Diamond r \vee \Diamond s] \wedge \neg\Diamond p \wedge \neg\Diamond q$
$= \bot$

Appendix II: Comparing with Liao and Liu

Liao (2011: ch. 4) makes the first attempt to provide a uniform semantics treatment of the three uses

[26] In computing the embedded recursive exhaustification, F-alternatives must be pruned to avoid the undesired exclusive inference. Complications with σ-alternatives are ignored here.

of *dou*. Her analysis of the FCI-licenser use is too complex to be reviewed here. Hence, the following introduces only the technicalities in her proposal needed for getting the scalar additive operator use and the distributor use. Liao assumes that *dou* has no meaning per se, but that it indicates the existence of focus and is subject to syntactic dependency with a covert c-commanding E-operator, as in (107a). The meaning of this E-operator equals to what Karttunen and Peters (1979) assume for *even*: the E-operator is truth conditionally vacuous but presupposes that its prejacent is the most unlikely proposition among its alternatives.

(107) (Lian) JOHN$_F$ dou arrived.
  a. [E$_C$ [JOHN$_{F,i}$ **dou** t_i arrived]]
  b. $[\![\text{E}_C]\!] = \lambda p \lambda w : \forall q \in C[p \neq q \rightarrow q >_{\text{likely}} p].p(w) = 1$

When *dou* applies to a distributive sentence, the scalar presupposition of the E-operator is trivially satisfied: under a distributive reading, the prejacent of *dou* entails all of its alternatives, and hence is not less likely than any of its alternatives.

Liu (2016b,c, 2018) differs from Liao (2011: ch. 4) in two respects. First, instead of placing an E-operator in the logical form, he equivocates the meaning of *dou* and *even*:

(108) **Semantics of** *dou* (Liu 2016b,c, 2018)
$[\![dou_C]\!] = \lambda p \lambda w : \forall q \in C[p \neq q \rightarrow p <_{\text{likely}} q].p(w) = 1$

This change is advantageous since it captures the locality of *even*-inferences. In example (109), the *even*-inference is generated within the antecedent *lian ... dou* clause and projects over the conditional, as in (109a). If the *even*-inference of a *dou*-sentence were from an E-operator, we would expect the possibility of placing E above the entire conditional (i.e., E [if **lian** JOHN$_F$ **dou** came, Mary will be happy]), which however yields the undesired conditional scalar inference in (109b).

(109) If **lian** JOHN$_F$ **dou** came, Mary would be happy.
  a. $\rightsquigarrow$ *Compared with others, JOHN is less likely to come.*
  b. $\not\rightsquigarrow$ *Compared with others' visits, it is more likely that JOHN's visit would make Mary happy.*

Second, based on Link-Landman's approach of encoding distributivity/collectivity distinction (Link 1983; Landman 1996, 2012), Liu improves on the treatment of distributivity/collectivity in the derivation of alternatives. (See the problem of cover-based analysis of distributivity/collectivity in footnote 14. Details of Liu's implementation are omitted due to the scope of this paper.) Liu's analysis predicts the follows: when taking a distributive reading, the propositional argument of *dou* entails all of its alternatives, and hence is not less likely than any of its alternatives; when taking a collective reading, the propositional argument of *dou* and its alternatives are logically independent, forcing to order the alternatives by likelihood, yielding the *even*-like use of *dou*.

Liu's account was developed in parallel with the proposed account, as witnessed by preliminary presentations of the two accounts (Xiang 2015, 2016b; Liu 2016a). Although both Liu's and mine accounts use Alternative Semantics, we ended up with views contradictory with respect to which function(s) and semantics of *dou* are primary. Briefly, Liu assumes that *dou* is primarily equivalent to the likelihood-based particle *even*, and that it takes a distributor-like use when the scalar presupposition of *dou* is trivially satisfied. In contrast, my account predicts that the *even*-like use of

dou is secondary: it is employed only when the semantics of sub-alternatives is weakened from logical strength to likelihood. I argue that the prediction of my account is more compatible with the asymmetric distributions of the distributor use and the *even*-like use of *dou* in (100) and (101). If the likelihood-based semantics were the default semantics, *dou* should be licensed whenever the presupposition of its likelihood-based semantics is satisfied, and hence should have the same distribution in basic declaratives and [*lian* ... *dou* ...] constructions, contra fact. For example, for the basic declarative (110) (repeated from (101a)), if *they bought houses together* is contextually more likely than *the others bought houses together*, the likelihood-based semantics of *dou* should have been defined even if the prejacent takes a collective reading, contra fact.

(110) They **dou** bought houses. (#collective, $\surd$distributive)

Liu so far has no written work on the $\forall$-FCI licenser use of *dou*. But he suggested to me an attempt through a private conversation, described as follows. When the propositional argument of *dou* is existential or disjunctive, the plain value of this propositional argument is too weak to satisfy the universal scalar presupposition of *dou*; therefore, the propositional argument of *dou* is forced to be recursively exhaustified, giving rise to an FC interpretation. This analysis is pretty much the same as what was described in (104) in Appendix I, except that here *dou* presupposes a universal scalar presupposition.

(111) John or Mary **dou** can teach Intro Chinese.

a. LF: $\textbf{dou}_{C'}$ [O^R_C [John or Mary can teach Intro Chinese]]

b. $[\![dou_{C'}]\!] = \lambda p \lambda w : \forall q \in C'[p \neq q \rightarrow p <_{\text{likely}} q].p(w) = 1$

However, this analysis faces two problems. First, the same as the analysis reviewed in Appendix I, this analysis unpleasantly requires the D-alternatives of the prejacent disjunction to be used twice — once by O^R and once by *dou*. Second, this analysis over-generates *even*-like inferences. Due to the non-monotonicity of the O^R-operator, the scalar presupposition of *dou* is non-trivial and is only satisfied in proper contexts. Hence, contra fact, this analysis predicts that *dou* always evokes an *even*-like inference when associated with a pre-verbal disjunction or a pre-verbal *wh-/any*-phrase, as it would in a [*lian*...*dou*] construction. Examples in (112) show that the FCI-licenser use and the *even*-like use of *dou* are complementarily distributed. In (112a), the $\forall$-FCI use of a preverbal *wh-/any*-phrase is not licensed in the focal position of a [*lian* ... *dou*] construction. In (112b-c), when *dou* is associated with a preverbal disjunction, the *even*-like inference is available only when *lian* is overtly used or the disjunction is stressed.

(112) a. (*Lian) [na-ge/ renhe -ren] **dou** keyi jiao jichu hanyu.
LIAN which-CL/ any person DOU can teach introductory Chinese
Intended: 'Anyone can teach Intro Chinese.'

b. [Yuehan huozhe Mali] **DOU** keyi jiao jichu hanyu.
John or Mary DOU can teach introductory Chinese
Intended: 'Both John and Mary can teach Intro Chinese.'
$\not\rightsquigarrow$ *Even [John and Mary]$_F$ can teach Intro Chinese.*

c. (Lian) [Yuehan huozhe Mali]$_F$ **dou** keyi jiao jichu hanyu.
LIAN John or Mary DOU can teach introductory Chinese
'Even John and Mary can teach Intro Chinese.'

Acknowledgement
[To be added ...]

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