Alternations of logical functions: Mandarin particle *dou* as a pre-exhaustification exhaustifier[1]

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1. Introduction

1.1. A cross-linguistic puzzle

- The logical system of universal grammar (UG) should be simple and consistent. But, cross-linguistically, many particles possess various basic logical functions. Hence:
  - the functions of a multi-usage particle should have primarily **the same source**;
  - the alternations of these functions should be triggered by **minimal variations**.
- *Dou* can trigger distributivity, license a free choice item (FCI), and evoke an *even*-like inference. I present a uniform semantics to capture the diverse functions of the Mandarin particle *dou*.

1.2. Describing the uses of *dou*

- **Quantifier-distributor:**

  In a basic declarative, *dou* universally (∀-)quantifies over the subparts of the denotation of the associated item (enclosed in "[●]").

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

  Under this use, *dou* brings up more semantic consequences than ∀-quantification. Descriptively:

  "Distributivity Requirement": if the prejacent sentence admits both collective and (atomic/non-atomic) distributive readings, applying *dou* **eliminates the collective reading** (Lin 1996).

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

  "Plurality Requirement": the item associated with *dou*, overt or covert, must be **non-atomic**.

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

- **Universal FCI-licenser:**

  When associated with a pre-verbal *wh*-item/disjunction, *dou* evokes a free choice (FC) reading.

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(4) [Shei] *(**dou**) dou keyi jiao jichu hanyu.
Who$_{\text{FCI}}$ DOU can teach Intro Chinese
'Anyone/everyone can teach intro Chinese.'

(5) [Yuehan huozhe Mali] (**dou**) keyi jiao jichu hanyu.
John or Mary DOU can teach Intro Chinese
Without *dou*: 'Either John or Mary can teach Intro Chinese.'
With *dou*: 'Both John Andy Mary can teach Intro Chinese.'

- **Scalar marker:**

  A [*lian...dou...*] construction evokes an *even*-like inference: the prejacent proposition is less likely than some of its alternatives. The presence of *lian* is optional, but the associate must be stressed.

(6) (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).*

When associated with a scalar item (usually stressed), *dou* implies that the prejacent sentence ranks relatively high w.r.t the contextually relevant measurement.

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

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

- **Disambiguation by focus:**

  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.

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

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

c. (Lian) [TAMEN]$_F$ **dou** lai -guo liang-ci -le.
LIAN they DOU come -EXP two-time -ASP
'Even THEY have been here twice.'

1.3. Overview

- I propose that *dou* is a special exhaustivity operator, which (i) operates on sub-alternatives, (ii) has a pre-exhaustification effect, and (iii) presupposes the existence of at least one sub-alternative.

  Descriptively:

(9) $[\![\textbf{dou}(\text{S}_A)]\!]$ (S is the prejacent clause, A is the associate of *dou*)
$\approx \mathbf{S}_A$ and not only $\mathbf{S}_{A'}$ (A' is a subpart/ weak scale-mate/ sub domain-alt/ ... of A, ...)

E.g. [A and B] **dou** came
= A and B came, not only A came, and not only B came.
[A or B] **dou** can teach
= A or B can teach, not only A can teach, and not only B can teach.
= A and B both can teach.
It is **dou** [five o'clock]
= It's 5 o'clock, not just 4 o'clock, not just 3 o'clock, ...

Roadmap
- Section 2: Previous representative approaches
- Section 3: Defining *dou* as a pre-exhaustification exhaustifier
- Section 4: Deriving the uses of *dou*
- Section 5: Sorting the parameters

2. Two representative approaches

2.1. The distributor analysis (Lin 1998)

- *Dou* is a generalized distributor "Part" (Schwarzschild 1996). It distributes over the contextually determined cover of the associated item.

(10) '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.

(11) C is a cover of x iff (i) C is a set of subparts of x; and
(ii) every subpart of x is a subpart of some member in C

Possible covers of abc 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'

– Problems:

1. Unlike the Part, *dou* eliminates a single-cover/collective reading (M. Xiang 2008).
   (2′) abc **dou** bought houses. (# collective)
2. Unlike English distributors like *each* and *all*, *dou* can be associated with a distributive expression like NP-*gezi* 'NP each'.
   (12) They each (*each/*all) has some advantages.
   (13) [Tamen] gezi **dou** you yixie youdian.
   They each DOU have some advantage
   'They each **dou** has some advantages.'
3. This analysis cannot be extended to other uses of *dou*.

2.2. The maximality operator analysis (Cheng & Giannakidou 2006, Xiang 2008)

- *Dou* is a maximality operator ($\approx$ *the*) with a plural presupposition; it operates on a set that has been partitioned by covers and picks out the maximal plural individual.

(14) 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.)

– Problems:

1. It predicts no distributivity effect. Prediction: "abc dou bought houses" asserts that 'the maximal element in the cover of abc bought houses', not that 'every element in the cover of abc bought houses'.
2. The plurality requirement comes as a stipulation on the presupposition of *dou*: *dou* presupposes that the selected maximal element is non-atomic.

3. Defining *dou* as a special exhaustifier

3.1. Alternative Semantics for focus and the canonical exhaustifier *only*

- A focused sentence is associated with a set of **alternatives**, derived by replacing the focused item with a contextually relevant item of the same semantic type (Rooth 1985, 1992, 1996). Alternatives that not entailed by the original sentence are called "**excludable (excl-)alternatives**."

(15) $Alt(\textsf{ANDY}_F\ \textsf{came}) = \{\textsf{came}(x) : x \text{ is a contextually relevant human individual}\}$
$= \{\textsf{came}(a), \underbrace{\textsf{came}(b), \textsf{came}(a \oplus b)}_{\text{excl-alternatives}}\}$

- *Only* negates the excl-alternatives, and presupposes the truth of the prejacent (Horn 1969) as well as the existence of at least one excl-alternative (Xiang 2016a).

(16) **The meaning of** *only*
$[\![only]\!](p) = \lambda w[\underbrace{\textit{Excl}(p) \neq \varnothing}_{\text{additive pres.}} \wedge \underbrace{p(w) = 1}_{\text{prejacent pres.}} . \underbrace{\forall q \in \textit{Excl}(p)[q(w) = 0]}_{\text{exhaustivity assertion}}]$

a. Additive presupposition: The prejacent has at least one excl-alternative.
b. Prejacent presupposition: The prejacent proposition is true.
c. Exhaustivity assertion: All the excl-alternatives are false.

(17) (Among Andy and Billy,) only ANDY_F came.
a. $\rightsquigarrow$ 'Andy came.'
b. $\rightsquigarrow$ 'Billy didn't come.'

(18) Which of John and Mary will you invite?
a. Only JOHN_F, (not Mary / not both).
b. # Only BOTH_F.
c. BOTH_F.

only is odd in (18b) because the prejacent is the strongest among the alternatives.

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

- In analogous, *dou* affirms the prejacent, negates on pre-exhaustified **sub-alternatives** and presupposes the existence of a sub-alternative.

(19) **The meaning of** *dou*

$$[\![dou]\!](p) = \lambda w[\underbrace{\textit{Sub}(p) \neq \varnothing}_{\text{additive pres.}}. \quad \underbrace{p(w) = 1}_{\text{prejacent assertion}} \quad \wedge \underbrace{\forall q \in \textit{Sub}(p)[O(q)(w) = 0]}_{\text{anti-exhaustivity assertion}}]$$

a. Additive presupposition: There is at least one sub-alternative.

b. Prejacent assertion: The prejacent proposition is true.

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

- By default, sub-alternatives are complements of excl-alternatives. The pre-exhaustification effect is realized by applying an O-operator ($\approx$ 'only') to each sub-alternative.

(20) a. $\textit{Sub}(p) = (\textit{Alt}(p) - \textit{Excl}(p)) - \{p\}$ (Default definition)
(The set of alternatives that are not excludable and distinct from the prejacent)
(= The set of alternatives that are weaker than the prejacent)

b. $O(p) = \lambda w[p(w) = 1 \wedge \forall q \in \textit{Excl}(p)[q(w) = 0]]$ (Chierchia et al. 2012)
(p is true and every excl-alternative of p is false.)

Examples: The anti-exhaustification condition (underlined) is entailed by the prejacent.

(21) [a and b] **dou** came.

a. $[\![S]\!] = \mathsf{came}(a \oplus b)$

b. $\textit{Alt}(S) = \{\mathsf{came}(x) : x \text{ is a contextually relevant individual}\}$

c. $\textit{Sub}(S) = \{\mathsf{came}(a), \mathsf{came}(b)\}$

d. $[\![\textit{dou}(S)]\!] = \mathsf{came}(a \oplus b) \wedge \underline{\neg O[\mathsf{came}(a)] \wedge \neg O[\mathsf{came}(b)]}$

4. Deriving the uses of *dou*

4.1. Predicting the quantifier-distributor use

- I argue that the requirements of distributivity and plurality are illusions. All the facts that are thought to be from these two requirements actually result from the presupposition of *dou*.

4.1.1. Explaining the "distributivity requirement"

- In (22), under a single-cover/collective reading, no alternative is asymmetrically entailed by the prejacent and no sub-alternative is available, making the use of *dou* undefined.[2]

[2] In the alternatives, C constantly denotes 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 2012: ch. 4.) For example, if $C = \{a, b, c\}$, the alternative $\text{Part}_C(f, d)$ is 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 fine for now. Nevertheless, problems arise in case that we want an operator to operate on excl-alternatives. For example, to derive the exhaustification inference of (1), 'b bought houses' shall not be a tautology. See a solution in Liu (2016) based on Link-Landman's approach of encoding the distributivity/collectivity distinction.

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

(22) 'abc **dou** bought houses.'

a. $p = \text{Part}_C(f, a \oplus b \oplus c)$

b. $\mathit{Alt}(p) = \{\text{Part}_C(f, X) : X \in D_e\} = \{\forall y \in C[y \leq X \rightarrow f(y)] : X \in D_e\}$

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

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

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

$$\mathit{Alt}(p) = \left\{ \begin{array}{ccc} & \boxed{f(a) \wedge f(b \oplus c)} & \\ \swarrow & & \searrow \\ f(a) & & f(b \oplus c) \end{array} \right\}$$

× **Collective:** If $C = \{a \oplus b \oplus c\}$, then:
$\mathit{Alt}(p) = f(a \oplus b \oplus c)$ and $\mathit{Sub}(p) = \varnothing$

- *Dou* can be applied to a collective statement iff this collective predicate is **divisive**.

(23) P is divisive iff $\forall x[P(x) \rightarrow \exists y < x[P(y)]]$
(Whenever P holds of something x, it also holds of some proper subpart(s) of x.)

Compare:

(24) [abc] **dou** shi pengyou.
abc DOU be friends
Intended: 'abc are friends (of each other).'

a. $\mathit{Sub}(abc$ are friends$) = \{ab$ are friends, bc are friends, ac are friends$\}$

b. 'abc **dou** are friends' means: abc are friends, not only ab are friends, not only bc are ...

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

4.1.2. Explaining the "plurality requirement"

- This plurality is illusive; it is neither necessary nor sufficient.

– Unnecessary: *dou* can be associated with an atomic element as long as the predicate is divisive.

(26) Yuehan ba [na-ping shei] **dou** he -le (*yi-ban).
John BA that-bottle water DOU drink -ASP one-half

a. √'J had that bottle of water.' ⇒ J had x. (x is part of that bottle of water)
Sub(J had that bottle of water) = {J had $x : x <$ that bottle of water}

b. ×'J had half of that bottle of water.' ⇏ J had half of x. (x is part of that bottle of water)
Sub(John had half of that bottle of water) = $\varnothing$

– Insufficient: when applied to a statement with a **divisive** collective predicate, *dou* requires its associated item to denote a group containing at least 3 members. This is so because collective predicates are undefined for proper subparts of a dual-individual (i.e. atomics).

(27) 'ab (***dou**) are friends.'
  a. $[\![\text{are friends}]\!] = \lambda x[\neg \mathit{Atom}(x).\text{be-friends}(x)]$
  b. $\mathit{Sub}(ab \text{ are friends}) = \varnothing$

4.2. Predicting the ∀-FCI-licenser use

- **Pre-verbal disjunctions**

Sub-alternatives of a disjunction are the disjuncts. Applying **dou** affirms this disjunction and negates the exhaustification of each disjunct, yielding a ∀-FC/conjunctive inference.[3]

(5′) "[A or B] **dou** can teach Intro Chinese."
  a. $[\![\text{A or B can teach Intro Chinese}]\!] = \Diamond f(a) \vee \Diamond f(b)$
  b. $\mathit{Sub}(\text{A or B can teach Intro Chinese}) = \{\Diamond f(a), \Diamond f(b)\}$
  c. $[\![\textbf{dou} [\text{ A or B can teach Intro Chinese}]]\!]$
  $= [\Diamond f(a) \vee \Diamond f(b)] \wedge \neg O\Diamond f(a) \wedge \neg O\Diamond f(b)$
  $= [\Diamond f(a) \vee \Diamond f(b)] \wedge [\Diamond f(a) \rightarrow \Diamond f(b)] \wedge [\Diamond f(b) \rightarrow \Diamond f(a)]$
  $= \Diamond f(a) \wedge \Diamond f(b)$

! *Problem:* Disjuncts are stronger than a disjunction, how can they be considered as sub-alternatives?
Solution: Weaken the definition of sub-alternatives.

Sub-alternatives are the complements of **"innocently (I)-excludable" alternatives** (roughly, I-excludable alternatives are alternatives that can can always be negated consistently).

(28) a. $\mathit{Sub}(p) = (\mathit{Alt}(p) - \mathit{IExcl}(p)) - \{p\}$ (For ∀-FCI-licenser use)
  (The set of alternatives excluding the I-excludable alternatives and the prejacent itself)
  b. $\mathit{IExcl}(p) = \bigcap\{A : A \text{ is a maximal subset of } \mathit{Alt}(p) \text{ such that } A^{\neg} \cup \{p\} \text{ is consistent}\}$,
  where $A^{\neg} = \{\neg q : q \in A\}$
  (q is I-excludable to p iff q is included in every maximal set of alternatives of p s.t. the exclusion of this set is consistent with p.) (Fox 2007)

Disjuncts are not I-excludable: affirming a disjunction contradicts negating both of its disjuncts:

(29) $[\Diamond f(a) \vee \Diamond f(b)] \wedge \neg\Diamond f(a) \wedge \neg\Diamond f(b) = \bot$

- **Other ∀-FCIs**

Wh-items and existential polarity items (e.g., *renhe*-NP 'any-NP') are existential quantifiers (Karttunen 1977; Chierchia 2006). Their ∀-FCI uses are derived in exactly the same way.

[3] This derivation looks close to that of applying Fox's (2007) recursive exhaustifier O_R or Chierchia's (2013) pre-exhaustification operator $O_{\text{D-EXH}}$. But *dou* is not exactly O_R/$O_{\text{D-EXH}}$. First, unlike O_R, *dou* does not negate the I-excludable alternatives and hence doesn't yield an exhaustification inference. Second, while $O_{\text{D-EXH}}$ operates on domain alternatives, which are grammatically defined, *dou* operates on sub-alternatives, which are defined purely semantically. See Xiang (2016: §2.7) for a comparison of these three operators.

Interim Summary (I)

- *dou* triggers an additive presupposition that the prejacent of *dou* must have at least one sub-alternative. Sub-alternatives are by default **weaker alternatives**.
- For the quantifier-distributor use of *dou*, both the distributivity and plurality requirements are illusions from the additive presupposition of *dou*.
- When *dou* is associated with a disjunction or an existential quantifier, sub-alternatives are weakened to be the **non-I-excludable alternatives**. Applying *dou* affirms the disjunction and negates the exhaustification of each disjunct, yielding a **free choice** inference.

4.3. Predicting the *even*-like marker use

- English *even* triggers a scalar presupposition: the propositional argument is less likely than some contextually relevant alternative. (Bennett 1982, Kay 1990; cf. Karttunen & Peters 1979)[4]

(30) $[\![\textit{even}]\!](p) = \exists q \in \textit{Alt}(p)[q >_{\text{likely}} p].p$
($[\![\textit{even}]\!](p)$ is defined only if p is more likely than some contextually relevant alternative; when defined, $[\![\textit{even}]\!](p) = p$)

- **Getting the *even*-like reading of [*lian*...*dou*...]**

When *dou* is associated with *lian*-DP, the measurement for ordering alternatives is shifted from logical strength to **likelihood**. Thus: (i) Sub-alternatives are weakened to the ones that are **more likely** than the prejacent; (ii) pre-exhaustification is realized by a scalar exhaustifier JUST.

(31) a. $\textit{Sub}(p) = \{q : q \in \textit{Alt}(p) \wedge q >_{\text{likely}} p\}$ (For the *even*-like use)
(The set of alternatives that are more likely than p)
b. $\textsc{just}(q) = \lambda w[q(w) = 1 \wedge \forall r \in \textit{Alt}(q)[r <_{\text{likely}} q \rightarrow r(w) = 0]]$
(q is true, and any alternative less likely than q is false.)

Consequently, *dou* becomes semantically equivalent to *even*: the additive presupposition of *dou* = the scalar presupposition of *even*; the assertion is vacuous.[5]

(32) $[\![dou]\!](p) = \lambda w[\exists q \in \textit{Sub}(p).\ p(w) = 1 \wedge \forall q \in \textit{Sub}(p)[\textsc{just}(q)(w) = 0]]$
$= \exists q \in \textit{Alt}(p)[q >_{\text{likely}} p].p = [\![\textit{even}]\!](p)$

Interim Summary (II)

- When *dou* is associated with *lian*-DP, sub-alternatives are weakened to be the **more likely alternatives**. *Dou* becomes semantically identical to *even*.

[4]Karttunen & Peters (1979) assumes a universal scalar presupposition: the propositional argument of *even* is less likely than all of its alternatives that are not identical to it. This presupposition is too strong. *Even*-sentences can also describe non-extreme cases. Examples are from Kay (1990:90).

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

[5]Computation for (32). Note that the assertion is vacuous. [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 $r = p$.]

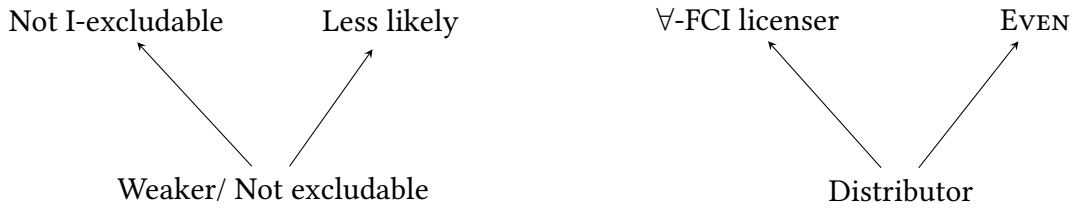
(1) $[\![dou]\!](p) = \exists q \in \textit{Sub}(p).p \wedge \forall q \in \textit{Sub}(p)[\textsc{just}(p)(w) = 0]$
$= \exists q \in \textit{Sub}(p).\lambda w[p(w) = 1 \wedge \forall q \in \textit{Sub}(p)\exists r \in \textit{Alt}(q)[r(w) = 1 \wedge q >_{\text{likely}} r]]$
$= \exists q \in \textit{Alt}(p)[q >_{\text{likely}} p].\ \lambda w[p(w) = 1 \wedge \forall q \in \textit{Alt}(p)[q >_{\text{likely}} p \rightarrow \exists r \in \textit{Alt}(q)[r(w) = 1 \wedge q >_{\text{likely}} r]]]$
$= \exists q \in \textit{Alt}(p)[q >_{\text{likely}} p].p$

5. Sorting the parameters

- We've defined *dou* uniformly an exhaustifier that negates pre-exhaustified sub-alternatives. The function of *dou* varies purely by the meaning of sub-alternatives:

	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

- I argue for the development path for the semantics of sub-alternatives as in Figure 2a: Def A is primary, while that Def B-C are derived from Def A by two independent weakening operations.



(a) For the semantics of sub-alternatives (b) For the logical functions of *dou*

Figure 1: Developing paths for the functions of *dou* and the semantics of sub-alternatives

- **Prediction 1**: the distributor use is primary, while the other uses are derived, as in Figure 2b.

  Diachronic evidence: 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 marker or a ∀-FCI licenser before the Ming Dynasty.

- **Prediction 2**: the likelihood-based semantics of *dou* shall be strictly more restrictively used than the logical strength-based semantics of *dou*. In particular:

If the prejacent is ...	Can *dou* be licensed in...	
	(i) basic declaratives?	(ii) [*lian...dou...*] constructions?
a. the logically strongest alt	Yes	Yes
b. the logically weakest alt	No	No
c. neither	**No**	Yes

Synchronic evidence: for the prediction in (c-i), compare ... [6]

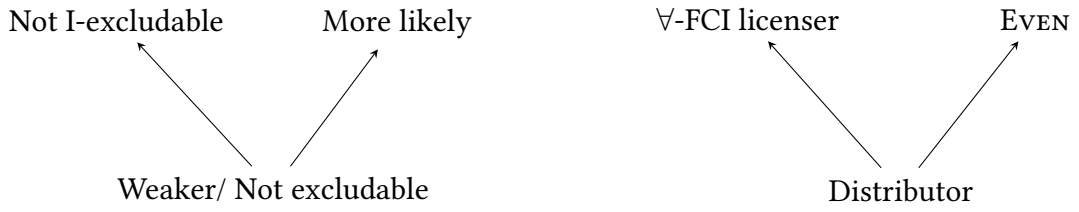
(33) a. They **dou** bought houses. (#collective, √distributive)
b. (Lian) THEY **dou** bought houses. (√collective,√distributive)

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

[6]The prediction for (c-i) favors my proposal over Liu's (2016). Liu treats the likelihood-based (i.e., *even*-like) semantics as the default semantics of *dou*. But, if this were the case, *dou* should be licensed whenever its likelihood-based semantics is satisfied, and hence should have the same distribution in (i) and (ii), contra the fact. For example, for (33a), if 'they bought houses together' $>_{\text{likely}}$ 'the others bought houses together', the likelihood-based semantics of *dou* would be licensed even if the prejacent takes a collective reading.

6. Conclusions

- *Dou* is a pre-exhaustification exhaustifier operating on sub-alternatives. It affirms the prejacent, negates the exhaustification of each sub-alternative, and presupposes the existence of at least one sub-alternative.
  - The anti-exhaustivity assertion of *dou* is responsible for the derivation of ∀-FC inferences.
  - The presupposition of *dou* is responsible for:
    (i) the distributivity and plurality requirements of distributor/quantifier-*dou*,
    (ii) the *even*-like inference of a [*lian*...*dou*...] construction,
    (iii) many other effects: see appendex.
- Function alternations of *dou* results from minimal variations w.r.t. the meaning of sub-alternatives:



(a) For the semantics of sub-alternatives (b) For the logical functions of *dou*

Figure 2: Developing paths for the functions of *dou* and the semantics of sub-alternatives

Appendix 1: Explaining the licensing conditions of Mandarin ∀-FCIs

A. Mandatory presence of *dou*

- In licensing the FCI use of a pre-verbal *wh*-word, the use of *dou* is mandatory.

  Explanation: When a *wh*-word has a non-interrogative use, its sub-alternatives are obligatorily activated and must be used by a c-commanding exhaustifier. (Liao 2012, Chierchia & Liao 2015) When *dou* is absent, these sub-alternatives would have to be used by a basic O-exhaustifier, yielding a contradiction:

(35) $[\![O\ [\text{shei can teach Intro Chinese}]]\!] = O[\Diamond f(a) \vee \Diamond f(b)]$
$= [\Diamond f(a) \vee \Diamond f(b)] \wedge \neg\Diamond f(a) \wedge \neg\Diamond f(b)$
$= \bot$

B. Modal Obviation

- The English polarity item *any* is licensed as a ∀-FCI when appearing over a possibility modal, but not when it appears in an episodic statement or over a necessity modal.

(36) a. * Anyone came in. — Episodic statements
b. Anyone can come in. ≈ Everyone can come in. — Over possibility modals
c. * Anyone must come in. — Over necessity modals

– Likewise in Mandarin, the licensing of the ∀-FCI use of a pre-verbal disjunction is only licensed in a pre-*dou*+◇ position. If the possibility modal *keyi* 'can' is dropped or replaced with a necessity modal *bixu* 'must', the presence of *dou* makes the sentence ungrammatical.

(5′) a. [Yuehan huozhe Mali] (*__dou__) jiao -guo jichu hanyu.
John or Mary DOU teach -EXP Intro Chinese

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

The ∀-FCI use of a bare *wh*-word can sometimes be licensed without a possibility modal (Giannakidou & Cheng 2006), but this pattern is not very productive.

- **Explanation:** A focused disjunction obligatorily triggers a scalar implicature (SI).

– In a non-modalized context, the ∀-FC implicature clearly contradicts the SI, therefore FC-disjunctions are not licensed in episodic statements. (Same as Chierchia 2013 on English *any*.)

∀-FC: $f(j) \wedge f(m)$ SI: $\neg[f(j) \wedge f(m)]$

– In a modalized context, the SI restricts the modal base M to worlds where the SI is true.

(37) [John or Mary] **dou** can teach Intro Chinese.
$\rightsquigarrow$ We are only considered with cases where only one person will teach IC.
$\not\rightsquigarrow$ Not that both John and Mary will teach IC.

a. SI pre-restricts the modal base M:
If $f = \{\langle w1, \{j\}\rangle, \langle w2, \{m\}\rangle, \langle w3, \{j, m\}\rangle\}$, then $M = \{w1, w2\}$
b. Prejacent of *dou*: $\Diamond f(j) \vee \Diamond f(m)$
c. Applying *dou* yields a ∀-FC implicature: $\Diamond f(j) \wedge \Diamond f(m)$ (True in M)

(38) *[John or Mary] **dou** must teach Intro Chinese.

a. SI pre-restricts the modal base M:
If $f = \{\langle w1, \{j\}\rangle, \langle w2, \{m\}\rangle, \langle w3, \{j, m\}\rangle\}$, then $M = \{w1, w2\}$
b. Prejacent of *dou*: $\Box f(j) \vee \Box f(m)$
c. Applying *dou* yields a ∀-FC implicature: $\Box f(j) \wedge \Box f(m)$ (False in M)

Appendix 2: Minimizer-licensing

- **Fact 1:** Minimizers can be licensed in [*lian* MIN *dou* ...]. A post-*dou* negation is usually needed:

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

Analysis: Interpreting (39) involves reconstructing the minimizer, so as to satisfy the presupposition of *dou*. Without negation or if the minimizer scopes above negation, the prejacent clause of *dou* is logically the weakest among its alternatives (*a la* Crinč 2011 on English *even*).

(40) For any n > 1:

a. $\exists 1x\neg[\text{know}'(j,x)] \Leftarrow \exists nx\neg[\text{know}'(j,x)]$ MIN > NEG
b. $\neg\exists 1x[\text{know}'(j,x)] \Rightarrow \neg\exists nx[\text{know}'(j,x)]$ NEG > MIN

A minimizer cannot be licensed if it cannot be reconstructed to a position below negation.

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

- **Fact 2**: The post-*dou* negation is optional in (42).

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

Analysis: The desire predicate *xiang* 'want' is non-monotonic (Heim 1992, a.o.). If the minimizer takes scope below *xiang*, the alternatives are semantically independent.

(43) [**dou** [John$_i$ want$_{\text{NM}}$ [**one-cent** λx [e$_i$ has x]]]]

We can order the alternatives based on likelihood. Sub-alternatives are the ones more likely than the prejacent: it is more likely that John wants more than one cent.

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