Dou as *Even* and Plural Universal Quantification in Mandarin Chinese *

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1. Introduction

Interestingly, a universally quantified sentence in Mandarin Chinese is expressed through a combination of two elements *mei* and *dou*:

(1) **mei**-ge ren *(**dou**) lai-le.
every-CL person DOU come-PFV
'Everyone came.'

There is extensive debate as to what *mei* and *dou* are. There are broadly three camps, based on the analysis of *dou*: *dou* as quantifier-distributor (Lin 1998, Sun 2018), *dou* as anti-exhaustifier (Xiang 2020), and *dou* as *even* (Liu 2021).

This paper provides evidence for the *dou* as *even* approach through a re-examination of the data first presented in Sun (2018), where *mei* is combined with a plural numeral (which I will call *plural universal quantifiers*), and *dou* becomes optional, moderating a semantic alternation.

(2) **mei** liang-ge xuesheng (**dou**) he-xie-le yi-pian lunwen.
every 2-CL student DOU co-write-PFV 1-CL paper
With *dou*: 'Every possible pair of students co-wrote a paper.'
Without *dou*: 'Every pair in a partition of the students into pairs co-wrote a paper.'

To better understand the two readings, suppose that 4 students are salient in the context. The first reading, called the *exhaustive reading* by Sun (2018), is produced when *dou* is present. In general, the universal quantification is over $\binom{N}{n}$ pluralities for 'mei *n*-CL NP' in the exhaustive reading with *N* total individuals. Thus, 'mei 2-CL NP' quantifies over all 6

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possible pairs of students constructible from the 4 salient students. (2) with *dou* means that all 6 of the 6 possible pairs of students each co-wrote a paper, resulting in 6 total papers written.

The second reading, the *partition reading* of Sun (2018), is obtained when *dou* is absent. It requires an additional licensing condition where the VP predicate must contain an indefinite, reflexive, or a numeral; the reason for this condition on the licensing of the partition reading will not be discussed in this paper. In general, the universal quantification is over $\frac{N}{n}$ pluralities for 'mei *n*-CL NP' in the partition reading. 'Mei 2-CL NP' quantifies over all pairs in a partition of the salient students into pairs. Therefore, (2) without *dou* means that the 2 pairs of a partition of the 4 students into 2 pairs each co-wrote a paper, resulting in 2 total papers written. The analytic goal of this paper is to present an account of the alternation between (2) and (1), which I will call the *exhaustive-partition* alternation. It should be noted that the alternation is *strict*: the exhaustive reading requires *dou*, while the partition rejects *dou*. As the approach that I will be advancing takes the analysis of *dou* in Liu (2017, 2021) as its backbone, an introduction to that analysis in the next section is necessary.

2. Liu (2017, 2021): *dou* as *even* and *mei-dou* co-occurrence

Liu (2017) is the first to analyze *dou* as the Mandarin counterpart of English *even*. This is motivated by the basic, *scalar* use of *dou*:

(3) Zhangsan$_F$ **dou** lai-le.
Z. DOU come-PFV
'Even Zhangsan$_F$ came.'

Liu (2021) extends this analysis to an account of the co-occurrence of *mei* and *dou* in a universally quantified sentence, which I will present in this section.

According to Liu (2017, 2021), *dou* has the usual semantics of *even*:

(4) $[\![\text{dou}_C\ S]\!]$ is defined iff $\forall q \in \{[\![S']\!] \mid S' \in \text{ALT}(S)\} \cap C.\, [\![S]\!] \neq q \rightarrow [\![S]\!] \prec q$.
If defined, $[\![\text{dou}\ S]\!] = [\![S]\!]$ *(where $\prec$ is either $\preceq_{\text{likely}}$ or $\subseteq$).

In prose, this definition means that *dou* presupposes that its prejacent is the strongest among the alternatives with respect to an ordering over propositions that is based on either likelihood or entailment. If this presupposition is met, then the prejacent is asserted.

This analysis also makes the assumption that *dou* covertly moves from its clause-medial position to a position that can take the entire clause as its argument; this is also assumed in Crnič (2014) for *even*. (5) is an illustration of the structure at LF. It should be noted that the lower copy of *dou* is ignored for semantic interpretation.

(5) dou [subject$_F$ ~~dou~~ VP].
foc assoc
Move

Liu (2021) extends this approach to the universal case, when *dou* is used with *mei*. The universal quantifier *mei* has the regular semantics, augmented with a variable *D* that restricts the domain of quantification:

(6) $[\![\text{mei}_D]\!] = \lambda P_{et}.\lambda Q_{et}.\forall x_e.x \in D \wedge P(x) \to Q(x)$

The associate of *dou* is the domain variable *D* on *mei*, providing the following LF:

(7)
move
foc assoc
dou [mei$_{D_F}$ yi-ge xuesheng ~~dou~~ lai-le].
every 1-CL student DOU come-PFV
'Every student came.'
$\forall x.x \in D \wedge \mathsf{student}(x) \to \mathsf{came}(x)$

The alternatives of *D* are the subdomain alternatives: D' such that $D' \subseteq D$. The alternatives of the prejacent are then the prejacent with *D* replaced with its subsets. The ordering relation over propositions $\prec$ that *dou* takes is entailment. In a context where there are three students $\{\mathbf{a},\mathbf{b},\mathbf{c}\} = D$, we have the following alternatives to the prejacent of (7):

(8) $\forall x \in \{a\}.\mathsf{came}(x), \forall x \in \{b\}.\mathsf{came}(x), \forall x \in \{c\}.\mathsf{came}(x), \forall x \in \{a,b\}.\mathsf{came}(x), \forall x \in \{b,c\}.\mathsf{came}(x), \forall x \in \{c,a\}.\mathsf{came}(x), \underline{\forall x \in \{a,b,c\}.\mathsf{came}(x)}$

The alternatives have subsets of *D* as the domain of quantification and are all going to be entailed by the prejacent, satisfying *dou*'s presupposition. *Dou* is therefore licensed to co-occur with *mei* in a universally quantified sentence.

3. *Dou* as *even* and plural universal quantification

In this section, I will make a series of attempts to apply the *dou* as *even* approach in Liu (2017, 2021) to the new data on *dou* and plural universal quantification in Sun (2018). The proposal, as the result of the multiple accommodations, is that 1) the exhaustive and partition readings each call for a separate domain variable that contains the appropriate pluralities to quantify over, and that 2) domain alternatives are redefined in terms of parthood relationships between sums of the atomic individuals involved, so that domain alternatives are not necessarily subdomains, but any domains that do not involve atomic individuals not involved in the original domain. This section will motivate the two accommodations step by step.

3.1 An attempt to apply Liu (2021) with minimal adaptation

The hope is for Liu's analysis of *dou* as *even* to be directly applicable to the exhaustive-partition alternation with minimal adaptations. First, the domain variable *D* on *mei* should be closed under $\oplus$ to enable quantification over pluralities. Second, we assume the following semantics for numerals:

(9) $[\![n\text{-CL NP}]\!] = \lambda X.\, |X| = n \wedge X \in *[\![\text{NP}]\!]$

Essentially, the denotation of 'n-CL NP' is a set containing n-sized pluralities that are sums of individuals in the denotation of the NP. However, given these provisions, only the exhaustive reading is derivable:

(10) a. $[\![\text{mei}_D \text{ 2-CL student}]\!] = \lambda P. \forall X.\, |X| = 2 \wedge X \in *[\![\text{student}]\!] \cap D \rightarrow P(X)$
b. $[\![\text{mei}_D \text{ 2-CL student co-wrote a paper}]\!] =$
$\forall X.\, |X| = 2 \wedge X \in *[\![\text{student}]\!] \cap D \rightarrow \textsf{co-write.a.paper}(X)$

In this case, since D is the closed under $\oplus$, it will contain every possible pair of salient students. What is derived is therefore the exhaustive reading, saying that every possible pair of students co-wrote a paper. Further, replacing D with any of its subsets D' will result in an alternative that is entailed by the prejacent, satisfying *dou*'s presupposition. The partition reading and the obligatory absence of *dou* are not yet possible to be derived.

3.2 Further accommodation 1: exhaustive and partition domains

There is no mechanism in Liu's original approach to derive a quantificational pattern like the partition reading. The easiest way to deliver one is through manipulating the domain variable on *mei*. Instead of a D closed under $\oplus$, a smaller D whose n-sized elements form a partition of the sum of all the involved atomic individuals in D will properly restrict the domain of quantification to a partition. I will call a D that is closed under $\oplus$, D_{exh}, and D whose n-sized elements form a partition of D_{exh}, D^n_{part}. More formally and more concretely, D_{exh} and D^n_{part} are defined as follows:

(11) D_{exh} is the closure under $\oplus$ of the set of contextually salient atoms in $[\![\text{NP}]\!]$

(12) D^n_{part} is different from D_{exh} in that the n-sized pluralities form a partition of $\bigoplus D_{\text{exh}}$.

These two domains are motivated for universal quantification in general, with cross-linguistic support. Universal quantification seems to display an inherent ambiguity between the exhaustive and partition readings. Consider the following two English sentences:

(13) a. %Every two students shook hands with each other.
b. %Every two students co-wrote a paper.

Not every English speaker I have consulted considers the phrase *every n students* acceptable, but for those who do find it acceptable, the most salient reading of (13a) should be the exhaustive reading, while the most salient reading of (13b) should be the partition reading.[1] The two domains just defined are suited to capture this ambiguity. (12) would have D_{exh} as the domain variable on *every*, while (13) would have D^2_{part} as the domain variable on *every*. More importantly, it is clear that these two domains can be used to derive the exhaustive and partition readings of plural universal quantification in Mandarin Chinese:

(14) *Exhaustive reading*
Domain of 'mei n-CL NP' with *dou*: D_{exh}

(15) *Partition reading*
Domain of 'mei n-CL NP' without *dou*: D^n_{part}

The derivation of the exhaustive is already demonstrated in section 3.1, as D_{exh} is the same as the D used there. The partition reading will also be derived straightforwardly given D^n_{part}. Suppose that there are four students in the context, a,b,c,d. Consider (2) without *dou*, repeated here:

(16) **mei** liang-ge xuesheng (***dou**) xie-le yi-pian linden.
every 2-CL student DOU wrote 1-CL paper
'Every pair in a partition of the students into pairs co-wrote a paper.'

We then have

(17) a. $D_{\text{exh}} = *\{a,b,c,d\} = \{a,b,c,d,a\oplus b,a\oplus c,a\oplus d,b\oplus c,b\oplus d,c\oplus d,a\oplus b\oplus c,a\oplus b\oplus d,a\oplus c\oplus d,b\oplus c\oplus d,a\oplus b\oplus c\oplus d\}$.
b. $D^2_{\text{part}} = \{a,b,c,d,a\oplus b,c\oplus d,a\oplus b\oplus c,a\oplus b\oplus d,a\oplus c\oplus d,b\oplus c\oplus d,a\oplus b\oplus c\oplus d\}$

The 2-sized pluralities from D^2_{part}, $a\oplus b, c\oplus d$, form a partition of $\bigoplus D_{\text{exh}} = a\oplus b\oplus c\oplus d$. Then, the semantics will be

(18) $[\![\text{mei}_{D^2_{\text{part}}}\ 2\ \text{student co-wrote a paper}]\!] =$
$\forall X.\,|X| = 2 \wedge X \in *[\![\text{student}]\!] \cap D^2_{\text{part}} = \{a\oplus b, c\oplus d\} \rightarrow \textsf{co-write.a.paper}(X)$

This denotation corresponds to the partition reading, where only pairs in a partition are quantified over by the plural universal quantifier.

However, the exhaustive-partition *alternation* is still not yet handled. Using D^n_{part}, combined with the assumption that its alternatives are also subdomain alternatives, will predict that *dou* should also be licensed in the partition reading, contrary to the fact that *dou*

[1] The following examples seem to be acceptable to more native speakers of English:

(i) a. There is a line between every two points on the graph.
b. There is a triangle connecting every three points on the graph.

(ia, b) seem to have clear exhaustive readings.

is incompatible with the partition reading. The alternatives to (18) based on subdomains $D^{2\prime}_{\text{part}} \subseteq D^{2}_{\text{part}}$ are the following:

(19) a. $\forall X. X \in \{a \oplus b\} \rightarrow \textsf{co-write.a.paper}(X)$
b. $\forall X. X \in \{c \oplus d\} \rightarrow \textsf{co-write.a.paper}(X)$
c. $\forall X. X \in \{a \oplus b, c \oplus d\} \rightarrow \textsf{co-write.a.paper}(X)$

The prejacent, (18) or (19c), entails all these alternatives, licensing *dou*.

3.3 Further accommodation 2: redefining domain alternatives

Thus, the task now is to make *dou*'s presupposition fail when D^{n}_{part} is used. For this purpose, I propose the following redefinition of domain alternatives:

(20) Given a domain D, if $\bigoplus D' \sqsubseteq \bigoplus D$, D' is a domain alternative of D.

Alternatively and more concretely,

(21) Given a domain D, if $\forall X \in D'. \forall z. z \sqsubseteq X \wedge \textsc{Atom}(z) \rightarrow \exists Y \in D. z \sqsubseteq Y$, D' is a domain alternative of D.

Informally, as long as D' does not involve (contain an element that contains) any atom not involved (contained by an element) in D, D' should be a domain alternative to D. If D' does not involve atoms not involved in D, then as long as we have D, we have everything we need to reconstruct D', hence allowing D' to become an alternative of D. When the prejacent domain is already the maximal one in the context, for example, D_{exh}, then it becomes the case that any alternative domain constructible from the salient atoms will be a subset of D_{exh}, giving the illusion that domain alternatives are only subdomains. Another case would be when only domains that contain only atoms are concerned. Here, $\bigoplus D' \sqsubseteq \bigoplus D$ is equivalent to $D' \subseteq D$, and what we get are just regular subdomains.

(22) If $\forall x \in D, \textsc{Atom}(x)$, then $\bigoplus D' \sqsubseteq \bigoplus D \Leftrightarrow D' \subseteq D$.

Under this new definition, even though $D^{n}_{\text{part}} \subset D_{\text{exh}}$, D^{n}_{part} and D_{exh} are alternatives to each other because $\bigoplus D^{n}_{\text{part}} = \bigoplus D_{\text{exh}}$, and so both $\bigoplus D^{n}_{\text{part}} \sqsubseteq \bigoplus D_{\text{exh}}$ and $\bigoplus D_{\text{exh}} \sqsubseteq \bigoplus D^{n}_{\text{part}}$ hold. This means that a plural universal sentence with D_{exh} as the variable on *mei* will continue to entail all the alternatives. More formally,

(23) $\forall D'. \bigoplus D' \sqsubseteq \bigoplus D_{\text{exh}} \Rightarrow D' \subseteq D_{\text{exh}}$

This translates to the following:

(24) $\forall D' \in \textsc{Alt}(D_{\text{exh}}).$
$$\begin{array}{ll} \forall X \in *[\![n\text{-CL NP}]\!] \cap D_{\text{exh}}.\, |X| = n \to [\![\text{VP}]\!](X) & \Rightarrow \\ \forall X \in *[\![n\text{-CL NP}]\!] \cap D' \quad .\, |X| = n \to [\![\text{VP}]\!](X) & \end{array}$$

Then, in the exhaustive reading, *dou* is licensed because its presupposition that the prejacent, implicating D_{exh}, is strongest among the alternatives, is satisfied.

However, a plural universal sentence with D^n_{part} on *mei* will no longer entail all the alternatives, because at least we know that D_{exh} is among the alternatives, and the prejacent is asymmetrically entailed by the alternative based on D_{exh}, among others. More formally,

(25) For any D^n_{part}, at least its corresponding D_{exh} is such that $\bigoplus D_{\text{exh}} \sqsubseteq \bigoplus D^n_{\text{part}}$ but $D^n_{\text{part}} \subset D_{\text{exh}}$.

This translates to the following:

(26) $\exists D' = D_{\text{exh}} \in \textsc{Alt}(D^n_{\text{part}}).$
$$\begin{array}{ll} \forall X \in *[\![n\text{-CL NP}]\!] \cap D^n_{\text{part}} \qquad .\, |X| = n \to [\![\text{VP}]\!](X) & \not\Rightarrow \text{ and in fact } \Leftarrow \\ \forall X \in *[\![n\text{-CL NP}]\!] \cap D' = D_{\text{exh}}.\, |X| = n \to [\![\text{VP}]\!](X) & \end{array}$$

Then, in the partition reading, *dou* is unlicensed because its presupposition that the prejacent is the strongest among the alternatives is not satisfied. Thus, we can account for the exhaustive-partition alternation: in the exhaustive reading, the prejacent is the strongest among the alternatives, satisfying the presupposition of *dou* and licensing its presence; in the partition reading, the prejacent is not the strongest among the alternatives in that at least the alternative corresponding to the exhaustive reading is stronger, and thus the presupposition of *dou* is not satisfied, its presence impossible.

4. Extension: plural NPI universal Free Choice

The present approach makes a prediction in a separate but related domain: the universal Free Choice readings of plural negative polarity items (NPI). In English, an NPI with Free Choice readings is *any*, which takes place when embedded under a $\Diamond$-modal:

(27) Any (one) student can write a paper.

(27) has the meaning that every student salient in the context is such that they can write a paper. The analogous construction in Mandarin Chinese is as follows:

(28) renhe (yi-ge) xuesheng dou keyi xie yi-pian lunwen.
any 1-CL student DOU can write 1-CL paper
'Any (one) student can write a paper.'

The present approach predicts that universal Free Choice readings of plural NPIs are limited to the exhaustive rather than the partition reading, which is borne out. I will call the content of this prediction the *exhaustive-only* restriction. By plural NPIs, I mean NPI DPs that are formed from an NPI determiner such as *any* or *renhe* and a numeral larger than two. Examples are the following:

(29) Any two students can co-write a paper.

(30) renhe liang-ge xuesheng *(dou) keyi hexie yi-pian lunwen.
any 2-CL student DOU can co-write 1-CL paper
'Any two students can co-write a paper.'

The present approach will predict that both (29) and (30) will have only one reading, the exhaustive reading, which in the context of Free Choice is that given a domain of salient students, all possible pairs of students that can be assembled from atomic students in the domain are allowed to co-write a paper, rather than only pairs of students in a certain partition of students into pairs being allowed to co-write a paper. This prediction is indeed borne out, as (29) and (30) only have this reading.

To see how the present approach makes this prediction, several assumptions must be introduced and a derivation of Free Choice readings of NPIs illustrated. To capture the cross-linguistic pattern involving NPIs *any* and *renhe*, as well as *even* and *dou*, I will use ANY to refer to both *any* and *renhe*, and EVEN to refer to both *even* and *dou*.

I assume, following Lahiri (1998), Crnič (2017, 2019), that NPIs are licensed through the associates of EVEN (or any element with equivalent semantic and pragmatic contributions), which can either be overt or covert. It is covert in English, but overt in Mandarin Chinese (see (30)), and as long as the NPI is in a position that satisfies *dou*'s syntactic constraint that its associate appears to its left, *dou* is always present in an NPI-FC construction. This lends further cross-linguistic support to the EVEN-approach to NPI licensing just introduced and assumed. For the ANY-phrases to be licensed by EVEN, and for the correct semantics to be derived, a mechanism must be in place to give construction with ANY-phrases a universal meaning in these universal Free Choice readings. There are many such mechanisms; prominent ones include pragmatic approaches like exhaustification (Fox 2007, Bar-Lev and Fox 2020) and semantic approaches (Aloni 2022, Goldstein 2019, Willer 2018). Regardless of the mechanism assumed, the Free Choice reading has a universal meaning, where the universal quantification scopes above the possibility modal. More concretely, every sentence of the form (31a) can be rewritten as (31b):

(31) a. EVEN $\Diamond$ ANY$_{D_F}$ student $\lambda x.x$ write a paper.
b. EVEN EVERY$_{D_F}$ student $\lambda x.\Diamond x$ write a paper.

If D_{exh} and D_{part} can be used with plural universal quantification, then they should also be usable with ANY-phrases translated to universal quantifiers. We then expect NPI Free Choice to have both exhaustive and partition readings:

(32) *Exhaustive*

a. original: EVEN $\Diamond$ ANY$_{D_{\text{exh}}}$ two students $\lambda X.X$ co-write a paper.
b. translated: EVEN EVERY$_{D_{\text{exh}}}$ two students $\lambda X.\Diamond X$ co-write a paper.
c. interpretation: Every possible pair of students is such that the pair can co-write a paper.

(33) *Partition*

a. original: EVEN $\Diamond$ ANY$_{D^2_{\text{part}}}$ two students $\lambda X.X$ co-write a paper.
b. translated: EVEN EVERY$_{D^2_{\text{part}}}$ two students $\lambda X.\Diamond X$ co-write a paper.
c. interpretation: Every pair of students in a partition of the students into pairs is such that the pair can co-write a paper.

However, as we have already seen in section 3, the partition reading is incompatible with EVEN that associates with it.[2] Due to the licensing conditions of ANY assumed in this paper, EVEN must be present in the structure as long as the original structure we are dealing with has ANY. Therefore, it is predicted that with plural NPI Free Choice, the partition reading is unavailable, which is borne out by the observation that (33b) is not a reading that *any two students can co-write a paper* has.

Notice that in the Mandarin Chinese plural NPI-FC, *dou* must be overtly present when the NPI is in the subject position. Therefore, I do not need to assume the EVEN-approach to NPI licensing to derive the exhaustive-only restriction for plural NPI-FC in subject positions in Mandarin Chinese. However, I would like to also account for the same restriction in English, as well as when the ANY-phrase appears inside the VP in Mandarin Chinese:

(34) $\emptyset_{\text{EVEN}}$ Any$_{D_F}$ two students can co-write a paper.

(35) $\emptyset_{\text{EVEN}}$ Zhangsan keyi du renhe$_{D_F}$ liang-ben shu.
Z. can read any 2-CL book
'Zhangsan can read any two books.'

In these constructions, there are no overtly present instances of EVEN. For EVEN's presupposition to still force the exhaustive reading, a covert EVEN must be assumed to be in the structure. The EVEN approach to NPI licensing naturally provides us with this covert EVEN, since there is an NPI, the ANY-phrase, to license, in these constructions.

5. Conclusion

In this paper, I have re-examined the data on the exhaustive-partition alternation concerning plural universal quantification involving *mei* and *dou* first introduced in Sun (2018). I have

[2]For this statement to be safely drawn, one needs to verify that the redefinition of domain alternatives as well as the partition domain does not affect the calculation of the translated Free Choice readings. In a longer version of this paper, this verification is carried out, at least concerning the Innocent Inclusion approach to Free Choice (Bar-Lev and Fox 2020).

proposed an account based on the *dou*-as-*even* approach in Liu (2017, 2021). Specifically, I employ two accommodations: the first is to recognize the inherent ambiguity of plural universal quantifiers between the exhaustive and the partition readings and implement the ambiguity through the domain variable on the universal quantifier, and the second is to redefine domain alternatives in terms of the atoms involved. Assuming that Free Choice inferences are essentially universal in meaning and that NPIs are licensed through association with overt or covert *even* (Lahiri 1998, Crnič 2014), a related prediction is made by this approach about the Free Choice readings of plural NPIs: there is an exhaustive-only restriction.

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