Quantifying over thematic roles: Mandarin distributive Numerals and reciprocals

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Overview We investigate the interaction between distributive numerals (DistNums) and reciprocals in Mandarin Chinese, which reveals a core property of DistNums: they quantify over not only events and but also over thematic roles. Our proposal sheds light on how DistNums and reciprocals distribute over events differently.

Mandarin DistNums Adverbial DistNums are constructions built by reduplicating a numeral-classifier combination that distribute a plural DP over salient *non-overlapping* subevents [3,5]. (1) is ambiguous between two readings, corresponding to which DP it associates with.

(1) Xuesheng **liang-ge.liang-ge-de** chi-le pingguo.
student two-CL.two-CL-DE eat-PERF apple
'The students ate the apples in groups of two.'
a. For each occasion, there is an event of **two students** eating apples.
b. For each occasion, there is an event of students eating **two apples**.

DistNums only associate with a single DP; as such, under (1-a), it doesn't matter how many apples were eaten in each subevent. Furthermore, (1) is false in a "mixed" scenario like (2):

(2) e_1 = Alex+Lee eat apple$_1$, e_2 = Jane eats apple$_1$+apple$_2$, e_3 = Jack+Jill eat apple$_2$

DistNums & Reciprocals Sentences with a DistNum and the reciprocal pronoun *bici*, such as (3), have surprising truth conditions: in these cases, the DistNum seems to be imposing a cardinality test on *both* arguments of the sentence. (4) presents scenarios followed by judgements.

(3) Xuesheng-men **liang-ge.liang-ge-de** zai quxiao bici.
student-PL two-CL-two-CL-DE PROG mock RECIP
'The students are mocking each other in twos.'

(4) There are six students: A, B, C, D, E, and F.
a. A+B mocks C+D, C+D mocks E+F, E+F mocks A+B ⇒ **True!**
b. A mocks B and B mocks A, C mocks D and D mocks C, ... ⇒ **True!**
c. A+B mocks C, C+D mocks A, E+F mocks D, ... ⇒ **False!**
d. A mocks B+C, B mocks C+D, C mocks E+F, ... ⇒ **False!**
e. A+B mocks C, C mocks D+E, ... ⇒ **False!**

The presence of the DistNum in (3) requires that, in each salient subevent, *both* the agent *and* the theme have cardinality two. This is so even though the DistNum in (3) only associates with the subject *students* - which we know to be the case because DistNums above the progressive marker *zai* cannot associate with the object:

(5) Xuesheng$_S$ **liang-ge.liang-ge-de**$_{S/??O}$ zai chi pingguo$_O$.
student two-CL.two-CL-DE PROG eat apple
Only: '[The boys in groups of two] are eating apples.'

We argue that the difference between (3) and (1) lies in the fact that only in the former do the subject and the object co-refer. We propose that in each salient subevent, DistNums impose a cardinality test on the bearer of *the thematic roles* that its antecedent bears in the topic event. This means that the DistNum in (3) imposes a cardinality test on both the agent and the theme, because its antecedent bears both thematic roles in the topic event.

Theoretical Background Our analysis is couched within the framework of algebraic Neo-Davidsonian event semantics [2]. The domain of individuals and events are closed under sum formation ($\oplus$) and partially ordered by a 'part-of' ($\leq$) relation. Verbs denote monadic predicates of events and arguments are syntactically stitched to the sentence via covert prepositions that introduce thematic roles. Verbs and thematic roles are taken to be lexically cumulative.

(6) a. $[\![\text{mock}]\!]^{g,C} = \lambda e.\ {*}\textbf{mock}(e)$ b. $[\![\text{AG}]\!]^{g,C} = \lambda e.\ {*}\textbf{ag}(e)$

As can be seen in (6), aside from g, a parameter C is added to $[\![\cdot]\!]$, which stands for a cover on the domain of events. (7) presents a couple of definition concerning cover-event pairs.

(7) a. $\textbf{Good-Fit}(C,e)$ iff $\forall e' \leq e \exists C' \subseteq C[e' \leq \oplus C' \wedge \forall e'' \leq \oplus C'[e'' \leq e]]$

b. $\textbf{Partition}(C,e)$ iff $\textbf{Good-Fit}(C,e) \wedge \neg\exists e', e'' \in C[e' \leq e \wedge e'' \leq e \wedge e' \circ e'']$

A New Entry for DistNums We propose that DistNums have the entry in (8), which involves quantification over events and thematic roles. First, in order to account for the non-overlap condition imposed by the DistNum, we add a presupposition which states that C must partition e. Furthermore, we take DistNum to be anaphoric: they bear an individual index that must be syntactically bound. Finally, we take DistNums to involve quantification over pairs of events and thematic roles (where Θ is the set of all attested thematic roles).

(8) $[\![n\text{-}n_i]\!]^{g,C} = \lambda e\!:\!\textbf{Partition}(C,e).\ \forall e' \in C \forall \theta \in \Theta[e' \leq e \wedge \theta(e) = g(i) \rightarrow |\theta(e')| = n]$

Leaving aside its presuppositions, sentence (1) under reading (1-a) would have the LF and truth conditions in (9). Since the DistNums's antecedent bears a single thematic role in e (agent), it only imposes the condition that the agents of the subevents of e must have cardinality two.

(9) a. [students λ_1 [2-2_1 [AG t_1] eat [TH apple]]]

b. $\exists e : {}^*\textbf{ag}(e) = \textbf{the.students} \wedge {}^*\textbf{eat}(e) \wedge {}^*\textbf{apple}({}^*\textbf{th}(e)) \wedge$
$\forall e' \in C \forall \theta \in \Theta[e' \leq e \wedge \theta(e) = \textbf{the.students} \rightarrow |\theta(e')| = 2]$

It is important to point out that DistNums don't change the value of C; they only impose constraints on its value. This is a desired result because, as discussed in [5], when two DistNums modify the same event, the values of their cover have to match.

Reciprocals Our analysis of reciprocals is built on [4]. The core idea is that reciprocity involves identity between two thematic roles in the topic event but disjointness between these thematic roles in all relevant subevents. An entry for *bici* is given in (10), in which, following [4], we assume that *bici* is syntactically co-indexed with the thematic role of its antecedent.

(10) $[\![\text{bici}_\theta]\!]^{g,C} = \lambda P_{evt}.\lambda e.\ P(\theta(e))(e) \wedge \exists C' \sqsubseteq C \forall e' \in C[e' \leq e \rightarrow$
$\exists x[P(x)(e') \wedge \neg(x \circ \theta(e'))]]$

(11) For any covers on the domain of events, $C \sqsubseteq C'$ iff $\forall x \in C' : \exists P \subseteq C : \oplus P = x$

Crucially, differently from DistNums, don't distribute the elements of C, but the elements of a cover that has potentially smaller cells than C. This is to account for the reading (4-b) of (3): in this reading, the reciprocal applies to events that been already broken down by the DistNum.

Back to DistNums & Reciprocals We assign the LF and truth condition in (12) to (3). We now see the payoff of having quantification over thematic roles: given that *the students* bears two thematic roles, in the matrix clause, the DistNum now imposes that both the agent and the theme must have cardinality *two* in each salient subevent.

(12) a. [students λ_1 [2-2_1 [AG t_1] mock [TH bici_{AG}]]]

b. $\exists e : {}^*\textbf{ag}(e) = \textbf{the.students} \wedge {}^*\textbf{mock}(e) \wedge {}^*\textbf{th}(e) = {}^*\textbf{ag}(e) \wedge$
$\exists C' \sqsubseteq C \forall e' \in C'[e' \leq e \rightarrow \exists x[{}^*\textbf{th}(e') = x \wedge \neg(x \circ {}^*\textbf{ag}(e'))] \wedge$
$\forall e' \in C \forall \theta \in \Theta[e' \leq e \wedge \theta(e) = \textbf{the.students} \rightarrow |\theta(e')| = 2]$

Implications The interaction between DistNums and reciprocals shows interesting properties of DistNums that are not observable otherwise. We have argued that our data can be straightforwardly accounted for if DistNums quantify over thematic relations, an advantage of adopting the event semantics framework which captures properties that previous accounts such as [1] and [5] cannot account for.

References: [1] Cable (2014) Distributive numerals and distance distributivity in Tlingit (and beyond) [2] Champollion (2017) *Parts of a whole* [3] Donazzan & Müller (2014) Reduplicated Numerals as Pluractionals [4] Dotlačil (2012) Reciprocals Distribute over Information States [5] Kobayashi & Chen

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