Ways of Decomposing Events:
Structural Differences between Adnominal and Adverbial Distributive Numerals*

Filipe Hisao Kobayashi & Sherry Yong Chen

CLS55 | May 18, 2019

1 Introduction

- **Distributive numerals** are morphosyntactic constructions containing a numeral whereby
  - the sentence as a whole receives a distributive reading, and
  - the numeral is interpreted as if within the scope of a distributive operator. (Cable, 2014)
- Mandarin distributive numerals (**NumNums**) are formed by reduplicating a numeral+classifier.[1]

(1) Haizi-men **liang-ge-liang-ge-de** dao le.
child-PL two-CL-two-CL-DE arrive PERF
'The children arrived in twos/two by two.'

- NumNums come in two flavors, adverbial and adnominal,[2] distinguished by
  - their position: adnmonial ones are pre-nominal, adverbial ones are pre-verbal;
  - orthographically distinct markers: 的$_{adn}$ and 地$_{adv}$

(2) a. Yanhua **liang-duo-liang-duo-de** zai kong-zhong zhanfang.
firework two-CL-two-CL-DE$_{adv}$ at sky-in explode
'The fireworks are exploding in the sky in twos/two by two.' *Adverbial*

b. **Liang-duo-liang-duo-de** yanhua zai kong-zhong zhanfang.
two-CL-two-CL-DE$_{adn}$ firework at sky-in explode
'The fireworks are exploding in the sky in twos/two by two.' *Adnominal*

▷ Though one might think that sentences with adverbial and adnominal NumNums are truth-conditionally equivalent, we present new data showing that this is not always the case.

- The crucial minimal pair will involve sentences with more than one NumNum in contexts in which there is more than one salient way to break down the event the sentence describes.
- The different ways of decomposing events between adverbial and adnominal NumNums will be explained as a result of structural rather than denotational differences.

*We thank Roger Schwarzschild for numerous discussions on this project. Thank you to Lucas Champollion, Simon Charlow, Cater Chen, our CLS reviews, and audience at the 2018 Southern New England Workshop in Semantics (SNEWS) at UMass Amherst for their helpful comments. All remaining errors are ~~typos~~ ours.

[1] As far we're aware, Mandarin NumNums have only been previously analyzed in Donazzan & Müller (2015).

[2] The distribution of adnominal NumNums is very limited, in ways we don't fully understand yet, but Cable notes that there seems to be a cross-linguistic tendency for distributive numerals to be adverbial.

2 A working analysis of NumNums

- To help us navigate through the main puzzle, we'll need a working analysis of NumNums:

  2.1 Determines the scope of distributivity in sentences with NumNum.

  2.2 Presents a denotation for NumNum within the framework of algebraic event semantics.

2.1 The scope of distributivity

- NumNum is an event modifier that:
  - ○ breaks the topical event down into non-overlapping subevents, and
  - ○ distributes a plural target over these subevents.

- Given this, there are two different ways of rendering the truth condition of (1):

(1′) There is an event e s.t.
e **can be broken down into salient non-overlapping subevents** e' s.t.
e' is an event of two children arriving

(1″) There is an event e s.t.
e is an event of the children arriving, and
e **can be broken down into salient non-overlapping subevents** e' s.t.
e' is an event in which the number of participants is two

- The difference between (1′) and (1″) is in the **scope of distributivity**:
  - ▷ in (1′), distributivity take scope above the verb and its participants;
  - ▷ in (1″), distributivity only takes scope above the numeral itself.

- These two alternatives don't render distinguishable truth conditions for a sentence like (1), but when investigating other sentences, we see that (1″) seems to be on the right track.

- Some evidence that NumNums involve very local distributivity:
  - ○ NumNums can modify clauses that describe a collective event:[3]

(3) Haizi-men **liang-ge-liang-ge-de** jianqi le yi-dong fangzi.
child-PL two-CL-two-CL-DE build PERF one-CL house
'The children built a house in twos/two by two.'

  - ○ Verbal classifiers cannot be interpreted in the scope of NumNum's distributivity:

(4) Haizi-men **liang-ge-liang-ge-de** tiao le liu-xia.
child-PL two-CL-two-CL-DE jump PERF six-CL
'The children jumped in twos six times.
$\rightsquigarrow$ there were a total of six jumps by children-pairs
$\not\rightsquigarrow$ there were six jumps for each children-pair

[3] (Brasoveanu & Henderson, 2009) use a similar test for English *one by one* (p.15-16).

- ... despite being obligatorily interpreted under the scope of distributive *dou*:

(5) Haizi-men dou tiao le liu-xia.
child-PL DOU jump PERF six-CL
'The children each jumped six times.'
$\not\rightsquigarrow$ there were a total of six jumps by children
$\rightsquigarrow$ there were six jumps for each child

2.2 Framework & a denotation for NumNum

- **The domain**: The domain of individuals D_e and the domain of events D_v are composed of singularities and pluralities (i.e, sums of singularities).
- These domains are closed under sum formation and they are partially ordered by a 'plural-part' relation ($\sqsubseteq_{\text{PL}}$), induced by the sum formation operation.

(6) **D_e and D_v are closed under sum**
a. $\forall x \forall y (x, y \in D_e \rightarrow x \oplus y \in D_e)$
b. $\forall e \forall e' (e, e' \in D_v \rightarrow e \oplus e' \in D_v)$

(7) **The 'plural-part' relation'**
$\forall x \forall y (x \sqsubseteq_{\text{PL}} y \leftrightarrow x \oplus y = y)$

- **Neo-Davidsonian semantics and syntax**: Verbs are predicates of events, and verbal arguments are stitched to sentences via thematic roles.

(8) $[\![\text{explode}]\!] = \lambda e_v .\, \text{explode}(e)$

(9) $[\![\text{TH}]\!] = \lambda x_e \lambda e_v .\, \text{th}(e) = x$

- **Lexical Cumulativity**: Verbs are cumulative, and so are thematic roles (Kratzer 2007):

(10) $^*P$ is the smallest set P' s.t. $P \subseteq P'$ and $\forall x \forall y (x, y \in P' \rightarrow x \oplus y \in P')$

(11) a. $V(e_1) \wedge V(e_2) \rightarrow {}^*V(e_1 \oplus e_2)$
b. $\theta(e_1) = x_1 \wedge \theta(e_2) = x_2 \rightarrow {}^*\theta(e_1 \oplus e_2) = x_1 \oplus x_2$

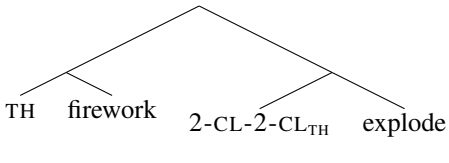
(12) $[\![\text{explode}]\!] = \lambda e_v .\, {}^*\text{explode}(e)$

(13) $[\![\text{TH}]\!] = \lambda x_e \lambda e_v .\, {}^*\text{th}(e) = x$

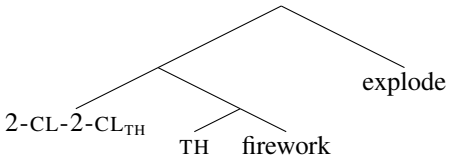
- **Theta-indexing**: Distance distributive items target an NP via 'θ-indexing.' (Champollion, 2016)
- Toy analysis for NumNum & truth conditions assigned to the sentences in (2):

(14) $[\![\text{NumNum}_\theta]\!]^C = \lambda e : e \in {}^*\lambda e' (\text{CL}(\theta(e')) \wedge C(e')).\, e \in {}^*\lambda e' (|\theta(e')| = n \wedge C(e'))$
where *C* is a contextually given cover on e, and
CL the presupposition restriction imposed by the classifier

(15) a.



b.

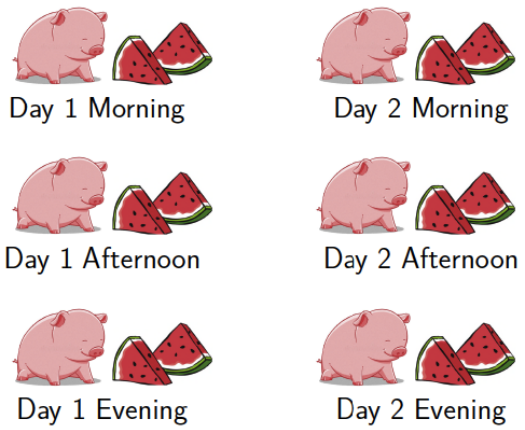


c. $\exists e ({}^*\text{th}(e) = \bigoplus \text{firework} \wedge {}^*\text{explode} \wedge e \in {}^*\lambda e' (|{}^*\text{th}(e')| = 2 \wedge C(e')))$

3 The Puzzle

- Consider the following scenario:

(16) *There was a two-day festival, with a total of 6 pigs and 12 pieces of watermelons.*



- There are two salient ways to break down the "topical event", i.e. the festival, into subevents:
  - By *day*: Agent = 3 pigs, Theme = 6 pieces of watermelon
  - By *meal*: Agent = 1 pig, Theme = 2 pieces of watermelon

- When using **one** adverbial NumNum:
  - Either of these two salient partitions can be accessed: by *day* in (18), by *meal* in (19).
  - Our toy analysis can easily handle these cases by using different covers.

(17) a. Zhu **san-tou-san-tou-de** ba xigua chi-wan le.
pig three-CL-three-CL_{AG}-DE BA watermelon eat-finish PERF
'The pigs, three by three, ate up the watermelons.' (True)

b. $\exists e(*\text{ag}(e) = \bigoplus\text{pig} \wedge *\text{eat}(e) \wedge *\text{th}(e) = \bigoplus\text{wtml} \wedge e \in *\lambda e'(|*\text{ag}(e')| = 3 \wedge \underline{\text{day}(e')}))$

(18) a. Zhu ba xigua **liang-kuai-liang-kuai-de** chi-wan le.
pig BA watermelon two-CL-two-CL_{TH}-DE eat-finish PERF
'The pigs ate up the watermelons, two pieces at a time.' (True)

b. $\exists e(*\text{ag}(e) = \bigoplus\text{pig} \wedge *\text{eat}(e) \wedge *\text{th}(e) = \bigoplus\text{wtml} \wedge e \in *\lambda e'(|*\text{th}(e')| = 3 \wedge \underline{\text{meal}(e')}))$

- When using **two** adverbial NumNums:
  - Given that there are two salient ways of partitioning the festival event, one could expect that two NumNums in the same sentence would be able to slice up the event in different ways.
  - However, the contrast between (19a) and (20a) suggests that this is not the case: two adverbial NumNums modifying the same event must decompose the topical event in the same way.

(19) a. Zhu **san-tou-san-tou-de** ba xigua **liang-kuai.liang-kuai-de** chi-wan le.
pig three-CL-three-CL_{AG}-DE BA watermelon two-CL-two-CL_{TH}-DE eat-finish PERF
'The pigs, three by three, ate up the watermelons, two pieces at a time.' (False)

b. $\exists e(*\text{ag}(e) = \bigoplus\text{pig} \wedge *\text{eat} \wedge *\text{th}(e) = \bigoplus\text{wtml} \wedge e \in *\lambda e'(|*\text{ag}(e')| = 3 \wedge \underline{\text{day}(e')})$
$\wedge\, e \in *\lambda e'(|*\text{th}(e')| = 3 \wedge \underline{\text{meal}(e')}))$

(20) a. Zhu **yi-tou-yi-tou-de** ba xigua **liang-kuai-liang-kuai-de** chi-wan le.
pig one-CL-one-CL_{AG}-DE BA watermelon two-CL-two-CL_{TH}-DE eat-finish PERF
'The pigs, one by one, ate up the watermelons, two pieces at a time.' (True)

b. $\exists e(*\text{ag}(e) = \bigoplus\text{pig} \wedge *\text{eat} \wedge *\text{th}(e) = \bigoplus\text{wtml} \wedge e \in *\lambda e'(|*\text{ag}(e')| = 1 \wedge \underline{\text{meal}(e')})$
$\wedge\, e \in *\lambda e'(|*\text{th}(e')| = 3 \wedge \underline{\text{meal}(e')}))$

▷ Our working analysis overgenerates!

- Why is this data unexpected given our current assumptions?
  - NumNums are themselves responsible for decomposing the main event and the distributivity associated with them doesn't take scope above their complement.
  - Therefore, nothing should prevent two NumNums from slicing the same event in their own ways.
- This problem is also faced by the analyses developed in Cable (2014) and Donazzan & Müller (2015).
- One possible way of accounting for this is to postulate the following constraint:

(21) CONSTRAINT ON NUMNUM COVERS (to be revised)
Multiple NumNums must share the same cover.

- This is not descriptively accurate, however.
- When using one adnominal and one adverbial NumNum to describe the scenario in (16):
  - (19a) vs (22): the first NumNum is adverbial vs. adnominal.
  - Contrary to (19a), the two NumNums in (22) do *not* need to distribute over the same subevent.

(22) **San-tou-san-tou-de** zhu ba xigua **liang-kuai-liang-kuai-de** chi-wan le.
three-CL-three-CL_{AG}-DE pig BA watermelon two-CL-two-CL_{TH}-DE eat-finish PERF
'The pigs in threes ate up the watermelons, two pieces at a time.' (True)

- A revision of (21) is thus in order:

(23) CONSTRAINT ON NUMNUM COVERS
The covers of adverbial NumNums have to match, but the covers of an adnominal and an adverbial NumNum don't.

- However, even though this constraint is descriptively accurate, it is not explanatory at all.
- In the next section, we'll argue an analysis in which (23) follows directly from the grammar.

4 Analysis

4.1 Sentences with two adverbial NumNums

- **Restating the issue**: When two adverbial NumNums modify the same event, they have to decompose it into subevents with the same *granularity*.
- **Proposal**: Rather than assuming that this is achieved via a constraint on covers, we'll propose that NumNums breaks down the topical event into *subevents that are singularities*.

(24) $[\![\text{NumNum}_\theta]\!] = \lambda e.\ e \in {}^*\lambda e'(|\theta(e')| = n \wedge \text{SG}(e'))$

(25) $\forall e(\text{SG}(e) \leftrightarrow \neg\exists e'(e' \neq e \wedge e' \sqsubseteq_{\text{PL}} e))$

- **Some remarks about event singularities**:
  - Nothing in definition in (25) implies that event singularities don't mereologically overlap.
  - This is so because it is based on the 'plural-part', rather than the mereological 'part-of', relation.
  - Thus, the singular event e' of John moving his right leg is a mereological part – but not a plural part – of the singular event e of John running.
- **Festival scenario.** We argue for there being 9 salient *singular* events: 6 meals, 2 days, and 1 festival.
- To the extent that certain nouns can denote predicates events, this assumption is supported by the fact that descriptions like *the meal* and *the day* can refer to singular events that temporally overlap.[4]
- Accounting for the falsity of (19a), repeated in (26a):

(26) a. Zhu **san-tou.san-tou-de** ba xigua **liang-kuai.liang-kuai-de** chi-wan le.
pig three-CL-three-CL_{AG}-DE BA watermelon two-CL-two-CL_{TH}-DE eat-finish PERF
'The pigs, three by three, ate up the watermelons, two pieces at a time.' (False)

b. $\exists e({}^*\text{ag}(e) = \bigoplus \text{pig} \wedge {}^*\text{eat}(e) \wedge {}^*\text{th}(e) = \bigoplus \text{wtml}$
$\wedge\ e \in {}^*\lambda e'(|{}^*\text{ag}(e')| = 3 \wedge \text{SG}(e')) \wedge e \in {}^*\lambda e'(|{}^*\text{th}(e')| = 2 \wedge \text{SG}(e')))$

- The agent NumNum is true of the sum of the days, but the theme NumNum isn't:

(27) a. $\bigoplus\text{day} \in {}^*\lambda e'(|\text{agent}(e')| = 3 \wedge \text{SG}(e'))$
b. $\bigoplus\text{day} \notin {}^*\lambda e'(|\text{theme}(e')| = 2 \wedge \text{SG}(e'))$

- The theme NumNum is true of the sum of the meals, but the agent NumNum isn't:

(28) a. $\bigoplus\text{meal} \in {}^*\lambda e'(|\text{theme}(e')| = 2 \wedge \text{SG}(e'))$
b. $\bigoplus\text{meal} \notin {}^*\lambda e'(|\text{agent}(e')| = 3 \wedge \text{SG}(e'))$

- (26a) is false because there is no single witness to both NumNums.

[4] Thanks to Roger Schwarzschild for discussing this matter with us.

4.2 Adnominal NumNums

- As it is, our analysis also predicts adnominal and adverbial NumNums to match, contrary to fact.
- A possible solution: give adnominal NumNums a different denotation from adverbial NumNums.
- However, we'd like to pursue a different route.

- Schein (1993), in a different context, suggested the following:
  - each conjunct of a neo-Davidsonian logical form is true of its own event argument, and
  - the events in such a logical form are glued together via complete (mereological) overlap.
- Our implementation of this idea:

(29) a. The boys arrived.
b. $\exists e_1 \exists e_2(*\text{ag}(e_1) = \bigoplus \text{boy} \wedge *\text{arrive}(e_2) \wedge \text{O}(e_1, e_2))$

(30) $\text{O}(e_1, e_2) \Leftrightarrow \forall e(e \circ_{\text{m}} e_1 \leftrightarrow e \circ_{\text{m}} e_2)$

- **Final Proposal**:
  - Adverbial and adnominal NumNums have the same denotation.
  - Adverbial NumNums modify the event argument of the verb.
  - Adnominal NumNums modify the event of the thematic role of the nominal they adjoin.
- We can thus maintain a uniform semantics for NumNums, and explain away their different behaviour as a matter of where they attach in the structure.
- Truth conditions for a sentence with two adverbial NumNums:

(31) $\exists e_1 \exists e_2 \exists e_3(*\text{ag}(e_1) = \bigoplus \text{pig} \wedge \text{O}(e_1, e_3) \wedge *\text{eat}(e_3) \wedge *\text{th}(e_2) = \bigoplus \text{wtml} \wedge \text{O}(e_2, e_3)$
$\wedge \underline{e_3} \in *\lambda e_3'(|*\text{ag}(e_3')| = 3 \wedge \text{SG}(e_3')) \wedge \underline{e_3} \in *\lambda e_3'(|*\text{th}(e_3')| = 2 \wedge \text{SG}(e_3'))$

- Truth conditions for a sentence with one adverbial and one adnominal NumNum:

(32) $\exists e_1 \exists e_2 \exists e_3(*\text{ag}(e_1) = \bigoplus \text{pig} \wedge \text{O}(e_1, e_3) \wedge *\text{eat}(e_3) \wedge *\text{th}(e_2) = \bigoplus \text{wtml} \wedge \text{O}(e_2, e_3)$
$\wedge \underline{e_1} \in *\lambda e_1'(|*\text{ag}(e_1')| = 3 \wedge \text{SG}(e_1')) \wedge \underline{e_3} \in *\lambda e_3'(|*\text{th}(e_3')| = 2 \wedge \text{SG}(e_3'))$

5 Some predictions and remaning puzzles

- The two sentences below have different truth conditions: while (33) is false if describing the festival event, (34) is true.

(33) Zhu **san-tou-san-tou-de** dou ba liang-kuai xigua chi-wan le.
pig three-CL-three-CL_{AG}-DE DOU BA two-CL watermelon eat-finish PERF
'The pigs in threes ate up the watermelons, two pieces at a time.' (False)

(34) **San-tou-san-tou-de** zhu dou ba liang-kuai xigua chi-wan le.
three-CL-three-CL_{AG}-DE pig DOU BA two-CL watermelon eat-finish PERF
'The pigs in threes ate up the watermelons, two pieces at a time.' (True)

- We correctly predict this contrast if we assume the distributivity found in sentences with *dou* also involves distributivity down to atomic events:
  - (33) is false because the distributor in the sentence and the adverbial NumNum must decompose the topical event into events with same granularity.
  - (34) is however true because the distributor in the sentence and the adnominal NumNum are modifying different events.
- Our account, however, cannot explain why (35) is judged to be false in the festival scenario:

(35) **Yi-tou-yi-tou-de** zhu ba xigua **liu-kuai-liu-kuai-de** chi-wan le.
one-CL-one-CL_{AG}-DE pig BA watermelon six-CL-six-CL_{TH}-DE eat-finish PERF
'The pigs, one by one, ate up the watermelons in sixs.' (False)

- Given that one NumNum is adnominal and the other is adverbial, we'd expect them to be freely able to decompose the main event in different ways.

6 Final Remarks

- We have presented a new puzzle concerning the interpretation of distributive numerals in Mandarin Chinese, which could suggest that their adnominal and adverbial uses have different meanings.
- We have pursued a different route: we argued that differences in the interpretation of sentences with adnominal and adverbial NumNums are due to the structural position to which these items attach to.
- Future research will attempt to find other instances in which differences between adverbial and nominal modifiers are also due to their structural position in the sentence.

References

Brasoveanu, A., & Henderson, R. (2009). Varieties of distributivity: 'one by one' vs 'each'. In *Semantics and linguistic theory* (Vol. 19, pp. 55–72).

Cable, S. (2014). Distributive numerals and distance distributivity in Tlingit (and beyond). *Language*, *90*(3), 562–606.

Champollion, L. (2016). Covert distributivity in algebraic event semantics. *Semantics and Pragmatics*, *9*, 15–1.

Donazzan, M., & Müller, A. L. (2015). Reduplicated numerals as pluractionals: Distributivity as a window to the individuation of events. *Journal of Portuguese Linguistics*, *14*(1).

Schein, B. (1993). *Plurals and events* (Vol. 23). MIT Press.