Are adnominal and adverbial distributive numerals the same? Perspectives from Mandarin Chinese*

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December 2, 2018 | SNEWS@UMass Amherst

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): formed by reduplicating a numeral+classifier.

  (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 flavours, adnominal and adverbial, distinguished by
  - their word order with respect to the noun, and
  - orthographically distinct markers for adnominals and adverbials.

  (2) a. Yanhua liang-duo-liang-duo-de zai kong-zhong zhanfang.
       firewall two-CL.two-CL.DE adv at sky-in explode
       ‘The fireworks explode in twos/in groups of two/two by two.’  
       Adverbial

     b. Liang-duo-liang-duo-de yanhua zai kong-zhong zhanfang.
        two-CL.two-CL.DE advn firewall at sky-in explode
        ‘The fireworks explode in twos/in groups of two/two by two.’ Adnominal

- **Today’s talk**: some novel data with the hope to shed light on the following questions:
  - How can we provide an adequate compositional analysis for NumNum?
  - Do adverbial and adnominal NumNums ever differ? If so, how?

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*We are in debt to Roger Schwarzschild for offering extensive discussions and suggestions on this project. We are also grateful to Lucas Champollion, Cater Chen, and the audience at NASSLLI 2018 for their comments. All errors are our own.
2 Basic properties & framework

2.1 Basic properties of (adverbial) NumNum

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

- Not only must NumNum’s target be plural, but it must also satisfy the classifier’s restriction:

  (3) Haizi-men liang-ge-liang-ge-de dao le.
  child-PL two-CL two-CL-DE_{adv} arrive PERF
  ‘The children arrived two by two/in twos/in groups of two.’

  → where ge is the general classifier and zhi is used for small, round and fluffy/cute things.

- Ambiguity: NumNum can in principle target either the agent or the theme of the sentence.

  (4) Haizi-men liang-ge-liang-ge-de chi-wan le huashendou
  child-PL two-CL two-CL-DE_{adv} eat-finish PERF peanut
  ‘The children ate the peanuts two by two.’ (Donazzan & Müller 2014)

\begin{itemize}
  \item a. For each occasion/location, there is an event of two children eating peanuts.
  \item b. For each occasion/location, there is an event of children eating two peanuts.
\end{itemize}

2.2 Framework & Toy analysis

- 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 $\subseteq_{PL}$, induced by the sum formation operation.

\begin{align*}
(5) \quad & 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)
\end{align*}

\begin{align*}
(6) \quad & \forall x \forall y (x \subseteq_{PL} y \leftrightarrow x \oplus y = y)
\end{align*}

\begin{align*}
(7) \quad & x = \bigoplus P = \text{def } \forall y (P(y) \rightarrow y \subseteq_{PL} x) \land \forall z (z \subseteq_{PL} x \rightarrow \exists z' (P(z') \land z \circ z'))
\end{align*}

‘An entity $x$ is the sum of a set of entities $P$ if and only if everything in $P$ is a plural-part of $x$ and every plural-part of $x$ overlaps with something in $P$.’ (Champollion 2016)

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

\begin{align*}
(8) \quad & [\text{explode}] = \lambda e_v. \text{explode}(e) & (9) \quad [\text{TH}] = \lambda x_e. \lambda e_v. \text{th}(e) = x
\end{align*}

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

\begin{align*}
(10) \quad & *P = \{ x : P' \subseteq P \land x = \bigoplus P' \}
\end{align*}

\begin{align*}
(11) \quad & a. \quad V(e_1) \land V(e_2) \rightarrow *V(e_1 \oplus e_2) \\
& b. \quad \theta(e_1) = x_1 \land \theta(e_2) = x_2 \rightarrow *\theta(e_1 \oplus e_2) = x_1 \oplus x_2
\end{align*}
\[(\text{explode}) = \lambda e. *\text{explode}(e)\]  
\[(\text{TH}) = \lambda x. \lambda e. *\text{th}(e) = x\]

- **Theta-indexing**: We follow Champollion (2016) in assuming that distance distributive items target an NP via ‘θ-indexing.’ Nothing here hinges on this assumption.

- Toy analysis for NumNum & truth conditions of (2):

\[(\text{NumNum}_e)^C = \lambda e : \text{CL-RESTRICTION}(\theta(e)). e \in *\lambda e'(|\theta(e')| = n \land C(e'))\]

where \(C\) is a contextually given cover on \(e\)

\[(\text{NumNum}_e)^C = \lambda e : \text{CL-RESTRICTION}(\theta(e)). e \in *\lambda e'(|\theta(e')| = n \land C(e'))\]

3 The Puzzle

- Adnominal and adverbial NumNums appear to be truth conditionally equivalent.
  - The data in (2a-b) seems to be in line with this idea.
  - We are not aware of any existing empirical observation against this.

- Here, we report novel observations regarding this matter. Specifically, differences between adnominal and adverbial NumNums can be observed in sentences with two NumNums.

- 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:
  o Either of these two salient ways can be accessed: by \textit{day} in (17), by \textit{meal} in (18)
  o 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\textsubscript{AG}-DE BA watermelon eat-finish PERF
‘The pigs, three by three, ate up the watermelons.’ (True)

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

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

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

• When using two adverbial NumNums:
  o Each NumNum can have its own way of decomposing the topical event.
  o However, the contrast between (19a) and (20a) suggests that the two adverbial NumNums must decompose the topical event in the same way. Our toy analysis in (20b) overgenerates!

(19) a. Zhu yi-tou.yi-tou-de ba xigua liang-kuai.liang-kuai-de chi-wan le. pig \textit{RED} one-CL\textsubscript{AG}-DE BA watermelon \textit{RED} two-CL\textsubscript{TH}-DE eat-finish PERF
‘The pigs, one by one, ate up the watermelons, two pieces at a time.’ (True)

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

(20) a. Zhu san-tou.san-tou-de ba xigua liang-kuai.liang-kuai-de chi-wan le. pig \textit{RED} three-CL\textsubscript{AG}-DE BA watermelon \textit{RED} two-CL\textsubscript{TH}-DE eat-finish PERF
‘The pigs, three by three, ate up the watermelons, two pieces at a time.’ (False)

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

• The problem we face right now is the following:
  o NumNums are being treated as specifying the cardinality of individuals that participate in subevents of the topical event.
  o NumNums have their own partition, and thus each NumNum is independently responsible for decomposing the topical event into subevents,
  o This predicts that if a sentence contains two NumNums, they should be able to decompose the topical event in different ways, an unwelcome result.

• Note that the same problem is faced by the approaches developed in Balusu (2006) and Cable (2014).
Proposal #1: Multiple NumNums must share the same cover.

- However, the problem is more complicated as soon as we start looking at data that involves one adnominal and one adverbial NumNum.

- When using one adnominal and one adverbial NumNum to describe the scenario in (16):
  - (20a) vs (21): the first NumNum is adverbial vs. adnominal.
  - Contrary to (20a), the two NumNums in (21) do not need to distribute over the same subevent.

(21) 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)

- If we are to further entertain Proposal #1, we will need a more complex version of the story, namely something like the following:

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

- Issues with this proposal:
  - This constraint is descriptively accurate but not explanatory.
  - In fact, it’s hard to see how such a constraint on NumNum’s covers should be incorporated into the grammar.

4 Analysis

4.1 Sentences with two adverbial NumNums

- When two adverbial NumNums modify the same event, they have to break it down into subevents with the same granularity.

- Rather than assuming that this is achieved via a constraint on covers, we’ll argue for the following:

Proposal #2: NumNum breaks down the topical event into subevents that are singularities.

(23) \[[\text{NumNum}_\theta] = \lambda e. e \in *\lambda e' (|\theta(e')| = n \land \text{SG}(e'))\]
(24) \(\forall e (\text{SG}(e) \leftrightarrow \neg \exists e' (e' \neq e \land e' \subseteq \text{PL} e))\)

- Event singularities:
  - Nothing in definition in (24) 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 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.
• We propose that in the festival scenario sketched above, there are in fact 9 salient singular events: 6 meals, 2 days, and 1 festival.

• To the extent that certain nouns can denote predicate events, this assumption is supported by the fact that descriptions like the meal and the day refer to singular events that temporally overlap.¹

• Accounting for the falsity of (20a), repeated in (25a):

      pig RED three-CL_AG-DE BA watermelon RED TWO-CL_TH-DE eat-finish PERF
      'The pigs, three by three, ate up the watermelons, two pieces at a time.' (False)

  b. ∃e (*ag(e) = ⊕ pig ∧ *eat(e) ∧ *th(e) = ⊕ wtml
      ∧ e ∈ *λe′(|*ag(e′)| = 3 ∧ SG(e′)) ∧ e ∈ *λe′(|*th(e′)| = 2 ∧ SG(e′))

     ◦ The agent NumNum is true of the sum of the days, but the theme NumNum isn’t:

  (26) a. ⊕ day ∈ *λe′(|agent(e′)| = 3 ∧ SG(e′))
  b. ⊕ day ̸∈ *λe′(|theme(e′)| = 2 ∧ SG(e′))

     ◦ The theme NumNum is true of the sum of the meals, but the agent NumNum isn’t:

  (27) a. ⊕ meal ∈ *λe′(|theme(e′)| = 2 ∧ SG(e′))
  b. ⊕ meal ̸∈ *λe′(|agent(e′)| = 3 ∧ SG(e′))

     ◦ (25a) is false because there is no single witness to both NumNums.

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
   ◦ those events are then glued together by a relation of complete (mereological) overlap.

• Our take:

  (28) a. The boys arrived.
      b. ∃e₁∃e₂(*ag(e₁) = ⊕ boy ∧ *run(e₂) ∧ O(e₁, e₂))
  (29) O(e₁, e₂) ⇔ ∀e(e ◦ₘ e₁ ↔ e ◦ₘ e₂)

¹Thanks to Roger Schwarzschild for discussing this matter with us.
• The idea we’d like to advance:
  ◦ Adverbial and adnominal NumNums do 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 behaviours as a matter of where they attach in the structure.

• Truth conditions for a sentence with two adverbial NumNums:

\[
\exists e_1 \exists e_2 \exists e_3 (*ag(e_1) = \bigoplus \text{pig} \land O(e_1, e_3) \land *\text{eat}(e_3) \land *\text{th}(e_2) = \bigoplus \text{wtml} \land O(e_2, e_3) \land e_1 \in *\lambda e'_1(|*ag(e'_1)| = 3 \land \text{SG}(e'_1)) \land e_3 \in *\lambda e'_3(|*\text{th}(e'_3)| = 2 \land \text{SG}(e'_3))
\]

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

\[
\exists e_1 \exists e_2 \exists e_3 (*ag(e_1) = \bigoplus \text{pig} \land O(e_1, e_3) \land *\text{eat}(e_3) \land *\text{th}(e_2) = \bigoplus \text{wtml} \land O(e_2, e_3) \land e_1 \in *\lambda e'_1(|*ag(e'_1)| = 3 \land \text{SG}(e'_1)) \land e_3 \in *\lambda e'_3(|*\text{th}(e'_3)| = 2 \land \text{SG}(e'_3))
\]

5 More puzzles & future directions

• Adnominal NumNum as a distributive operator Our proposal as it is overgenerates:

(32) 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, six pieces at a time.’ (False)

  ◦ This data seems to suggest that adnominal NumNum can take scope. But note that it’s not obligatory.

• NumNums & reciprocals NumNum has an interesting interaction with reciprocals:

(33) Xuesheng-men liang-ce.liang-ce-de quxiao le.  bici.
  student-PL two-CL two-CL DE  mock each.other PERF each other
  ‘The students mocked each other in twos.’

  ◦ The sentence above is only true in scenarios in which NumNum breaks down the topical events into subevents with both an agent and a theme that has the cardinality of two.

• NumNums & wh-indefinites A wh-indefinite ji ‘a few’ can be used in NumNum:

(34) Xuesheng-men ji-ge.ji-ge-de  zou le.
  student-PL  few-CL few-CL DE  togeth left PERF
  ‘The students left, a few at a time.’

  ◦ The cardinality of the participant that NumNum associates with in each subevent doesn’t need to be identical, as long as it is a small number.

• Adnominal vs. Adverbial NumNums crosslinguistically We’d like to investigate whether the same data we discussed is attested in other languages with adnominal and adverbial NumNums.
References


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