Distributive numerals in Mandarin Chinese at the syntax-semantics interface

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Introduction

Distributive numerals in Mandarin Chinese (NumNum) are adverbial constructions formed by reduplicating a numeral+classifier combination:

(1) *Haizi-men liang-ge.liang-ge-de chi-wan le huasheng*
child-PL RED.two-NCL-DE$_2$ eat-finish PERF peanut
'The children ate the peanuts two by two.' [3, p.96]
a. For each occasion, there is an event of two children eating peanuts.
b. For each occasion, there is an event of children eating two peanuts.

Objective: Provide a compositional semantics for NumNum in light of novel data.

Framework

Key ingredients

- Association with an argument is established via 'parasitic scope'.
- NumNum is a modifier of **sets** of events.
- A predicate that holds between an event and any of its thematic participant.

Syntax: NumNum associates with an argument via **parasitic scope**, i.e., it is late merged between a moved DP and its lambda abstractor [1,2].

(2) $[\ldots \text{DP} \ldots] \rightarrow [\text{DP } [\lambda x[\ldots x \ldots]]] \rightarrow [\text{DP } [\text{NumNum } [\lambda x[\ldots x \ldots]]]]$

Event semantics with sets and sums:

- The domain of individuals D_e and the domain of events D_v have the structure of complete join semi-lattices without the bottom element.
- All predicates of events and thematic relations are cumulative [4]:

(3) a. $\forall P \in D_{vt} : P(e_1) \wedge P(e_2) \rightarrow P(e_1 \oplus e_2)$
b. $\forall \theta \in D_{ve} : \theta(e_1,x_1) \wedge \theta(e_2,x_2) \rightarrow \theta(e_1 \oplus e_2, x_1 \oplus x_2)$

- Verbs denote functions of type <vt,t>, and thematic roles are introduced by thematic heads of type <e,<vt,t>>:

(4) a. $[\![\text{eat}]\!] = \lambda E_{vt}.\ ^*\text{eat}(\oplus E)$
b. $[\![\text{AG}]\!] = \lambda x_e.\lambda E_{vt}.\ ^*\text{agent}(\oplus E, x)$

- Existential closure is over sets of events:

(5) $[\![\exists]\!] = \lambda V_{<vt,t>}.\ \exists E[V(E)]$

The 'Participant' predicate: Our semantics makes use of a predicate that holds between an event and any of its thematic participant, following [2]:

(6) Participant(e,x) iff x bears a 'theta relation' to e
iff $^*\text{agent}(e,x) \vee {}^*\text{theme}(e,x) \vee \ldots$

Analysis

Lexical entry for NumNum:

(7) $[\![\text{NumNum}]\!] = \lambda P_{<e,<vt,t>>}.\lambda x_e.\lambda E_{vt}.\ P(x)(E) \ \&\ \forall e[e \in E \rightarrow \forall y[y \leq x \ \&\ \text{Participant}(e,y) \rightarrow |y| = n]]$

LF and truth-conditions of (1a):

(8) [∃ [children [2-CL-2-CL [λx [[AG x] [ate [TH peanuts]]]]]]]

(9) $[\![(8)]\!] = 1$ iff $\exists E[^*\text{agent}(\oplus E, \oplus \text{child}) \ \&\ ^*\text{eat}(\oplus E) \ \&\ ^*\text{theme}(\oplus E, \oplus \text{peanut}) \ \&\ \forall e[e \in E \rightarrow \forall y[y \leq \oplus \text{child} \ \&\ \text{Participant}(e,y) \rightarrow |y| = 2]]]$

LF and truth-conditions of (1b):

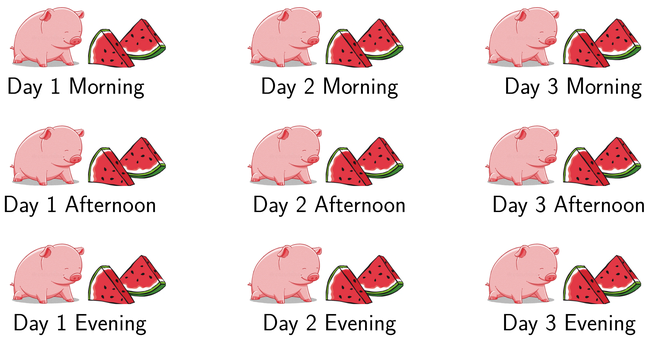
(10) [∃ [children [λx [peanuts [2-CL-2-CL [λy [[AG x] [ate [TH y]]]]]]]]]

(11) $[\![(10)]\!] = 1$ iff $\exists E[^*\text{agent}(\oplus E, \oplus \text{child}) \ \&\ ^*\text{eat}(\oplus E) \ \&\ ^*\text{theme}(\oplus E, \oplus \text{peanut}) \ \&\ \forall e[e \in E \rightarrow \forall y[y \leq \oplus \text{peanut} \ \&\ \text{Participant}(e,y) \rightarrow |y| = 2]]]$

Modifying sets of events

Sentences with two NumNums require breaking down into the same subevents.

Scenario: There was a three-day festival.....



(12) *Zhu san-tou.san-tou-de ba xigua liang-kuai.liang-kuai-de chi le.*
pig RED.three-NCL$_{\text{SUBJ}}$-DE$_2$ BA watermelon RED.two-NCL$_{\text{OBJ}}$-DE$_2$ eat PERF
'The pigs, three by three, ate the watermelons two pieces at a time.' (False)

⇒ This follows from the proposal that NumNum is a modifier of sets of events:

(13) $\exists E[^*\text{agent}(\oplus E, \oplus \text{pig}) \ \&\ ^*\text{eat}(\oplus E) \ \&\ ^*\text{theme}(\oplus E, \oplus \text{watermelon}) \ \&\ \forall e[e \in E \rightarrow \forall y[y \leq \oplus \text{pig} \ \&\ \text{Participant}(e,y) \rightarrow |y| = 3]] \ \&\ \forall e[e \in E \rightarrow \forall y[y \leq \oplus \text{watermelon} \ \&\ \text{Participant}(e,y) \rightarrow |y| = 2]]]$

By contrast, sentences with two *each* allow breaking down into different subevents [6]:

(14) They baked two pies each$_{\text{AG}}$ for the contest, each$_{\text{TH}}$ with just one egg.

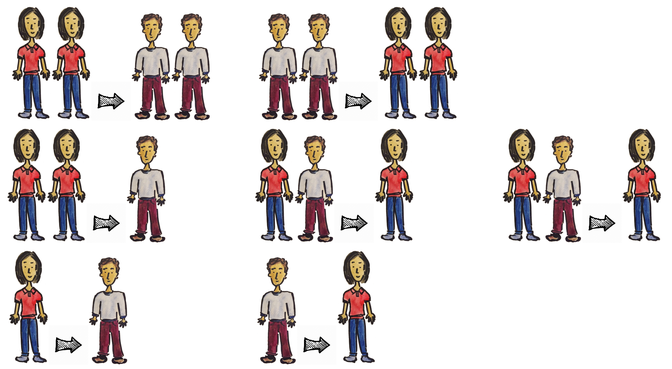
The underspecified 'Participant'

Reciprocals provide further support for the underspecified predicate 'Participant'.

- Reciprocals: the same entities take up the role of Agent and Theme in an event.
- In Mandarin Chinese: *bici* 'each other'

(15) *Xuesheng-men liang-ge.liang-ge-de quxiao le bici.*
student-PL RED.two-NCL-DE$_2$ mock PERF each.other
'The students two by two mocked each other.'

Scenario: Today, a group of students mocked each other.....



(True)

(False)

(False)

⇒ Both Agent and Theme must have the cardinality 2 in each subevent. Our account captures this, with a semantics of reciprocals adopted from [5]:

(16) $\exists E[^*\text{agent}(\oplus E, \oplus \text{student}) \ \&\ ^*\text{mock}(\oplus E) \ \&\ \forall x[x \leq \oplus \text{student} \rightarrow \exists E'[\oplus E' \leq \oplus E \ \&\ ^*\text{agent}(\oplus E', x) \ \&\ \exists y[y \leq \oplus \text{student} \ \&\ \neg(x \circ y) \ \&\ ^*\text{theme}(\oplus E', y)]] \ \&\ \forall e[e \in E \rightarrow \forall z[z \leq \oplus \text{student} \ \&\ \text{Participant}(e,z) \rightarrow |z| = 2]]]$

References

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