Every boy bought two sausages each: Distributivity and dependent numerals

Lucas Champollion
NYU
champollion@nyu.edu

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1 Introduction

- Distance-distributive (DD) items often occur in the scope of universal quantifiers.
- These sentences all mean 'Every boy ate two sausages' (surface scope reading):

(1) Jeder Junge hat **jeweils** zwei Würstchen gegessen. *(German)*
Every boy has **each** two sausage eaten.

(2) Subete-no danshi-ga sosegi-o fu-tatsu-**zutsu** tabeta. *(Japanese)*
Every-Gen boy-Nom sausage-Acc two-CL-**each** ate.

(3) Every boy ate two sausages each. *(some English dialects, Szabolcsi 2010)*

- Given that vacuous distributivity over individuals is unacceptable out of the blue, as in (4), it is not clear why it should be acceptable in (1)-(3).

(4) *Alex bought two sausages each.

- DD items are standardly analyzed either as universal quantifiers or as distributive operators (e.g. Zimmermann 2002; Dotlacil 2011; Champollion 2012).
- These previous accounts all have the same problem: the subject already distributes and so there is nothing left to do for the DD item.

2 Proposal

- I suggest that for those speakers and languages that conform to the pattern above, DD items do not themselves introduce distributivity but instead are licensed by it.
- Formally, I treat them as **dependent numerals**, analogously to dependent indefinites (Farkas 1997; Henderson 2012, in press).

- Dependent indefinites/numerals are required to be in the scope of an operator with respect to which they can covary, their "licensor".
- They can be licensed by *every* in Hungarian, Romanian, and Russian:

(5) Minden gyerek olvasott **hét-hét** könyvet. *(Hungarian)*
Every child read SEVEN-SEVEN book-ACC
'Every child read seven books.' (Farkas 1997) ✓$\forall > 7, *7 > \forall$

(6) Fiecare băiat a recitat **cîte un poem**. *(Romanian)*
Every boy has recited CÎTE a poem.
'Every boy recited a poem.' (Brasoveanu and Farkas 2011) ✓$\forall > 1, *1 > \forall$

(7) Každyj mal'čik vstretil **kogo-nibud' iz svoix odnoklassnic**. *(Russian)*
Every boy met who-NIBUD' of his girl-classmates.
'Every boy met one of his girl classmates.' (Yanovich 2005) ✓$\forall > 1, *1 > \forall$

- Distributive numerals (Gil 1982) can also be subsumed under this paradigm:

(8) Her çocuk **ikişer sosis** aldı. *(Turkish)*
Each child two-ER sausage bought.
'Every child bought two sausages.' (Tuğba Çolak-Champollion, p.c.)

- The idea is that adnominal *each* turns its host into a dependent indefinite:

(9) Every boy bought two sausages each.

- This is false if the same two sausages keep changing hands.

3 The river metaphor

Metaphor	Meaning
Riverboat	Anaphoric dependency
Departure harbor	Antecedent
Destination harbor	Pronoun
Stationary sentinel	Test
River	Assignment function (DPL)
River or river arm	Set of assignment functions (DPlL)
Branching river (e.g. river delta)	Distributivity operator (DPlL)
Traveling sentinel	Postsupposition
Sentinel stopper	Postsupposition plug

Table 1: The river metaphor

3.1 Analysis of *Every boy bought two sausages each*

- Let's apply PCDRT to "Every boy$_i$ bought two sausages$_j$ each":
- My main claim is that adnominal *each* does not distribute (it does not split up the river into arms). Instead, it sends out a traveling sentinel (a postsupposition) with sealed orders that ensure that its host DP covaries.

1. $[\![$every boy$_i]\!]$: Launch every boy on a different boat. All of them set sail under the "i" flag.
2. $[\![$[dist]$]\!]$: The river temporarily splits into a different arm for each boy.
3. On each river arm:
   (a) $[\![$two sausages$_j]\!]$: Load two sausages onto a boat and launch it under the "j" flag.
   (b) $[\![$each$]\!]$: Launch a sentinel with sealed instructions that say: "Check that the boats you see sailing under the j flag don't all carry the same sausages."
   (c) $[\![$bought$]\!]$: A sentinel checks if the boy on the i boat bought the sausages on the j boat.
4. Then we leave the scope of [dist], and the river arms join back into a big river.
5. A postsupposition plug at the end of the river / sentence stops the wandering sentinels.
6. They unseal their instructions and carry them out by checking that the boats sailing under the j flag don't all carry the same two sausages.
7. This will be true, for example, if sausage pairs were loaded at the different river arms (if every boy bought a different pair of sausages).

3.2 Analysis of **Alex bought two sausages each*

- $[\![$Alex$_i]\!]$: Launch a boat under the "i" flag and place Alex on it.
- $[\![$two sausages$_j]\!]$: Load two sausages onto a boat and launch it under the "j" flag.
- $[\![$each$]\!]$: Launch a sentinel with sealed instructions that say: "Check that the boats you see sailing under the j flag don't all carry the same sausages."
- $[\![$bought$]\!]$: A sentinel checks if Alex on the i boat bought the sausages on the j boat.
- A postsupposition plug at the end of the river / sentence stops the wandering sentinel. It unseals its instructions and follows them by checking that the boats sailing under the j flag don't all carry the same sausages.
- There is only one such boat, so the sentinel reports failure.
- Since there is no way to avoid this fate, the sentence is predicted deviant.

4 Formalization

See the Appendix.

5 Novel prediction

- On the view presented here, some DD items do not introduce their own distributive force but are licensed in the scope of a distributive quantifier.
- This predicts that a kind of "distributive concord" should be possible.
- This prediction is borne out, as shown in these examples. Both of them mean 'For every boy x, there are three books and three girls such that x gave them to them'.

(10)

Jeder	Junge	hat	jeweils	drei	Mädchen	jeweils	drei	Bücher
Every-Nom	boy	has	**each**	three	girl	**each**	three	books

gegeben. *(German)*
given.

(11)

Subete-no	danshi-ga	joshi-ni	san-nin-**zutsu**	hon-o	san-satsu-**zutsu**
Every-Gen	boy-Nom	girl-Dat	three-CL-**each**	book-Acc	three-CL-**each**

ageta. *(Japanese)*
gave

6 Conclusion

- In many languages, and for some speakers of English, it is not DD items themselves that contribute distributivity, but the universal quantifiers in whose scope they occur.
- This makes them more similar to dependent indefinites than to universal or distributive quantifiers.

Appendix: Formalization in PCDRT

- A context $G[\zeta]$ consists of a set of assignments G and a set ζ of postsuppositions.
- The operator $\downarrow(\phi)$ applies postsuppositions of ϕ to its output context.
- To send a context I through $\downarrow(\phi)$:
  1. send it through ϕ,
  2. call the resulting output context O,
  3. collect any postsuppositions that ϕ may have generated on the way,
  4. test whether they are all true in the output context O,
  5. and then forget about them.

(12) $[\![\downarrow(\phi)]\!]^{\langle I[\zeta],O[\zeta']\rangle}$ iff $\zeta'=\emptyset$ and there is a ζ'' s.t. $[\![\phi]\!]^{\langle I[\zeta],O[\zeta'']\rangle}$ and $[\![\bigwedge\zeta'']\!]^{\langle O[\emptyset],O[\emptyset]\rangle}$

- To check if ϕ is true, check if every input context $I[\emptyset]$ can be sent through $\downarrow(\phi)$.

(13) ϕ is true iff for all contexts $G[\emptyset]$ there is an $H[\emptyset]$ s.t. $[\![\downarrow(\phi)]\!]^{\langle G[\emptyset], H[\emptyset]\rangle}$ is true.

- PCDRT provides us with the notion of local/global evaluation cardinality.
- An indefinite's local evaluation cardinality correlates with the number feature of pronouns it can bind in its immediate vicinity.
  - **Example**: In *Every man loves [a woman]$_i$*, the local EC of the indefinite is 1 (*... and longs for her$_i$*).
- An indefinite's global evaluation cardinality correlates with the number feature of pronouns it can bind in unembedded contexts, such as in subsequent sentences.
  - **Example:** In *Every man loves [a woman]$_i$*, the global evaluation cardinality of the indefinite can be either 1 (*... She$_i$ is Brigitte Bardot*) or greater than 1 (*... They$_i$ are cute*), depending on whether the indefinite covaries.
- A plain indefinite like *a woman* does not care about its global evaluation cardinality.
- I propose that adnominal DD items force their hosts (e.g. *two sausages each*) to covary by requiring their global evaluation cardinality to be greater than 1.
- These numerals can satisfy this requirement only in the semantic scope of a non-vacuous distributivity operator, such as the one supplied by a universal quantifier.
- I propose that *n sausages each* is an instruction to do the following steps:
  1. look for a sum of n sausages in the model;
  2. store it under a fresh variable, say y, in each assignment of its input context;
  3. immediately test that $EC(y) = 1$ (EC stands for evaluation cardinality);
  4. attach a postsupposition that $EC(y) > 1$ to its output context.
- *Two sausages each* translates as follows (postsuppositions are superscripts):

(14) $[y] \wedge {}^{*}\text{SAUSAGE}(y) \wedge |y| = 2 \wedge EC(y) = 1 \wedge {}^{EC(y)>1}$

(15) a. $[\![|x| > n]\!]^{G[\zeta],H[\zeta']}$ iff $G = H \wedge \zeta = \zeta' \wedge \forall g[g \in G \rightarrow |\mathbf{atoms}(g(x))| > n]$
b. $[\![EC(x) > n]\!]^{G[\zeta],H[\zeta']}$ iff $G = H \wedge \zeta = \zeta' \wedge |\{g(x) : g \in G\}| > n$

- If we evaluate $[\![(14)]\!]$ in an input context $G[\zeta]$ and an output context $H[\zeta']$ we get the following. Here, $G[y]H$ is PCDRT variable assignment, i.e. each $g \in G$ differs from some $h \in H$ at most in the value of y and vice versa.

(16) $G[y]H \wedge \forall g \in G[{}^{*}\text{SAUS}(g(y)) \wedge |\mathbf{atoms}(g(y))| = 2] \wedge \zeta \cup \{EC(y) > 1\} = \zeta'$

- To avoid deviance, the $EC(y) = 1$ test must be interpreted in the local context, the $EC(y) > 1$ postsupposition in the global context, and these contexts must differ.
- The δ operator from Henderson in press does this by splitting up its input context into singleton sets (the local contexts, from the DD item's perspective), applying the material in its scope to each of them, collecting the outputs back together into a global context and then applying postsuppositions passed up from its scope (17).

(17) $[\![\delta(\phi)]\!]^{G[\zeta],H[\zeta']}$ iff $\zeta = \zeta'$, and there exists a partial function $\mathcal{F}$ such that $G = \mathbf{Dom}(\mathcal{F})$ and $H = \bigcup \mathbf{Ran}(\mathcal{F})$, and there is a set of tests ζ'' such that for all $g \in G$, both $[\![\phi]\!]^{\langle \{g\}[\zeta], \mathcal{F}(g)[\zeta \cup \zeta'']\rangle}$ and $[\![\bigwedge \zeta'']\!]^{\langle H[\zeta], H[\zeta]\rangle}$ are true.

- I assume that a distributive quantifier like *every boy* introduces the sum of all boys as a variable and then distributes over them (18).

(18) every boy $\phi \rightsquigarrow [\![\max^x(\textsc{boy}(x) \wedge \delta(\phi))]\!]^{G[\zeta],H[\zeta']}$

- The effect of this is that the test $EC(y) = 1$ is applied within the scope of the distributor and the postsupposition $EC(y) > 1$ outside of its scope, as in (19).
- When there is no distributor to create a local context separate from the global one, $EC(y) = 1$ and $EC(y) > 1$ are applied in the same context, as in (20).

(19) Every boy bought two sausages each. $\rightsquigarrow \max^x(\textsc{boy}(x) \wedge \delta([y] \wedge {}^*\textsc{sausage}(y) \wedge |y| = 2 \wedge \textsc{buy}(x, y) \wedge EC(y) = 1) \ \wedge \ EC(y) > 1)$

(20) *Alex bought two sausages each. $\rightsquigarrow \textsc{boy}(\textsc{Alex}) \wedge [y] \wedge {}^*\textsc{sausage}(y) \wedge |y| = 2 \wedge \textsc{buy}(\textsc{Alex}, y) \wedge EC(y) = 1 \wedge EC(y) > 1$

- The two requirements can't be met in the same context, so (20) will always fail.

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