Cumulative readings of *each*

Guillaume Thomas
University of Toronto

Yasutada Sudo
University College London

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Overview

- *Each* is often assumed to have distributive readings and lack collective readings and **cumulative readings**.

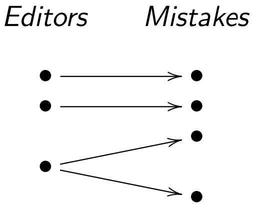
- We present evidence that cumulative readings with *each* are attested but modulated by Tunstall's (1998) **Differentiation Condition**.

Cumulative Readings and Differentiation Condition

Cumulative Readings

Plural noun phrases give rise to cumulative (alt.: co-distributive) readings.

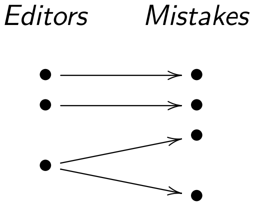
(1) Three copy editors caught { a. **the** / b. **five** / c. **all the** } mistakes in the manuscript.



Cumulative readings of *every* vs. *each*

In the same situation (2a) is true, (2b) is false.

(2) Three copy editors caught { a. **every** / b. **each** } mistake in the manuscript.



- This suggests that *every* has a cumulative reading, *each* does not.
- We raise data suggesting that *each* can have cumulative readings, but only when the **Differentiation Condition** is met.

Differentiation Condition

Tunstall (1998) proposes that *each* is subject to the **Differentiation Condition**:

Differentiation Condition (DC)

A sentence containing *each NP* can only be true of event structures where each individual in the restrictor of *each NP* is associated with a subevent that can be differentiated from the other subevents in some way.

In addition, we assume that the preferred way to differentiate the subevents is to have a one-to-one correspondence with the bearers of an overtly realized thematic-role distinct from that of each NP (a **co-participant**) (cf. Brasoveanu & Dotlačil 2015).

Suboptimal Ways of Satisfying DC

When there is no quantificational co-participant, every individual in the restriction of *each* is associated to an event with a different location/time.

(3) Take { a. **each** / b. **every** } one of these apples.

(3a) suggests you should take the apples one by one (cf. 3b).

> *[Each] directs one's attention to the individuals as they appear, in some succession or other, one by one* (Vendler 1962)

Wide Scope Preference

DC accounts for the tendency for *each* to take wide scope (Ioup 1975, Brasoveanu & Dotlačil 2015)

(4) She knows a solution to { a. **each** problem / b. **every** problem / c. **all** problems }.

	$\forall > \exists$	$\exists > \forall$
a. **each** problem	ok	?
b. **every** problem	ok	ok
c. **all** problems	??	ok

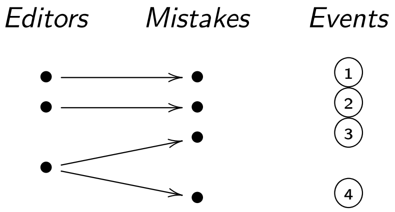
The preferred reading of (4a) is the one that satisfies DC with respect to the co-participant *a solution*, i.e. the $\forall > \exists$ reading.

DC and Cumulative Reading of *Each*

DC predicts that the preferred reading of (2b) is one where *each* takes distributive scope over the co-participant *three copy editors*.

(2b) Three copy editors caught **each** mistake in the manuscript.

Under the cumulative reading, the co-participant won't be in a one-to-one relation.

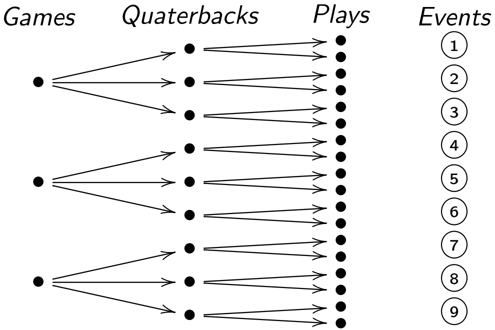


③ and ④ are not well-differentiated!

Prediction 1

What if there's another co-participant that *each* can distribute over?

(5) Three video games taught **each** quarterback **two new plays**.



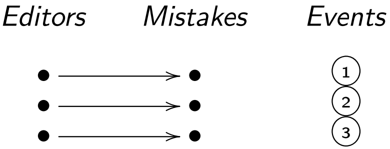
We expect there to be a cumulative reading between *three* and *each* here.

This will be tested in Experiment 1

Prediction 2

Cumulative reading of (2b) should become available in a one-to-one situation:

(2b) Three copy editors caught **each** mistake in the manuscript.



This will be tested in Experiment 2

Experiments

Experiment 1: Design

- Task: rate how well a sentence describes a picture
- Scale: **1** (worst) to **4** (best)
- Pictures only make the cumulative readings of the sentences true
- 78 subjects, MTurk filtered by IP (Canada, UK, USA)
- 6 target items per subject, 12 fillers.

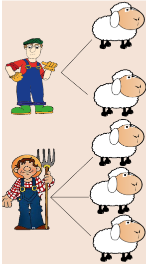
Valency: Transitive (one co-part) vs. Ditransitive (two co-parts)
Quantifier: *each* vs. *every* vs. numeral

- Numerals are a baseline. They should give rise to cumulative readings.
- Valency should only affect *each*.

Experiment 1: Design (cont.)

Transitive

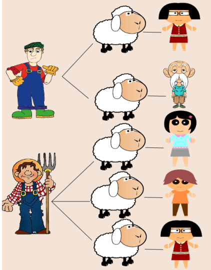
Two farmers sold { a. each / b. every / c. five } sheep.



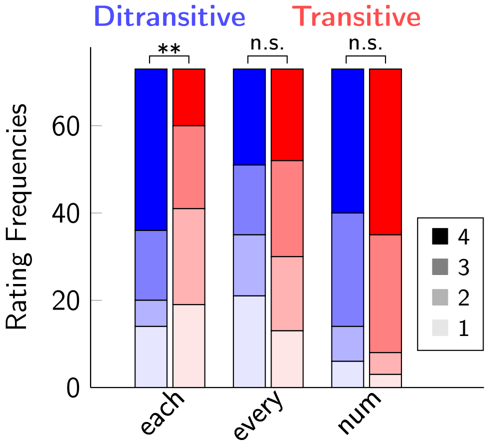
Di-transitive

Two farmers sold { a. each / b. every / c. five } sheep

to { a. one / b. one / c. five } customer(s).



Experiment 1: Results



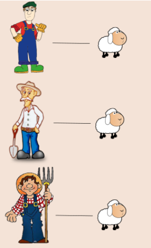
- The cumulative reading of *each* is more easily available in Ditransitive than in Transitive.
- *Every* and numerals are not affected by Valency.

⇒ Cumulative readings of *each* exist.
⇒ They are facilitated when DC can be satisfied with a third co-participants.

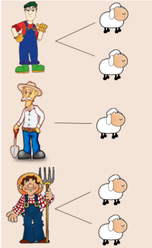
Experiment 2: Design

- Same task, target 4 items, 8 fillers, 50 subjects.
- Only transitive sentences.
- **Quantifier × Situation Type**

(6) Three farmers sold { a. each / b. every } sheep.

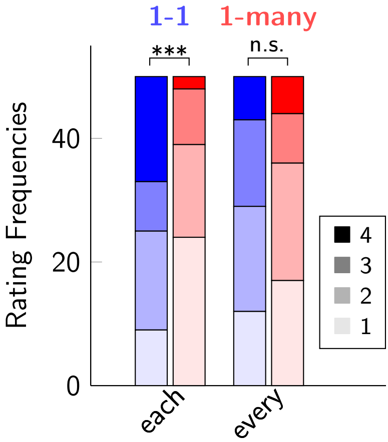


ONE-TO-ONE



ONE-TO-MANY

Experiment 2: Results



- The cumulative reading of *each* is more readily available in one-to-one situations than in one-to-many situations.
- Situation type has no effects on *every*.

⇒ Cumulative readings of *Each* are judged better when DC is satisfied.

Discussion

Summary

- *Each* can have cumulative readings.

- Their availability is restricted by the **Differentiation Condition**: "I want something to be dependent on me!"

  Cf. dependent indefinites (Farkas 1997, Henderson 2014, etc., the talks from yesterday): "I want to be dependent on something!"

- Preference for individuating event by one-to-one mapping between restrictor of *each NP* and restrictor of quantifiers, whenever applicable.

How to Derive Cumulative Readings of *Each*

Schein (1998) and Kratzer (2000) on cumulative readings of *every*:

- New-Davidsonian event semantics
- $\exists$-quantifier over subevents

We can account for cumulative readings of *each* analogously (See Appendix).

What is DC?

It is clear that DC is not a presupposition, e.g. it does not project.

(7) a. Does she know a solution to each of the problems?
b. If she knows a solution to each of the problems, I'll ask her.

Rather, DC is part of the assertion.

We could formulate DC in several different ways, e.g. as a **postsupposition** in the sense of Henderson (2014, yesterday) (see also Brasoveanu 2012, Constant 2012). See Appendix.

Every vs. *each*: Towards the Typology of ∀

Differentiation Condition (DC)

A sentence containing *each NP* can only be true of event structures where each individual in the restrictor of *each NP* is associated with a subevent that can be differentiated from **all the other subevents** in some way.

Tunstall (1998): *Every* is subject to a weaker condition:

Diversity Condition

A sentence containing *every NP* can only be true of event structures where each individual in the restrictor of *every NP* is associated with a subevent that can be differentiated from **at least one other subevent** in some way.

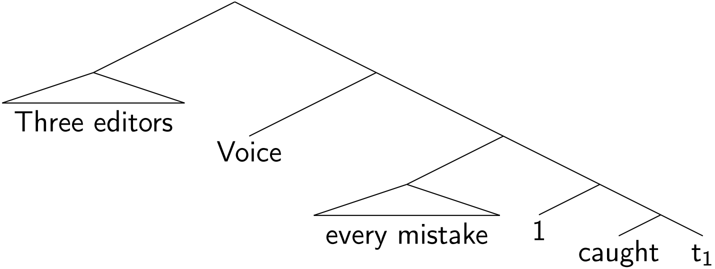
Future research: What about other universal quantifiers?: *All*, *chaque*, *tout*, etc.

Appendix 1: Deriving Cumulative Readings

Schein and Kratzer on Every

(8) Three copy editors caught every mistake in the manuscript.

$$[\![\text{every}]\!] = \lambda P.\lambda R.\lambda e.\left[\begin{array}{l}\forall x[P(x) \rightarrow \exists e'[e' \subseteq e \wedge R(e', x)]] \wedge \\ \exists y[P(y) \wedge R(e, y)]\end{array}\right]$$



1. $\exists$ sum event E whose agent is the sum of three editors.
2. $\forall$ mistake, $\exists e \sqsubseteq E$ in which that mistake is caught.
3. E is an event in which only mistakes are caught.

Extension to *Each*

Essential elements of this analysis:

1. Every introduces an existential quantifier of parts of events in its propositional scope.
2. The agent argument takes scope independently from the verb.

Applying this to *each*:

- Thematic separation of the agent argument is independent from the analysis of *every* vs. *each*.
- Their analysis of *every* is distributive and as such can be applied to *each*.
- We only need to assume that *each* has an event argument like *every*.

$$[\![\,\text{each}\,]\!] = [\![\,\text{every}\,]\!] = \lambda P.\lambda R.\lambda e. \begin{bmatrix} \forall x[P(x) \to \exists e'[e' \subseteq e \wedge R(e', x)]] \wedge \\ \exists y[P(y) \wedge R(e, y)] \end{bmatrix}$$

Appendix 2: DC as Postsupposition

Postsupposition

Postsuppositions are inferences that must be satisfied after the at-issue content has been processed.
Henderson (2014, yesterday) on postsuppositions (see also Brasoveanu 2012).

- Indexed information states G_ζ: G is a set of assignments and ζ is a set of *tests*, i.e. formulae that do not introduce new variables or postsuppositions.
- Postsuppositions are indicated by an overline:

$$G_\zeta [\![\overline{\phi}]\!] G'_{\zeta'} :\Leftrightarrow \phi \text{ is a test, } G = G' \text{ and } \zeta' = \zeta \cup \{ \phi \}$$

- Postsuppositions receive maximal scope:

$$\phi \text{ is true wrt } G_\zeta \text{ iff } \exists G'_{\zeta'} [G_\zeta [\![\phi]\!] G'_{\zeta'} \text{ and } G'_\emptyset [\![\bigwedge_{\psi \in \zeta'} \psi]\!] G'_\emptyset]$$

Postsuppositions (cont.)

$$\begin{array}{rcl}
G_\zeta [\![R(x_1,\ldots,x_n)]\!] G'_{\zeta'} & :\Leftrightarrow & G = G' \text{ and } \zeta = \zeta' \\
 & & \text{ and } \forall g \in G, \langle g(x_1),\ldots,g(x_n)\rangle \in \mathcal{I}(R) \\
G_\zeta [\![\phi \wedge \psi]\!] G'_{\zeta'} & :\Leftrightarrow & \exists G''_{\zeta''}[G_\zeta [\![\phi]\!] G''_{\zeta''} [\![\psi]\!] G'_{\zeta'}] \\
G_\zeta [\![\exists x]\!] G'_{\zeta'} & :\Leftrightarrow & G[x]G' \text{ and } \zeta = \zeta' \\
G_\zeta [\![\max^x(\phi)]\!] G'_{\zeta'} & :\Leftrightarrow & G_\zeta [\![\exists x \wedge \phi]\!] G'_{\zeta'} \text{ and} \\
 & & \neg\exists G''_{\zeta''}[G'(x) \subset G''(x) \text{ and } G_\zeta [\![\exists x \wedge \phi]\!] G''_{\zeta''}] \\
G_\zeta [\![\textbf{1-to-1}(x,y)]\!] G'_{\zeta'} & :\Leftrightarrow & G = G' \text{ and } \zeta = \zeta' \text{ and } \neg\exists g_1, g_2 \in G[\\
 & & [g_1(x) \neq g_2(x)] \rightarrow [g_1(y) \sqcap g_2(y) = \emptyset]]
\end{array}$$

'$each_y^{x,x'}\ \phi\ \psi$' translates into:

$$[\max^x(\phi) \wedge \max^{x'}(\psi) \wedge x = x' \wedge \overline{\mathcal{R}(x,y) \wedge \textbf{1-to-1}(x,y)}]$$

The postsupposition requires:

- x and y to stand in a particular relation $\mathcal{R}$ (e.g. being co-participants in some ψ-event);
- x and y to stand in a one-to-one relation.

Appendix 3: items and fillers

Experiment 1

(1) Items:

a. Two farmers sold {every|each}/five sheep (to one/five customer(s)).
b. Three cooks made {every|each}/five pie(s) (with four/twenty apples).
c. Two witches cooked {every|each}/four chicken (in one/four cauldron(s)).
d. Five teachers read {every|each}/eight book(s) (to one/eight child(ren)).
e. Three kids hit {every|each}/three target(s) (with two/six darts).
f. Two pirates found {every|each}/three treasure map(s) (inside one/three barrel(s)).

(2) Fillers:

a. Two policemen are following one thief.
b. Two gardeners planted three flowers.
c. Three dogs are chasing two cats.
d. Two pirates stole three treasure chests.
e. Two lions are hunting two sheep.
f. Two old men are feeding four pigeons.
g. Two rockstars kissed three groupies.
h. Two old men are feeding ten pigeons.
i. Three burglars broke into five houses.
j. Four children kicked eight balls.
k. Two eagles caught four sheep.
l. Two policemen are following three thieves.

Experiment 2

(3) Items:

a. Three farmers sold {every|each} sheep.
b. Three cooks made {every|each} pie.
c. Five teachers read {every|each} book.
d. Three kids hit {every|each} target.

(4) Fillers:

a. Two gardeners planted three flowers.
b. Three dogs are chasing two cats.
c. Two pirates stole three treasure chests.
d. Two lions are hunting two sheep.
e. One rock star kissed three girls.
f. Two old men are feeding ten pigeons.
g. Four children kicked eight balls.
h. Two eagles caught four sheep.