Collective quantification and the homogeneity constraint

Carmen Dobrovie-Sorin, SALT, May 30, 2014

Overview

Goal: solution to Dowty's 1986 puzzle illustrated in (1) based on the idea that (1a) vs (1b) is parallel to (2)a vs (2)b:

(1) a. All the/most of the students are meeting in the hall.
 b. *All the/most of the students are a good team.

(2) a. All the/most of the water is liquid/dirty.
 b. *All the/most of the water is heavy/weighs one ton.

Basic Assumption: a revised version of the Roeper 1983-Lønning 1987-Higginbotham 1994 analysis of mass Qs holds for **collective Qs:**

Collective Qs denote relations between partitioned groups ($Q_{<}e, e>$).

The main steps of the demonstration

(i) The **Homogeneity Constraint (HC) on Mass Qs** is **too strong** for collective Qs (and mass Qs) built with particular-referring restrictors => **weakening**

(ii) **The Divisiveness Constraint (DivC):**
The predicate in the nuclear scope of a Q<e,e> must be divisive.

(iii) **DivC itself is too strong (see *form a circle, form a mafia*) =>**

Conclusion: The predicate in the nuclear scope of a Q<e,e> must be partitive.

The HC on Mass Quantifiers

Mass Quantifiers as relations between entities $Q_{<e,e>}$

(Roeper 1983, Lønning 1987, Higginbotham 1994)

(3) Most water is liquid.

(4) $MOST_{mass}(\sum x.water(x), \sum x.liquid(x))$

Revising Higginbotham's analysis (Dobrovie-Sorin 2013):
(5) a. No nominalizing operator applies to the restrictor of mass Qs. An entity-denoting restrictor must be supplied by the syntax itself.
 b. The nominalizing operator that applies to the nuclear scope is the intensional Iota defined as a maximalizing operator (Link 1983, Sharvy 1980)

(6) $[[intensionalIota]] = \lambda P_{<e,<s,t>>}.\lambda s.\iota X[P(X)(s)]$

(7) is true iff the condition in (8) is satisfied:

(7) Most of this milk is sour.

(8) $\mu([[thismilk]] \cap \iota X.sour(X)) > \mu([[thismilk]] - ([[thismilk]] \cap \iota X.sour(X)))$
the measure μ of the meet $\cap$ of [[this milk]] and [the maximal sum of the sour parts in the domain, 'all that is sour'] is bigger than the relative complement of that product wrt to [[this milk]].

The Homogeneity Constraint

(9) **The predicate in the nuclear scope of a mass Q must be homogeneous.**
(Bunt 1979, 1985, Lønning 1987, Higginbotham 1994)
- *liquid*, *dirty*, *yellow* are [+homog] => (2)a *All/most water is liquid/dirty*
- *heavy*, *tall*, *cover a large space* are [-homog] => (2)b *All /most water is heavy

(10) **Homogeneity** (Higginbotham 1994:453)
 a. A predicate is homogeneous iff it is both cumulative and divisive.
 b. A predicate is cumulative iff it applies to the sum of two things whenever it applies to each (P is cumulative iff P(x) and P(y) implies P(x + y))
 c. A predicate is divisive iff it applies to the parts of the things to which it applies (P is divisive iff P(x) and y $\leq$ x implies P(y) provided $y \neq 0$)

(11) Minimal parts Problem (Quine 1960):
'[. . .] there are parts of water, sugar, and furniture too small to count as water, sugar, furniture'.

$\rightarrow$ **Weak Divisiveness**

(12) P is weakly divisive iff
$\forall x[P(x) \rightarrow \exists y[P(y) \& y < x] \& \forall x, y[P(x) \& P(y) \& y < x \rightarrow P(x - y)]]$
For all x with property P there is a proper part y of x which also has P, and for all x and y with P if y is a proper part of x then the subtraction of y from x also has P.

See also Champollion's (2010) *Stratified Reference*, a parametrized version of Weak Divisiveness.

Inference Patterns for Cumulative and Divisive Predicates (Lønning 1987)

(13) The white gold disappeared. **Cumulativity**
The non-white gold disappeared.
●● The gold disappeared

(14) The gold disappeared. **Divisiveness**
There was some white gold
●● The white gold disappeared

Explaining the HC (= Higginbotham's explanation *modulo* intensional Iota instead of Sigma)

(15) a. **Homogeneous predicates (*yellow*) denote join semi-lattices;** such predicates have a maximal element=> **The intensional Iota can apply** => the computation of **ALL/MOST can go through.**
 b. **Non-homogeneous (*heavy*) predicates denote sets of *unordered* objects;** such predicates do not have a maximal element => **The intensional Iota cannot apply => the computation of ALL/MOST cannot go through**.

From the HC to the Divisiveness Constraint

(16) **Collective Qs denote relations between partitioned groups** ($Q_{<}e, e>$)

Two classes of collective predicates (Dobrovie-Sorin 2012)
See also Winter (2001) and Hackl (2002).

(17) a. Non-homogeneous collective predicates denote sets of groups (no inherent ordering relation).
 Ex: *mafia, team, committee, numerous, elect*
 b. Homogeneous collective predicates denote join semi-lattices (sets of groups ordered by the part-of relation).
 Ex: *meet, gather, etc.*

(18) **Homogeneity Constraint on Collective Qs** (will prove too strong)
The predicate in the nuclear scope of a collective Q must be homogeneous.

(19) a. Most of the students met yesterday.
 b. *Most of the students are a mafia/numerous.

(20)
$\mu[[thestudents]] \cap \iota X.met(X)) > \mu([[thestudents]] - ([[thestudents]] \cap \iota X.met(X)))$

(21) Intensional Iota cannot apply to [-homog] P. (*mafia, numerous*) => *(19)b.

(22) **Problem:**
Some [-homog] Ps may appear in the nuclear scope of collective Qs.
Ex: love each other, be friends, be neighbours, be similar

Inference patterns

(23) The French students are friends with each other. **Cumulativity**
The non-French students are friends with each other.
The students are friends with each other.

(24) The students are friends with each other. **Divisiveness**
There are some French students among the students.
●● The French students are friends with each other.

On a closer look, even *gather* and *meet* turn out to be non-cumulative, hence non-homogeneous.

(25) (Most, maybe all) **Collective predicate are [-cum]**.
 a. **[-cum, +div]** : *friends, meet, work together*
 b. **[-cum, -div]** : *mafia, elect, heavy, be denser in the middle of...*
 (Dobrovie-Sorin 2012)

The HC seems too strong even for mass Qs:

(26) Most of the sand was pushed in a corner by the wind.

=> The HC must be weakened

The Divisiveness Constraint on $Q_{<}e, e>$
(27) **The predicate in the nuclear scope of a collective Q must be divisive.**

(28) **Problem:**
 (i) The intensional Iota can only apply to homogeneous (+cum, +div) predicates.
 (ii) **Q: How come** $Q_{<}e, e>$ **can take [-cum] predicates in the nuclear scope?**

(29) Most of my students are friends with each other.

(30) $\mu([[mystudents]] \cap \iota X.friends(X)) >$
$\mu([[mystudents]] - [[mystudents]] \cap \iota X.friends(X))$

A: The computation of a contextually restricted $Q_{<}e, e>$ **does not rely on the intensional Iota.**
Q: How come the computation of $Q_{<}e, e>$**, e.g., (30), can go through without the intensional Iota?**

(31) The computation of a $Q_{<}e, e>$ **built with a particular-referring** (as opposed to kind-referring) **restrictor** involves an **extensional Iota**: $[[Iota]] = \lambda P_{<e,t>}.\iota x P(x)$

Extensional Iota applies to a singleton set of groups and yields the unique maximal group it contains, e.g., the maximal group of friends in a given world/situation.

Q: Why is it that $Q_{<}e, e>$ **must take divisive predicates in the nuclear scope?**

(32) a. The computation of $Q_{<}e, e>$ depends on applying Meet to two entities (see (30))
 b. Meet can apply to two entities only if they can be represented as sums of parts of entities.
 c. The divisiveness of P allows $\iota X.P(X)$ to be written as the sum of the cells of a partition (non-overlapping cover) such that each cell satisfies P.

(33) $\iota X.friends(X) = \sum Y(Y \in R_{\iota X.friends(X)}) \cap friends(Y))$
$R_{\iota X.friends(X)}$ = partition of $\iota X.friends(X)$

(34) R_o is a partition of an object o if R_o is a set of parts {j, k . . . n} such that
 a. $\cup\{j, k...n\} = o$ exhaustivity
 b. $\forall j, k \in R_o \rightarrow j \cap k = \emptyset$ if $j \neq k$ non-overlap

Partitive Predicates

Problem: *Form a circle* is [-div], and yet it allows *most/all*.

(35) Most of my students formed a circle.

Non-divisive Ps are also allowed with mass DPs in the restrictor:

(36) ?Most of the water formed a square.

(37) a. [-div, -part(itive)] : *elect, numerous, be a mafia*
 b. [-div, +part(itive)] : *form a circle, form a mafia*

(38) **Divisiveness (and cumulativity) characterizes the structure of the denotation of P**

(39) **Partitivity characterizes the way in which P applies to its argument.**
 a. $P_{[+part]}$ may apply to part of the entity denoted by their DP argument.
 b. $P_{[-part]}$ can only apply to the overall entity denoted by their DP argument.

- $P_{[-part]}$ presuppose that no part of their argument might satisfy $P_{[-part]}$: *elect, numerous, be a mafia*
- This presupposition is incompatible with the semantics of *most/all* ($Q_{<}e, e>$)

(40) **The predicate in the nuclear scope of a Q<e,e> must be [+part] P.**

[+part, +div] P in the nuclear scope

(41) $[[most(of)the\,NP]]$:
$\lambda P_{div}.\mu(\iota X.NP(X) \cap \sum Y.Y \in R_{\iota Z.P[+div](Z)} \,\&\, P_{div}(Y)) > \frac{1}{2}\mu(\iota X.NP(X))$

Nuclear scope: $\iota Z.P_{div}(Z) = \sum Y.Y \in R_{\iota Z.P[+div](Z)} \,\&\, P_{div}(Y)$
The sum of parts Y of $\iota Z.P_{div}(Z)$ that satisfy P_{div}

=> The computation involves the meet of two sums.
=> The restrictor comprises several (disconnected) parts that are also parts of $\iota Z.P_{div}(Z)$

[+part, -div] P in the nuclear scope

(42) $[[most(of)theNP]] : \lambda P_{-div}.\mu(\iota X.NP(X) \cap \iota Z.P_{-div}(Z)) > \frac{1}{2}\mu(\iota X.NP(X))$

Nuclear scope: $\iota Z.P_{-div}(Z)$ cannot be represented as the sum of its parts that satisfy P_{-div}.
=> The computation involves the meet of a sum (restrictor) and a non-partitionable group (scope).
=> The restrictor comprises one part that is identical to the group supplied by the nuclear scope and the complement of that part wrt the entity denoted by the restrictor.

The difference between (41) and (42) explains the difference in interpretation:

(43) a. Most of my students gathered in the hall. (other people may have gathered in the hall)
 b. Most of my students formed a circle. (no other people formed that particular circle)

Brief Comparison with other Accounts

Matthewson 2001, Hackl 2002, 2009, Crnic 2009: *most/all* are of type $< e < e, t >>$

(44) a. $[[most(of)DP]] : \lambda P.\exists X.X \leq [[DP]] \,\&\, P(X) \,\&\, \mu(X) > \mu([[DP]] - X)$
 b. $[[all(of)DP]] : \lambda P.\exists X.X \leq [[DP]] \,\&\, P(X) \,\&\, \mu(X) = \mu[[DP]]$

This analysis (designed for distributive Qs) cannot explain the constraint on the nuclear scope of collective (and mass) Qs.

Under the Roeper-Lonning-Higginbotham type of analysis adopted here (*most/all* Qs are of type $< e, e >$), the constraint on the nuclear scope follows from the fact that the computation relies on the meet of two entities.

Conclusions

(45) **Basic assumption:** Mass and collective Qs denote relations between entities ($Q_{<}e, e>$)

(46) **New result:** Collective (as well as mass) Qs built with a particular-referring restrictor (as opposed to a kind-referring restrictor) **must take a** P_{part} **in the nuclear scope** (the Homogeneity Constraint, as well as Divisiveness Constraint, are too strong).

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Laboratoire de linguistique formelle