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One *many*, many readings

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1. INTRODUCTION

1.1 Three readings of *many*

- The quantifier *many* gives rise to three distinct readings (Partee 1989, Westerståhl 1985):

CARDINAL READING

(1) a. Tom has many toys.
b. 'The number of toys Tom has is large.'

PROPORTIONAL READING

(2) a. John read many (of the) books on the reading list.
b. 'John read a high proportion of the books on the reading list.'

REVERSE PROPORTIONAL READING (Westerståhl 1985)

(3) a. Many Scandinavians have won the Nobel Prize in literature.
b. 'A high proportion of the Nobel Prize winners in literature are Scandinavians.'

(4) Scenario (1984):
Of a total of 81 Nobel Prize winners in literature, 14 come from Scandinavia.

- This is modelled by employing three different lexical entries for *many* as determiner in the framework of Generalised Quantifier Theory:

(5) a. $[\![\text{many}_{\text{card}}]\!] = \lambda P.\lambda Q. \mid P \cap Q \mid > n$, where n is a large number
b. alternatively: *many* as a cardinality predicate (Partee 1989):
$[\![\text{many}_{\text{cardP}}]\!] = \lambda x. \mid x \mid > n$, where n is a large number

(6) $[\![\text{many}_{\text{prop}}]\!] = \lambda P.\lambda Q. \mid P \cap Q \mid : \mid P \mid > k$, where k is a large fraction

(7) $[\![\text{many}_{\text{re-prop}}]\!] = \lambda P.\lambda Q. \mid P \cap Q \mid : \mid Q \mid > k$, where k is a large fraction

- Notably, the reverse proportional reading seems to involve a non-conservative determiner (Westerståhl 1985), violating the Conservativity Universal (Barwise & Cooper 1981, Keenan & Stavi 1986), according to which determiners in natural languages are interpreted as conservative functions.

1.2 Goal of this paper

- Propose a uniform analysis that derives all three readings of *many* from a single lexical entry in a compositional manner.

- In particular, to elaborate the account of Romero (2015, 2016), which derives the reverse proportional reading while maintaining conservativity, but uses two lexical entries for *many* (cardinal determiner *many*, proportional determiner *many*).

- More generally, contribute to the growing body of work on quantifier decomposition.

1.3 Idea in a nutshell

- In a degree semantics account, *many* is decomposed into a gradable cardinality predicate and the positive operator POS.

- The different readings result from different scope of POS (cardinal vs. proportional readings) and (free) association with focus (regular vs. reverse readings).

2. INGREDIENTS OF THE ANALYSIS

2.1. *many*

- *many* as a gradable cardinality predicate (Schwarz (2006) and Hackl (2009) among many others):[1]

(8) $[\![\text{many}]\!] = \lambda d.\lambda x. |x| \geq d$, where $|x|$ is the cardinality of $\{y: \text{atom}(y) \ \& \ y \leq x\}$

- Quantificational force comes from a phonologically null existential determiner ∅.

[1] (8) is a version of the cardinality predicate view form (5b) above that makes the analogy to gradable adjectives transparent. Alternatively, the cardinality measure function can also be taken to be separate and not lexically contained in *many* (Solt 2009).

- Just as gradable adjectives, *many* combines with a range of degree operators like the comparative and superlative (Bresnan 1973; Hackl 2000, 2009), and the positive operator POS.

(9) a. /many/ = many + POS
b. /more/ = many + -er
c. /most/ = many + -est

2.2. Scope of degree operators and association with focus

- Superlatives are ambiguous between absolute and relative readings

(10) John climbed the highest mountain.
a. 'John climbed a mountain higher than any other (relevant) mountain' ABSOLUTE
b. 'John climbed a higher mountain than any other (relevant) individual' RELATIVE

(11) Analysis of superlatives (Heim 1999):
(i) the superlative operator *-est* is restricted by a covert variable C providing a comparison class, which is resolved contextually
(ii) the effects of focus are factored in when C is resolved (free association with focus in Beaver & Clark's 2008 terms)
(iii) *-est* can take local (DP-internal) or non-local scope (DP-external),
(iv) the material in the scope of *-est* determines the relation relative to which the members of C are compared.
(v) Lexical entry for-*est*:
- the comparison class C is a set of sets of degrees (type <<d,t,>t>)[2]
- the contribution of focus can be factored in in the usual way via the squiggle operator ~ (Rooth 1992).

(12) $[\![\text{-est C}]\!] = \lambda D_{<d,t>}. \exists d\, [D(d) \,\&\, \forall D' \in C\, [\, D' \neq D \rightarrow \neg D'(d)]$

- The lexical entry in (12) presupposes a monotone semantics of gradable adjectives, cf. (13).

(13) $[\![\text{ heigh}]\!] = \lambda d.\lambda x.\ \text{Height}(x) \geq d$

- The **absolute reading** results from DP-internal scope of *-est*. In this configuration, the heights of contextually relevant mountains are compared.

[2] In fact, C has to be a set of degree property intensions, i.e. of type <<s,<d,t>>,t>. I use the extensional version to keep things readable.

(14) Absolute reading:

a. LF: John climbed [$_{DP}$ the [2 [[-est C] [1 [t_2 t_1-high mountain]]]

b. climb(j, ιx [∃d [mountain(x) & Height(x) ≥ d &
∀D'∈ C [D'≠ [λd'. x is a d'-high mountain] → ¬ D'(d)]])

c. C = { λd'. Ben Nevis is a d'-high mountain,
λd'. Ben Macdhui is a d'-high mountain,
λd'. Braeriach is a d'-high mountain, ...}

- The **relative reading** obtains when *-est* takes non-local scope and focus is on the subject: this results in a comparison class C comparing contextually relevant individuals in terms of their mountain climbing achievements.

(15) Relative reading:

a. LF: [[-est C] [1 [John$_F$ climbed A t_1-high mountain]] ~C]

b. ∃d [∃x[climb(j,x) & mountain (x) & Height(x) ≥ d &
∀D'∈ C [D'≠ [λd'. John climbed a d'-high mountain] → ¬ D'(d)]]]

c. C = {λd'. John climbed a d'-high mountain,
λd'. Bill climbed a d'-high mountain,
λd'. Sam climbed a d'-high mountain,…}

2.3. The positive operator POS

- Building on Schwarz (2010), Romero (2015, 2016) argues that the properties (i)-(v) above do not only hold for the superlative operator, but also for the (phonologically null) positive operator POS.

(16) Analysis of adjectives in the positive:

(i) the positive operator POS is restricted by a covert variable C providing a comparison class, which is resolved contextually

(ii) the effects of focus are factored in when C is resolved (free association with focus in Beaver & Clark's 2008 terms)

(iii) POS can take local (DP-internal) or non-local scope (DP-external)

(iv) the material in the scope of POS determines the relation relative to which the members of C are compared.

(v) Lexical entry for POS:
- the comparison class C is a set of sets of degrees (type <<d,t>,t>)
- the contribution of focus can be factored in in the usual way via the squiggle operator (Rooth 1992)

- POS requires the degree property D serving as its first argument to hold to a degree exceeding a contextual standard θ, which is determined relative to the comparison class C taking into account the distribution of values in C.

(17) $[\![\text{POS C}]\!] = \lambda D_{<d,t>}. \exists d\, [D(d) \,\&\, d > \theta_C]$

- Adjectives in the positive give rise to an ambiguity between absolute and relative readings, too. In analogy to superlatives, this ambiguity is derived from DP-internal vs. DP-external scope of POS (Schwarz 2010, Romero 2015, 2016).

(18) Mia has an expensive hat.
a. 'Mia has a hat that is expensive for a hat' ABSOLUTE
b. 'Mia has a hat that is expensive for somebody like Mia (e.g. for a 3-year old) to have. RELATIVE

(19) Absolute reading – DP-internal scope of POS:
a. LF: Mia has [$_{DP}$ a [2 [POS C] [1 [t_2 t_1-expensive hat]]]
b. $\exists x$ [have(m,x) & $\exists d$ [hat(x) & Expensiveness(x) $\geq$ d & d > θ_C]]
c. C = { λd'. h_1 is a d'-expensive hat, λd'. h_2 is a d'-expensive hat, ...}

(20) Relative reading – DP-external scope of POS, focus on subject:
a. LF: [[POS C] [1 [Mia$_F$ has a t_1-expensive hat]] ~C]
b. $\exists d$ [$\exists x$ [have(m,x) & hat(x) & Expensiveness(x) $\geq$ d] & d > θ_C]
c. C = { λd'. Mia has a d'-expensive hat, λd'. Emma has a d'-expensive hat,
λd'. Hannah has a d'-expensive hat, ...}

- In relative readings, the focus associate of POS can be external the host NP (as in (20) above) or internal the host NP (as in (23) below) (Romero 2015, 2016).

(21) Scenario: Rockefeller just gave Kate a very expensive car. Still, his present compares poorly to his previous astronomically expensive presents (e.g., an apartment in Manhattan, an island in the Pacific, etc.)

(22) (For what he has been giving her, now) Rockefeller gave Kate an inexpensive car.
'Rockefeller gave Kate a car and this present is inexpensive compared to his other presents to her.'

(23) Relative reading – DP-external scope of POS, focus NP-internal:
a. LF: [[POS C] [1 [Rockefeller gave Kate a t_1-inexpensive car$_F$]] ~C]
b. $\exists d$ [$\exists x$ [give(r,k,x) & car(x) & Expensiveness(x) $\leq$ d] & d < θ_C]
c. C = { λd'. Rockefeller gave Kate a d'-inexpensive car,
λd'. Rockefeller gave Kate a d'-inexpensive apartment in Manhattan,
λd'. Rockefeller gave Kate a d'-inexpensive island in the Pacific, ...}

- With these ingredients, the different readings of *many* result from different scope of the positive morpheme POS and (free) association with focus.

3. ANALYSIS

3.1 Proportional reading

- The proportional reading arises if POS takes DP-internal scope.

- Following Hackl's (2009) analysis of the proportional reading of *most*, we assume that in this configuration the comparison class C consists of cardinalities of the pluralities denoted by the NP sister of *many*, e.g., in (24) pluralities of books are compared in terms of how many atomic parts they have.

(24) a. John read many books on the reading list.
b. LF: John read ∅ [2 [POS C] [1 [t_2 t_1-many books on the reading list]]
c. $\exists x[\text{read}(j,x) \,\&\, \exists d\, [|x| \geq d \,\&\, \text{books\_otrl}(x) \,\&\, d > \theta_C]]$
d. C = {λd'. x are d'-many books on the reading list: x is a plurality consisting of books on the reading list }

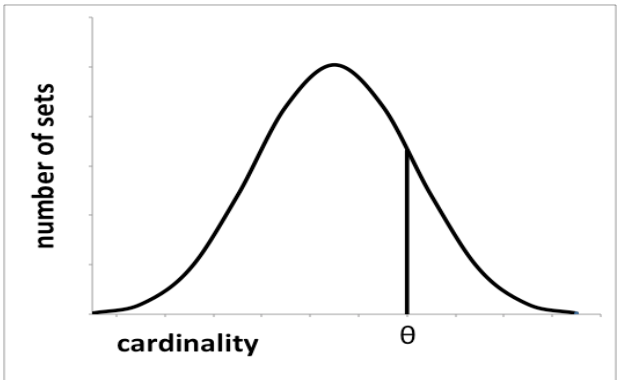
(25) Scenario w_{27}: There are 8 books on the reading list, $b_1, b_2, \ldots, b_8$. John read six of them.

(26) $[\![\text{books on the reading list}]\!]^{w27}$ = {

$b_1, b_2, \ldots, b_8$,	8 of cardinality 1
$b_1 \oplus b_2$, $b_1 \oplus b_3$, $b_1 \oplus b_3$, …., , $b_7 \oplus b_8$,	28 of cardinality 2
$b_1 \oplus b_2 \oplus b_3$, …., , $b_6 \oplus b_7 \oplus b_8$,	56 of cardinality 3
$b_1 \oplus b_2 \oplus b_3 \oplus b_4$, …., , $b_5 \oplus b_6 \oplus b_7 \oplus b_8$,	70 of cardinality 4
$b_1 \oplus b_2 \oplus b_3 \oplus b_4 \oplus b_5$, …., $b_4 \oplus b_5 \oplus b_6 \oplus b_7 \oplus b_8$,	56 of cardinality 5
$b_1 \oplus b_2 \oplus b_3 \oplus b_4 \oplus b_5 \oplus b_6$, …., $b_3 \oplus b_4 \oplus b_5 \oplus b_6 \oplus b_7 \oplus b_8$,	28 of cardinality 6
$b_1 \oplus b_2 \oplus b_3 \oplus b_4 \oplus b_5 \oplus b_6 \oplus b_7$, …., $b_1 \oplus b_3 \oplus b_4 \oplus b_5 \oplus b_6 \oplus b_7 \oplus b_8$,	8 of cardinality 7
$b_1 \oplus b_2 \oplus b_3 \oplus b_4 \oplus b_5 \oplus b_6 \oplus b_7 \oplus b_8$ }	1 of cardinality 8

- In general, the cardinalities of the pluralities in the NP denotation corresponds to a binominal distribution yielding a bell-shaped curve, cf. (27).

(27)



- Given this binominal distribution, the standard for 'many'ness relative to C is likely to be located somewhere in the rightmost third of the curve.[3]

- In effect, the truth conditions in (24c) express that John read a plurality of books whose cardinality is high relative to the cardinalities of the members of the power set of the set of books on the reading list. This mirrors the meaning assigned to proportional *many* by the GQT analysis, but crucially without making reference to actual proportions.

3.2 Cardinal reading

- Cardinal readings result when POS takes DP-external scope.

- In this configuration, the value of the comparison class C is fixed contextually, possibly restricted by focus. In (28), for instance, C is likely to consist of the numbers of toys owned by other kids comparable to Tom, e.g. kids of the same age.

(28) a. Tom has many toys.
b. LF: [POS C] [1 [Tom has [$_{DP}$ ∅ [t_1-many toys]]]]
c. C = {λd'. Tom has d'-many toys,
λd'. Ben has d'-many toys,
λd'. Nick has d'-many toys, … }
d. ∃d [∃x[toys(x) & |x| ≥ d & has(t,x)] & d > θ_C]

3.3 Reverse proportional reading

- The reverse proportional reading requires focus on the NP sister of *many* (cf. Herburger 1997). Following Romero (2015, 2016), we argue that it is the role that focus plays in determining the comparison class that gives the impression of a 'reverse' reading and conservativity can be maintained.

- The reverse proportional reading results when POS takes DP-external scope and the NP sister of *many* is focused.

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[3] Recall that I'm using extensional degree properties just to keep things readable, cf. n. 2. In fact, intensional degree properties are crucial to ensure that the degree properties corresponding to different pluralities with the same number of atomic elements are not equivalent. Note that e.g. (i-a) and (i-b) are different degree properties. Although the pluralities do not differ across worlds w.r.t. the number of atomic elements, (i-a) and (i-b) differ w.r.t. the worlds at which they are defined and are thus not equivalent (e.g., (i-a) would be undefined at world w_{29} if the individual b_1 doesn't exist in w_{29}).

(i) a. λw.λd'. $b_1 \oplus b_2$ are d'-many books on the reading list in w
b. λw.λd'. $b_3 \oplus b_4$ are d'-many books on the reading list in w

- In this configuration of (29), inhabitants of different world regions are compared with respect to the number of Nobel Prize winners they have produced. With this comparison class, the truth conditions in (29d) are fulfilled in case the number of Nobel Prize winners from Scandinavia is large compared to the number of Nobel Prize winners from other parts of the world.

(29) a. Many SCANDINAVIANS have won the Nobel Prize in literature.
b. LF: [[POS C] [1 [∅ [t_1-many Scandinavians$_F$]] have won the NP] ~C]
c. C = {λd'. d'-many Scandinavians have won the NP,
λd'. d'-many Mediterraneans have won the NP,
λd'. d'-many Eastern Europeans have won the NP, … }
d. ∃d [∃x[Scandinavians(x) & |x| ≥ d & won(x,NP)] & d > θ_C]

- This holds if Scandinavians make up a significant proportion of all the Nobel Prize winners, mirroring Westerståhl's (1985) paraphrase 'A high proportion of the Nobel Prize winners in literature are Scandinavians.'

3.4. Reverse proportional or reverse cardinal reading?

- In contrast to Romero (2015, 2016), who relates reverse proportional readings to proportional readings, employing a proportional determiner *many* as in (6), the reverse proportional reading is derived as a special case of a cardinal reading.

- Following Cohen (2001), Romero (2015) argues that Westerståhl's (1985) characterization of the truth conditions isn't fully accurate. According to their intuition the total number of individuals in the NP denotation matters for the truth of the sentence. That is, different countries are compared w.r.t. the proportion of the population who have won the Nobel Prize in literature (i.e. the proportion | P ∩ Q | : | P | enters into the truth conditions).

(30) a. Many SCANDINAVIANS have won the Nobel Prize in literature.
b. Many ANDORRANS have won the Nobel Prize in literature.

> It may be sufficient for as few as two or three Andorrans to have won the Nobel Prize in literature for (30b) to be true; but such a small number would not be enough for the truth of (30a). (Cohen 2001: 48)

- Others have claimed that the proportion of the population who have won the Nobel Prize in literature isn't relevant for the truth conditions:

> The sentence is even true if the nation in question is the biggest on earth, and the ratio of winners per nation is even rather bad. (Eckardt 1999:175)

- If the impression that the total number of individuals in the NP denotation matters to the

truth conditions of Westerståhl's example is correct, we argue that this comes in via the function determining the contextual standard to which POS makes reference. In determining the contextual standard relative to which a number stands out, expectations are factored in (Fernando & Kamp 1996), and it is a likely expectation that world regions with more inhabitants will also produce more NP winners.

- There are cases of reverse readings where the total number of individuals in the NP denotation clearly does not matter:

(31) a. This year, many students from CHINA were admitted.
b. 'A high proportion of the students who were admitted this year come from China.'

(32) a. There were many talks on DONKEY SENTENCES at this year's SuB.
b. 'A high proportion of the talks at this year's SuB were on donkey sentences.'

4. Conclusion and Issues for further research

4.1 Summary

- The various readings of *many* can be derived under a single uniform analysis, where *many* is decomposed into a gradable cardinality predicate and the positive morpheme POS.

- The proportional reading is generated from an LF where POS takes DP-internal scope.

- If POS takes non-local scope, cardinal readings are derived, with reverse proportional readings being a special case arising if the host NP is focused.

- This improves on existing accounts, which either employ more than one lexical entry for *many* (Romero 2015, 2016) or don't specify a compositional implementation (Solt 2009).

- In the spirit of recent work on quantifier decomposition (a.o. Hackl 2000, 2009), ambiguities that are puzzling from a GQT perspective follow if expressions that appear to be quantifying determiners are decomposed and analysed in analogy to gradable adjectives.

4.2 Issues for further research

- Extension to *few* is straightforward, but faces van Benthem's problem.

- It has been observed that the different readings of *many* (and *few*) are restricted to certain grammatical contexts (Milsark 1977, Partee 1989, Westerståhl 1985):

- With individual-level predicates, only the proportional reading is available.

(33) a. Many Germans have blue eyes.
b. Few students in my class are intelligent.

- In *there*- sentences, only the cardinal reading is available.

(34) There are many children in the garden.
'A high proportion of the (contextually relevant children) are in the garden.'

- The reverse reading isn't available with individual-level predicates:

(35) a. Many SCANDINAVIANS are Nobel Prize winners.
#'A high proportion of the Nobel Prize winners are Scandinavians.'

- But this correlation has been challenged (Cohen 2001).

(36) a. Many SCANDINAVIANS have a Nobel Prize in literature. (Cohen 2001: 49)
b. 'A high proportion of those who have a Nobel Prize in literature are Scandinavians.'

- How can the (tendency of a) correlation between grammatical contexts and readings be accounted for in the presented analysis?

- Under the present analysis, the gradable predicate *many* always operates on a cardinality scale, never on a proportion scale. This raises the question how to treat comparative cases that seem to involve a proportion scale.

(37) a. John read more than half of the books on the reading list.
b. There are more illiterate people in small rural towns than in large cities. (Partee 1989)

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