Nat Lang Semantics (2009) 17:63–98
DOI 10.1007/s11050-008-9039-x

On the grammar and processing of proportional quantifiers: *most* versus *more than half*

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Published online: 3 March 2009

Abstract Proportional quantifiers have played a central role in the development of formal semantics because they set a benchmark for the expressive power needed to describe quantification in natural language (Barwise and Cooper Linguist Philos 4:159–219, 1981). The proportional quantifier *most*, in particular, supplied the initial motivation for adopting Generalized Quantifier Theory (GQT) because its meaning is definable as a relation between sets of individuals, which are taken to be semantic primitives in GQT. This paper proposes an alternative analysis of *most* that does not treat it as a lexical item whose meaning is accessible without the help of compositional processes. Instead, proportional *most* is analyzed as the superlative of *many* (cf. Bresnan Linguist Inq 4(3):274–344, 1973). Two types of empirical evidence are presented in support of this view, both exploiting the fact that only a decompositional analysis of proportional quantifiers provides the means to generate different logical forms for seemingly equivalent statements of the form *most* A B and *more than half of the* A B.

Keywords Quantification · Generalized Quantifier Theory · Superlatives · Degrees · Verification · Psycholinguistics

1 Introduction

Formal semantic analyses focus their attention on capturing the correct set of entailment patterns associated with a particular expression. They usually do not concern themselves with comprehension or verification in real time. While this is a perfectly reasonable and useful strategy, semantic theories also have the

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responsibility to furnish the pieces that a processing theory requires to draw systematic distinctions that occur during real time comprehension. Whether a particular theory manages to live up to this obligation depends to a large extent on what type of semantic primitives it assumes, since the "size" of the primitives determines the resolution with which the theory can analyze its phenomena.

In the domain of quantification, questions about the semantic primitives have been answered most prominently within the framework of Generalized Quantifier Theory (GQT). According to GQT, quantification in natural language is a form of second order predication. The centerpiece of a quantificational structure is an expression that denotes a relation between sets of individuals. Importantly, relations between sets are assumed to be semantic primitives in GQT, i.e. semantic objects that can be denoted without the help of compositional processes. The key witness for this view is *most*, a seemingly morphosyntactically simple expression whose meaning can be naturally given as a relation between sets, but not in first order terms (Barwise and Cooper 1981).

This paper argues against the claim that *most* is a lexical item whose meaning is a semantic primitive, and, by extension, against the view that relations between sets are semantic primitives. Instead, I will defend an analysis of the proportional quantifier *most* as a superlative expression that is composed of, among other things, a degree function *many* and a degree quantifier–*est*. I will present two types of evidence in support of this view. Both types exploit the fact that a decompositional analysis of *most* provides the means to distinguish *most* from its close relative *more than half* (which employs comparative morphosyntax) based on differences in the logical forms projected over these quantifiers.

The first type of evidence comes in the form of a crosslinguistic observation concerning the form and inventory of proportional quantifiers. The key fact is that proportional determiners that are based on comparative morphosyntax (e.g. *more than half*) have polar opposites (*less than half*), while proportional determiners that are based on superlative morphosyntax (*most*) do not. That is, there is no proportional determiner *fewest* that expresses the meaning of *less than half*. I will argue that this is a semantic fact and that it can only be explained if proportional determiner meanings are compositionally derived.

The second type of evidence comes from experimental studies of verification procedures triggered by *most* and *more than half*. I will show that *most* and *more than half* have distinct verification profiles even though they are understood to be true and false in the same circumstances. To account for the systematic differences in verification it is once again necessary to recognize the semantic import of the morphosyntactic differences between the two expressions. Specifically, the verification strategy triggered by *most* does not make explicit reference to proportions while *more than half* does. Instead, *most* seems to trigger a strategy that employs set complementation (along the lines of *There are more A that are B than there are A that are not B*). I argue that this can be seen as a reflection of the superlative operator *–est*, which is an integral component of *most*.

These two arguments demonstrate the need for a theory of quantification that explains the meaning of quantificational expressions like *most* and *more than half* as a function of the meaning of their parts.

2 Generalized quantifier theory

A milestone in the development of the theory of quantification in natural language came from the study of proportional quantifiers (such as *most*, *more than half*, *two-thirds*, etc.) which—as Barwise and Cooper (1981) showed for *most*—cannot be defined within first order predicate logic. They demand a strictly richer apparatus for their proper characterization and therefore set a benchmark for the expressive power found in natural language. To accommodate the expressive power displayed by proportional quantifiers GQT (Mostowski 1957) was adopted. In GQT, the basic building blocks of quantificational expressions are determiners that denote relations between sets of individuals. To see the import of this move, compare the semantics of the universal quantifier *every* as given in familiar first order terms, (1a), with its treatment in GQT where *every* denotes the subset relation, (1b).

(1) a. $[\![\text{Every}]\!]\,(A)(B) = 1$ iff $\forall x\,[A(x) \rightarrow B(x)]$
b. $[\![\text{Every}]\!]\,(A)(B) = 1$ iff $A \subseteq B$

While both treatments seems equally feasible in the case of *every*, GQT proves its worth in the analysis of determiners like *most*, which cannot be defined in first order terms. That is, there is no first order quantifier *Mx*, which together with suitable Boolean operations over two sets A and B would provide a definition for *most* in the sense of *more than half*, (2a). GQT's assumption that determiners denote relations between sets provides an elegant solution to the puzzle, (2b).

(2) a. $*[\![\text{most}]\!]\,(A)(B) = 1$ iff $Mx[A(x)\ \{\ \&\ ,\vee,\ \rightarrow\ ,\neg\}\ B(x)]$
b. $[\![\text{most}]\!]\,(A)(B) = 1$ iff $|A \cap B| > |A - B|$

According to GQT, then, quantification in natural language is a form of second order predication where quantifiers such as *every student* denote predicates of predicates (or sets of sets) and quantificational determiners like *every* denote relations between sets of individuals. Importantly, these relations are assumed to be semantic primitives.

Primary motivation for this stance comes from the assumption that *most* is a lexical item that does not have any semantically significant internal structure. Assuming that *most* is a lexical item means that its meaning can be accessed without the help of compositional semantics. This means, of course, that it is a semantic primitive.

When treating relations between sets as semantic primitives, there is no need to decompose expressions that denote such relations into smaller pieces, even if their surface syntax is complex. For this reason, GQT does not provide a compositional analysis for surface-complex expressions like *more than half* but rather treats them as quasi-idiomatic.[1]

[1] Keenan and Westerstahl (1997, p. 17) use the terms "lexical and near lexical determiners" for morphosyntactically complex quantifiers like *more than half* while van Benthem (1986) calls them "tightly knit compounds" to indicate that their semantics is not a function of their parts.

Thus, GQT holds to the claim that relations between sets are semantic primitives of quantification in natural language and that the internal make-up of determiner quantifiers does not affect their (determiner) external behavior in any semantically significant way. According to GQT, then, no significant semantic generalizations are missed if the internal composition of determiners is ignored. Although GQT correctly characterizes the set of entailments associated with quantificational determiners, the problem with ignoring their internal make-up is that GQT becomes too coarse to distinguish between denotationally equivalent determiners even when they are morphosyntactically quite different.

2.1 Coarseness of GQT

The implications of GQT's inherent insensitivity to form can be seen in a number of different ways, two of which are relevant for the purpose of this paper.

Insensitivity to form predicts that expressions that describe the same relation are indistinguishable even if they are distinct in form. For instance, the expressions in (3) all denote the same relation and are therefore indistinguishable for GQT.[2]

(3) a. $[\![\text{no}]\!](A)(B) = 1$ iff $A \cap B = \varnothing$
b. $[\![\text{zero}]\!](A)(B) = 1$ iff $A \cap B = \varnothing$
c. $[\![\text{fewer than 1}]\!](A)(B) = 1$ iff $A \cap B = \varnothing$

Essentially the same problem surfaces when we consider various descriptions of the truth-conditional import of determiners. GQT maintains that any two descriptions are equally good as long as they describe the same relation and encode the same compositional commitments (i.e. they combine with two set denoting expressions). Hence, all of the treatments of *no* in (4) are equally good according to GQT.

(4) a. $[\![\text{no}]\!](A)(B) = 1$ iff $A \cap B = \varnothing$
b. $[\![\text{no}]\!](A)(B) = 1$ iff $|A \cap B| = 0$
c. $[\![\text{no}]\!](A)(B) = 1$ iff $|A \cap B| < 1$

These claims are somewhat unintuitive, as it seems that a description of the semantic import of *no, zero*, and *fewer than 1* as given in (5) would seem more faithful to the form of the determiners and therefore conceptually preferable.

(5) a. $[\![\text{no}]\!](A)(B) = 1$ iff $A \cap B = \varnothing$
b. $[\![\text{zero}]\!](A)(B) = 1$ iff $|A \cap B| = 0$
c. $[\![\text{fewer than 1}]\!](A)(B) = 1$ iff $|A \cap B| < 1$

To establish a preference for the analyses in (5) over those in (3) or (4) requires a theory of quantification that employs a different set of primitives for quantification.

[2] See Hackl (2000) and Geurts and Nouwen (2005) for a detailed discussion of systematic differences between *more than n* and *at least n + 1*.

This alternative, dismissed by Barwise and Cooper (1981) in passing[3] and henceforth largely unexplored,[4] would overcome the limitations of first order predicate logic by including numbers and functions from (sets of) individuals to numbers among the semantic primitives used for constructing natural language quantifiers. Prima facie appeal for such an approach lies in its promise to deliver a fully compositional account of the semantics of morpho-syntactically complex determiners such as those in (5). This would explain rather than stipulate why the above determiners all characterize exactly the same set of entailments and it would predict different LFs for them, which would employ the same operators that are used in the description of their truth-conditional import in (5).

The above considerations amount to a conceptual argument against GQT that could be strengthened on empirical grounds in two ways—language internally, if there are generalizations about the distribution of determiners that can be captured only if the form of the determiners is taken into account; and language externally, if it can be shown that the particular form in which truth conditions are stated affects language external cognitive systems. The next two sections present empirical arguments of both kinds concerning *most* and *more than half*.

3 MOST = MANY + EST

We saw in (2), repeated in (6a), how the proportional determiner *most* is defined in GQT. Notice that (at least under standard assumptions about counting individuals[5]) the same relation can be described as in (6b). Of course, exactly the same options are available for *more than half* given that these two determiners are truth-conditionally equivalent, as shown in (7).

(6) a. $[\![\text{most}]\!]\ (A)(B) = 1$ iff $|A \cap B| > |A - B|$
b. $[\![\text{most}]\!]\ (A)(B) = 1$ iff $|A \cap B| > ½\ |A|$

(7) a. $[\![\text{more than half}]\!]\ (A)(B) = 1$ iff $|A \cap B| > ½\ |A|$
b. $[\![\text{more than half}]\!]\ (A)(B) = 1$ iff $|A \cap B| > |A - B|$

The questions we discussed above arise here again: Are there reasons to prefer (6a) over (6b) and (7a) over (7b)? (7a) seems preferable over (7b) on conceptual grounds as it better encodes a correspondence between the pieces that make up *more than half* and the operators used to describe its truth-conditional import.[6] In

[3] Barwise and Cooper (1981, p. 161) write, "One possibility is to expand the domain E of quantification to a bigger domain $E \cup A$, where A includes numbers and functions from subsets of E to numbers. That is, one might mirror the high-order set-theoretic definition of *more than half* in the semantics by forcing every domain E to contain all of the abstract apparatus of modern set-theory. A different approach, one that model-theorists have found more profitable, is to keep the formal definition as part of the meta-language, and treat generalized quantifiers without bringing all the problems of set theory into the syntax and semantics of logic per se."

[4] But see Nerbonne (1994), Krifka (1999), and Hackl (2000), among others.

[5] See Fox and Hackl (2006) for a non-standard view.

[6] See Landman (2004) for a compositional analysis of *more than half* that does exploit "relational degrees" like *half* and the comparative operator, as well as quantifiers that range over pluralities.

the next section, I argue that the same holds for (6a) once *most* is analyzed as the superlative of *many*. In support of such an analysis I conduct a crosslinguistic study of *most, fewest*, and their German counterparts *die meisten* and *die wenigsten*, which allows me to present the core distributional pattern supporting an analysis of *MOST*[7] as superlative.[8] The German data presents the core generalization in a more straightforward way than English, which on the surface portrays a somewhat more complex pattern. However, I argue that English conforms to the same generalization. To account for the core facts, in Sect. 3.2 I offer a fully compositional analysis of *MOST* as the superlative of *MANY*.

3.1 *MOST* and *FEWEST*

In this section, I show that *most/die meisten* and *fewest/die wenigsten* are always the superlative forms of *MANY* and *FEW*. The argument is based on the observation that the principles that govern the interpretation of superlatives also govern the available interpretations of *MOST* and *FEWEST*. More specifically, depending on the environment, superlatives can give rise to two possible interpretations – the "absolute" reading and "relative" reading. *MOST* and *FEWEST* are sensitive to the same environmental factors. However, while *MOST* and *FEWEST* do have relative readings, in absolute environments *MOST* gives rise to a proportional reading while *FEWEST* is unacceptable. This pattern raises the following questions: (1) Why are *MOST* and *FEWEST* subject to principles that govern the interpretation of superlatives? (2) Why does *MOST* have a proportional reading in place of an absolute reading? (3) Why does *FEWEST* not have a proportional reading?

3.1.1 Relative-superlative and proportional readings

Bresnan (1973) noted that *most* has superlative morphosyntax and in fact can be analyzed as the superlative of *many*.[9] The same observation extends to German *die meisten*,[10] which is the superlative of *viel* ('many').

[7] I use capital letters for *MOST*, *MANY*, etc. to refer to the counterparts of *most*, *many*, etc. across languages.

[8] It is worth noting that not all that many languages have a determiner counterpart of *most*. This is surprising if the complex meaning denoted by *MOST* is in fact a semantic primitive. Those that don't (e.g. Italian) typically use constructions such as *la maggior parte* or open class items such as *majority* to express the same content. What is even more significant is that in a good number of structurally and genetically diverse languages that do have a counterpart to *most* (German, Finnish, Hindi, Basque, West-Greenlandic, etc.) it seems to be morpho-syntactically related to the comparative or superlative form of *MANY* or *NUMEROUS*. This pattern suggests that *MOST* is necessarily a complex expression, which is unexpected under GQT, and calls for a compositional approach to determiner meanings that provides the building blocks that a language needs to build *MOST*.

[9] See also e.g. von Stechow (1984), Yabushita (1989, 1998). Bresnan (1973) suggests that *most* is the spell-out of the superlative of the mass counterpart of *many* (*much*) as well. Although I believe that the analysis of *most* given below can be straightforwardly extended to *much-est*, I will ignore proportional mass quantifiers here.

[10] Superlatives are always accompanied by a definite article in German.

(8) a. most = many + EST
b. meist = viel + EST

The analysis in (8) is not just a fact of morphosyntax but is also supported by semantic observations. Specifically, *die meisten* can express the superlative meaning of *viel*, as indicated in (9a). However, it can also serve as a proportional determiner that can be paraphrased by *more than half*, as in (9b).

(9) Hans hat die meisten Bücher gelesen.
John has the most books read
a. 'John read more books than anybody else.' relative-superlative
b. 'John read more than half of the books.' proportional

It is easy to see that the two readings are independent. Imagine a situation with 10 books. John has read 5 but nobody else who is relevant has read more than 4 books. In that case, the truth conditions described in (9a) are met but the ones in (9b) aren't. If, on the other hand, John has read 6 books but there is at least one relevant person who read as many or more books, the truth conditions in (9b) are met while those in (9a) are clearly not.

Die wenigsten, which is the superlative of *wenige* ('few'), interestingly, has the superlative interpretation but not the counterpart proportional interpretation.

(10) Hans hat die wenigsten Bücher gelesen.
John has the fewest books read
a. 'John read fewer books than anybody else.' relative-superlative
b. *'John read less than half of the books.' *proportional

3.1.2 MOST and FEWEST as superlatives

Looking at the distributional properties of *die meisten* and *die wenigsten* (i.e., which circumstances allow for which readings), we observe that the same factors that govern the interpretation of superlatives in general also govern the availability of the interpretations of *die meisten* and *die wenigsten.* As is well known, superlatives such as the one in (11) can be interpreted in two ways—the relative and the absolute-superlative readings.[11]

(11) Hans hat den höchsten Berg bestiegen.
John has the highest mountain climbed
a. 'Among the relevant people, John climbed a higher mountain than anybody else.' relative-superlative
b. 'John climbed Mount Everest.' absolute-superlative

The absolute reading of *the highest mountain* refers to the mountain that is higher than all other (contextually relevant) mountains. Hence, if all mountains are

[11] Cf. Heim (1985, 1999), Szabolcsi (1986), Farkas and Kiss (2000), etc.

relevant *the highest mountain* is extensionally equivalent to *Mount Everest*. The relative reading of *the highest mountain*, on the other hand, refers to the mountain that is higher than any mountain climbed by somebody who is relevant in the discourse. Obviously, that mountain does not have to be Mount Everest. In fact, it could be a rather modest mountain as long as it is higher than any mountain climbed by somebody other than John.[12]

One noticeable fact, however, is that while *die meisten* and *die wenigsten* have a relative-superlative reading in the same enviroments that regular superlatives do, where regular superlatives have an absolute reading, *die meisten* has a proportional reading, and *die wenigsten* is simply unacceptable. Given that *die meisten* and *die wenigsten* are superlatives of *viele* ('many') and *wenige* ('few'), one would expect that the same types of interpretations we have observed in (11) are available for NPs like *die meisten/die wenigsten Berge* (the most/fewest mountains)—the only difference being that sets (or pluralities) of mountains are compared in terms of their cardinality rather than mountains in terms of their height. That we don't observe the same type of interpretations—namely that *die meisten* and *die wenigsten* have no absolute readings as Szabolcsi (1986) already noted for *most* and *fewest*—is somewhat surprising.

(12) Hans hat die meisten/die wenigsten Berge bestiegen.
John has the most/the fewest mountains climbed
a. 'John climbed more/fewer mountains than anybody else.' relative
b. *'John climbed the largest/smallest number of mountains.' *absolute

Since relative readings of superlatives are subject to licensing conditions (cf. Szabolcsi 1986, etc.), we can show that the observations in (10) and (12) are part of a larger generalization. In environments that disallow relative readings of superlatives in general, *die meisten* invariably receives a proportional quantifier interpretation. *Die wenigsten*, however, produces unacceptability.[13]

In support of this claim, I discuss the interpretation of *die meisten* and *die wenigsten* in three environments which are known to affect the interpretation of superlatives in general.

First, relative readings of superlatives require a licensor, typically a focused phrase or a wh-phrase. (13a) shows that if there is no licensor only the absolute interpretation for the superlative of *hoch* ('high') is available. (13b) provides a licensor in the form of a focused subject and therefore allows both relative and absolute readings.

[12] It is not always easy to distinguish genuine relative readings from absolute readings generated under a suitable domain restriction. See Heim (1999) and Sharvit and Stateva (2002) for discussion. Szabolcsi (1986) suggests, in fact, that the lack of an absolute reading for *fewest* provides a reliable probe for whether an environment allows for relative readings. If it doesn't, sentences that use *fewest* produce unacceptability.

[13] At least for some speakers, *die wenigsten* can receive an interpretation in absolute environments, which can be paraphrased as "very few." Since this interpretation is not relevant for the purposes if this paper, I will henceforth ignore it and simply mark sentences that have only a "very few" interpretation as unacceptable.

(13) a. Es schneite auf dem höchsten Berg.
'It snowed on top of the highest mountain.' absolute
b. Die FLACHAUER haben den höchsten Berg beschneit.
'The villagers of Flachau made snow on top of the highest mountain.'
relative, absolute

Replacing the superlative *den höchsten* with *die meisten* yields at first sight unexpected effects. First, there is no absolute reading for *die meisten*, no matter whether there is a licensor or not. Furthermore, if there is no licensor, as in (14a), *die meisten* is interpreted as a proportional determiner equivalent to *more than half*. Finally, if there is a licensor, as in (14b), we see that *die meisten* allows for a relative interpretation of the superlative ("more than anybody else"), as well as the proportional interpretation.

(14) a. Es schneite auf den meisten Bergen.
'It snowed on top of more than half of the mountains.' proportional
b. Die FLACHAUER haben die meisten Berge beschneit.
'The villagers of Flachau made snow on
more mountains than anybody else/ relative
more than half of the mountains.' proportional

Replacing *den höchsten* with *die wenigsten* yields even more unexpected results. As is the case for *die meisten*, there is no absolute reading. However, while there is a proportional reading for *die meisten*, which is the only reading we get when there is no licensor, there is no interpretation for *die wenigsten* at all—not even one that would be equivalent to *less than half*, as shown in (15).

(15) a. *Es schneite auf den wenigsten Bergen.
'It snowed on top of less than half of the mountains.' *proportional
b. Die FLACHAUER haben die wenigsten Berge beschneit.
'The villagers of Flachau made snow on
fewer mountains than anybody else/ relative
*less than half of the mountains.' *proportional

A second factor governing the availability of a relative interpretation of a superlative is that the licensor needs to be local (roughly a clause mate) to the superlative morpheme. The examples below employ a wh-phrase as potential licensor. We see in (16a) that if the trace of the wh-phrase is in a higher clause than the superlative, only the absolute interpretation remains. In (16b), the wh-phrase is extracted from the embedded clause, which also hosts the superlative. Since the trace of the wh-phrase is within the same clause both absolute and relative interpretations are available.

(16) a. Wer hat gesagt dass sie den höchsten Berg beschneit haben?
Who has said that they on the highest mountain snow made have?
'Who said that they made snow on top of the highest mountain?' absolute
b. Wer glaubst du hat den höchsten Berg beschneit?
Who think you has on the highest mountain snow made?
'Who do you think has made snow on top of the highest mountain?'
relative, absolute

Replacing *den höchsten* with *die meisten* shows once again that only a proportional reading is available in absolute environments, exemplified in (17a), while both a proportional and a relative interpretation are possible in relative environments, as in (17b).

(17) a. Wer hat gesagt dass sie die meisten Berge beschneit haben?
'Who said that they made snow on top of more than half of the mountains?'
proportional

b. Wer glaubst du hat die meisten Berge beschneit?
'Who do you think made snow on top of
more mountains than anybody else/ relative
more than half of the mountains?' proportional

As before, we observe that there is no absolute or proportional reading for *die wenigsten* when there is no accessible licensor, as in (18a) and if there is, as in (18b), the relative reading is the only reading available for *die wenigsten.*

(18) a. *Wer hat gesagt dass sie die wenigsten Berge beschneit haben?
'Who said that they made snow on top of less than half of the mountains?'
*proportional

b. Wer glaubst du hat die wenigsten Berge beschneit?
'Who do you think made snow on top of
fewer mountains than anybody else? relative
less than half of the mountains? *proportional

The third factor I want to discuss here that constrains the interpretations of superlatives is due to a special requirement of the relative interpretation, namely that there be a unique individual that has the gradable property to a higher degree than anybody else. The sentences in (19) employ universally quantified subjects, which do not satisfy this constraint and therefore disallow relative readings of superlatives.

(19) a. Jede Gemeinde hat den höchsten Berg beschneit.
Every town has on the highest mountain snow made
'Every town made snow on top of the highest mountain.' absolute

b. Wer aller hat den höchsten Berg beschneit?
Who-all has on the highest mountain snow made?
'Who all made snow on top of the highest mountain?' absolute

Given the lack of a suitable licensor for a relative reading, we expect that *die meisten* can only be interpreted as a proportional quantifier when it is used in place of the superlative adjective in (19). This is what we see in (20).

(20) a. Jede Gemeinde hat die meisten Berge beschneit.
'Every town made snow on top of more than half of the mountains.'
proportional

b. Wer aller hat die meisten Berge beschneit?
'Who all made snow on top of more than half of the mountains?'
proportional

Since *die wenigsten* has neither an absolute nor a proportional meaning, replacing *den höchsten* with *die wenigsten* yields unacceptable structures, as can be seen in (21).

(21) a. *Jede Gemeinde hat die wenigsten Berge beschneit.
'Every town made snow on top of less than half of the mountains.'
*proportional

b. *Wer aller hat die wenigsten Berge beschneit?
'Who all made snow on top of less than half of the mountains?'
*proportional

These three data sets show that the interpretation of *die meisten* and *die wenigsten* is governed by the same constraints that govern the interpretation of superlatives in general. Specifically, they illustrate the following generalization, (22), summarized in Table 1.

(22) a. Environments that allow for a relative interpretation of superlatives allow for a relative-superlative interpretation of *die meisten* and *die wenigsten*, as well as a proportional interpretation for *die meisten*.

b. Environments that allow only an absolute interpretation of superlatives disallow a (absolute or relative) superlative interpretation for *die meisten* and *die wenigsten*. *Die meisten* will be interpreted as a proportional determiner in those circumstances, whereas *die wenigsten* receives no interpretation at all.

Table 1 German

	HIGH-EST	*MANY-EST*	*FEW-EST*
Relative	*den höchsten*	*die meisten*	*die wenigsten*
Absolute	*den höchsten*	*	*
Proportional		*die meisten*	*

It is not immediately obvious that the generalization in (22) extends to English. However, I argue that it does. The key to this argument is provided by the fact that English (unlike German) has both a bare *most*, which is not accompanied by the definite article, as well as *the most.* Importantly, the range of interpretations for (*the*) *most* seems to be controlled by the presence or absence of the definite article. Specifically, *the most* is interpreted as relative-superlative while bare *most* is interpreted as a proportional quantifier. This can be seen in (23).

(23) a. John read the most books.
'John read more books than anybody else.' relative
b. John read most books.
'John read more than half of the books.' proportional

Given that the presence of a definite article forces a relative-superlative reading on *most*, we expect that *the most* yields no interpretation at all in environments that do not furnish an accessible licensor for a relative-superlative construal. Bare *most*, on the other hand, should be acceptable in these environments but should give rise to a proportional reading. That this is indeed so can be seen in (24)–(26), which replicate the relevant German data from above.

(24) a. *It snowed on top of the most mountains. *absolute[14]
b. It snowed on top of most mountains. proportional

(25) a. *Who said that Mary made snow on top of the most mountains? *absolute[15]
b. Who said that Mary made snow on top of most mountains? proportional

(26) a. *Who all made snow on top of the most mountains? *absolute
b. Who all made snow on top of most mountains? proportional

The pattern extends straightforwardly to *fewest*, as can be seen in (27)–(30). *The fewest* can only be interpreted as relative-superlative. Hence, *the fewest* is unacceptable in environments that do not support such a construal. Furthermore, since *FEWEST* does not have a proportional reading we expect these sentences to be unacceptable altogether. In fact, bare *fewest* by itself is always unacceptable, presumably because the absence of the definite article triggers a proportional interpretation which is unavailable for *fewest.*

(27) a. John read the fewest books.
'John read fewer books than anybody else.' relative
b. *John read fewest books.
'John read less than half of the books.' *proportional

(28) a. *It snowed on top of the fewest mountains. *absolute[16]
b. *It snowed on top of fewest mountains. *proportional

[14] It seems possible to construe the sentence in (24a) with a covert licensor such as *this year.* This gives rise to a relative interpretation of the superlative along the lines of 'It snowed on top of more mountains this year than any other year,' which falls in line with the claim made above.

[15] The relevant reading of (25a) that is starred is the one that would take the matrix wh-phrase as licensor rather than *Mary.* Since the embedded subject is a clause-mate of *the most* it is expected to be able to license a relative superlative reading of *the most.*

[16] Again, a covert phrase such as *this year* can provide the required licensor for a relative construal of *the fewest.*

(29) a. *Who said that Mary made snow on top of the fewest mountains? *absolute[17]
b. *Who said that Mary made snowed on top of fewest mountains? *proportional

(30) a. *Who all made snow on top of the fewest mountains? *absolute
b. *Who all made snow on top of fewest mountains? *proportional

These observations clearly show that—once the contribution of the definite article is factored in—English conforms to the distributional generalization in (22) just as much as German does. In fact, Table 2, which summarizes the English pattern, differs from the German table only in that the proportional interpretation of *MANY-EST* is expressed by a bare form rather than by a superlative that is accompanied by the definite article.[18]

Table 2 English

	HIGH-EST	*MANY-EST*	*FEW-EST*
Relative	*the highest*	*the most*	*the fewest*
Absolute	*the highest*	*	*
Proportional		*most*	*

The generalization in (22) says that *MOST* and *FEWEST* are subject to the licensing conditions that govern the interpretation of superlatives in general. This suggests, of course, that *MOST* and *FEWEST* should be analyzed as superlatives—irrespective of whether they are interpreted as superlative with a relative interpretation or as a proportional determiner. Such an analysis needs to address three questions: How can we derive a proportional interpretation of *MOST* under the assumption that it is the superlative of *MANY?* Why is a proportional interpretation not possible for *FEWEST?* And why are there no genuine absolute readings for *MOST* and *FEWEST*?

3.1.3 Unifying the relative and proportional readings

To see that the first question can be addressed in principle, observe that *MOST*, if analyzed as the superlative of *MANY*, will, in certain circumstances, yield truth conditions that are equivalent to a proportional meaning. Specifically, this arises if the following three conditions are met: there are only two sets that are compared in terms of their cardinality, the two sets are disjoint, and together they exhaust the extension of the noun phrase that *MOST* combines with. Claiming that one of the

[17] See footnote 15.

[18] The data sets considered here suffice to motivate the generalization in (22) but clearly fall short of giving a complete picture of the similarities and difference between English and German in this domain. A more extensive study that would provide it goes however beyond the scope of this paper.

sets is more numerous than its complement will result in proportional truth-conditions.

The example in (31) illustrates this fact using the focused predicate *MÄNNLICH* ('male') to license a relative reading. Since the only salient alternative to *MÄNNLICH* is *WEIBLICH* ('female') the domain of individuals is partitioned into two disjoint sets.

(31) Die meisten Studenten sind MÄNNLICH.
The most students are MALE
'More students are male than female.' relative (proportional)

Assuming that predicates like male/female jointly partition the domain, there will be only two subsets of students that are compared by the superlative *die meisten*: the students that are male and the students that are female. Thus the claim that the most numerous set of students is male amounts to the claim that more students are male than female. In other words, although the licensing conditions for relative readings of the superlative are met in (31)—there is local focus that the superlative can associate with—the resulting interpretation is equivalent to that of a proportional quantifier.[19]

Interestingly and importantly, in these circumstances *die wenigsten* does not have an interpretation at all, as shown in (32).[20]

(32) *Die wenigsten Studenten sind WEIBLICH.
The fewest students are FEMALE
*'Fewer students are female than male.' *relative (proportional)

Despite the fact that the syntactic licensing conditions for a relative reading of *die wenigsten* are all met in (32a) and despite the fact that there is nothing wrong with the predicted truth conditions that there are fewer female than male students, this interpretation is not available for *die wenigsten*.[21]

The combination of (31) and (32) argues quite forcefully for a unified analysis of the relative-superlative and the proportional readings. To account for (31), a non-uniform analysis could assume that there are two homophonous lexical items *die meisten*$_{sup}$ and *die meisten*$_{prop}$, which happen to produce the same truth conditions. However, to account for the absence of any interpretation in (32), the counterpart story for *die wenigsten* would have to be entirely stipulative. Specifically, one would have to have two separate explanations for why both *die wenigsten*$_{sup}$ and *die wenigsten*$_{prop}$ are unacceptable in partitioning environments of that sort. This would clearly miss the point.

[19] When replacing the focused predicate in (31) with e.g. *BLOND*, which doesn't bi-partition the students, both a distinct proportional and relative superlative reading become available.

[20] As mentioned earlier, (32) is acceptable under a "very few" interpretation of *die wenigsten*.

[21] Again, we can make sure that all structural conditions for a relative superlative interpretation of *die wenigsten* are met by replacing the focused predicate in (32a) with e.g. *BLOND*, which doesn't bi-partition the students. In this case, the sentence receives a relative superlative interpretation along the lines of *Fewer students are blond than any other hair color.*

The contrast between (31) and (32) also suggests what type of explanation we would like to have for what appears to be a systematic (lexical) gap in the inventory of proportional quantifiers, namely that *FEWEST* cannot be used to express *less than half*. The type of explanation suggested by (31) and (32) is that $FEWEST_{prop}$ doesn't exist because it can't be built, and that it can't be built because something goes wrong in the compositional semantics when *FEWEST* is placed in an environment that would produce a proportional meaning.

3.1.4 Blocking

To see what the structure of an explanation of this sort would look like, it is useful to consider the English counterparts of *die meisten* and *die wenigsten* in partitioning environments. Recall that the presence of the definite article imposes a relative-superlative interpretation on *most* and *fewest.* Given that partitioning environments such as those in (31) satisfy the syntactic licensing conditions for a relative-superlative, one would initially expect both *the most* and *the fewest* to be acceptable. Furthermore, one would expect that the resulting interpretations would be equivalent to *more than half* and *less than half*. This is not the case, however. Both *the most* and *the fewest* are in fact unacceptable, as (33a) and (33b) show.[22]

(33) a. *What gender do the most students at Pomona have? *proportional
b. *What gender do the fewest students at Pomona have? *proportional

The fact that *the fewest* is unacceptable in partitioning environments is in line with the German data in (32). However, the fact that *the most* is just as unacceptable is surprising, since the German counterpart *die meisten* is acceptable in partitioning environments. Of course, the resulting truth conditions of *die meisten* in partitioning environments are essentially those of a proportional quantifier. In English however, these truth conditions are expressed by bare *most*. And indeed, replacing *the most* with bare *most* results in a perfectly acceptable sentence, i.e. (34).

(34) What gender do most students at Pomona have? proportional

What appears to be the case, then, is that the availability of bare *most* blocks *the most* in partitioning environments. However, since there is no bare *fewest*, such an explanation is unavailable for (33b), which brings us back to our original question:

[22] We can easily see that the unacceptability of (33a) and (33b) is essentially a semantic phenomenon because the same frame results in perfectly acceptable sentences for both *the most* and *the fewest* once the licensor is not a partitioning predicate. This can be achieved by asking for instance for the nationality rather than the gender that is represented by the largest/smallest set of Pomona students.

(i) a. What nationality do the most students at Pomona have? relative
b. What nationality do the fewest students at Pomona have? relative

Why can the superlative of *MANY* express proportional truth conditions and, more pointedly, why can't the superlative of *FEW*?

Building on the idea that blocking is at play, one might appeal to the fact that superlatives are generally blocked by a competing definite comparative when it is established that there are only two entities that are compared, as exemplified in (35).

(35) The taller/??tallest of his two sons is playing basketball.

Applying the same consideration to partitioning environments such as those in (31), we can conclude that there must be a structure for *MOST* which is truth-conditionally equivalent to the relative-superlative structure in (31), yet is not blocked by a competing definite comparative. We can also conclude that such a structure does not exist for *FEWEST*.[23] Otherwise, *the fewest/die wenigsten* would be acceptable. Furthermore, the structure for *MOST* that is not blocked needs to be one that doesn't satisfy the conditions for blocking by a definite comparative. Specifically, in such a structure the number of compared entities cannot be two. An account of *MOST* and *FEWEST*, therefore, needs to explain how there can be an alternative structure for *MOST* that is both equivalent to a proportional determiner meaning and sidesteps blocking by a comparative, while there cannot be such an alternative structure for *FEWEST*.

Before I give an analysis of *MOST* and *FEWEST* which achieves these desiderata, it is useful to step back and evaluate the significance of the observations we have gathered to this point. The crosslinguistic generalizations regarding *MOST* and *FEWEST* constitute rather compelling evidence against a theory of quantification that is as insensitive to the form of determiner quantifiers as GQT is. Such insensitivity to form means, for instance, that systematic lexical gaps such as the unavailability of $FEWEST_{prop}$ are, in fact, accidental gaps, as the intended denotation of $FEWEST_{prop}$ is a perfectly fine semantic primitive according to GQT. Hence, there is no need to derive such a meaning compositionally. Given that there is nothing wrong with the morphosyntax of *FEWEST*, it remains a mystery why it cannot express that meaning when its polar opposite *MOST* can. GQT's insensitivity to form removes the need to decompose obviously complex quantifiers like *more/less than half* and $MOST_{prop}$ into smaller pieces and therefore loses the drive to explain what it takes for a language to build expressions that have these denotations.[24] Exactly that type of inherent disinterest

[23] Indeed, the way to express the intended meaning in (32) in some dialects of German is to use *die wenigeren* ('fewer') instead of *die wenigsten Studenten.* This option is also available for *die mehreren* ('more') but, importantly, *die meisten* is just as available.

(i) Die wenigeren (Studenten) sind MÄNNLICH.
'The fewer (students) are MALE.'
(ii) Die mehreren/die meisten (Studenten) sind MÄNNLICH.
'The more (students) are MALE.'

[24] What is important for my argument is that there is no closed-class lexical item that refers to a complex meaning like that of *MOST/MORE THAN HALF*. Of course it's possible that languages have open class items like *majority* that lexicalize complex meanings of that sort.

in the relation between form and meaning of determiner quantifiers is seriously challenged by the above observations.

3.2 $MOST_{prop}$

In this section, I will sketch a treatment of *MOST* as the superlative of *MANY*. The account is based on a fairly conservative extension of the movement account of superlatives given in Heim (1985) and Szabolcsi (1986), and discussed in detail in Heim (1999).[25] As a starting point, I assume an analysis of *MANY* as a gradable modifier that modifies plural NPs ranging over pluralities that can be measured in terms of how many atomic parts they are composed of, as shown in (36).[26]

(36) $[\![\text{MANY}]\!]\ (d)(A) = \lambda x.\ [A(x)\ \&\ |x| \geq d]$

I assume that the superlative morpheme *–EST* is a degree quantifier, which is restricted by a covert variable C that provides a comparison class. [-EST C] combines with a degree property D (type ⟨d, et⟩) and yields a predicate that is true of a given x if x has the degree property to a higher degree than any alternative to x in C, as shown in (37).

(37) $[\![\text{-EST}]\!](C)(D)(x) = 1 \text{ iff } \forall y \in C\,[y \neq x \rightarrow \max\{d: D(d)(x) = 1\} > \max\{d: D(d)(y) = 1\}]$

Furthermore, I follow Heim (1999) and assume that the superlative presupposes that the comparison class has at least two distinct members, one of which is the subject, as in (38).[27]

(38) $[\![\text{-EST}]\!](C)(D)(x)$ is defined only if $x \in C\ \&\ \exists y\ [y \neq x\ \&\ y \in C]$

The assumption that [-EST C] is base generated in the degree argument position of gradable adjectives such as *MANY* predicts that [-EST C] moves and adjoins to a predicate denoting node to yield an interpretable structure. This could be either a node inside the DP containing *MANY*, as in (39a), or outside, as in (39b).

(39) a. [John climbed [the [-est C]$_i$ [d_i-many mountains]]]
b. [John [-est C]$_i$ [climbed [the d_i-many mountains]]]

Following again Szabolcsi (1986) and Heim (1999), I assume that if [-est C] stays inside the DP, the comparison class C is identical to the NP sister of the degree function. If [-est C] moves into the matrix clause, the comparison class is a set of

[25] Many of the assumptions I make here (*MANY* being a gradable modifier of NPs, *etc*.) to analyze *most/die meisten* and *fewest/die wenigsten* are choices of convenience that could be replaced with alternatives without affecting the core of the proposal.

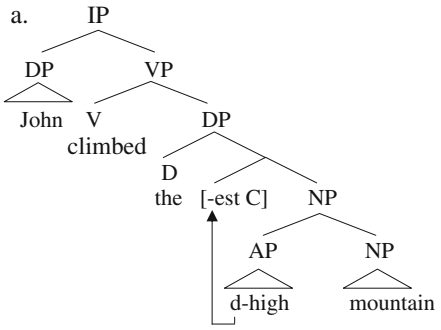
[26] DPs containing *MANY* are assumed to be closed by a silent existential determiner ∅.

[27] This presupposition explains the marked status of sentences like #*You are the best mother I have*, which strongly suggest that I have more than one mother, as pointed out in Fox (2006).

salient individuals including the subject.[28] Furthermore, following again Szabolcsi (1986), I assume that the definite article is optionally interpreted as an existential quantifier and that at least when [-est C] is extracted out of a DP it has to be interpreted in this way.

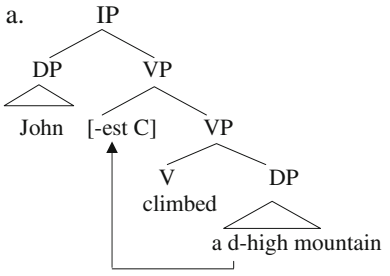
These assumptions produce the LFs in (40a) and (41a) and the denotations for the sub-trees containing [-est C] and its respective sister in (40b) and (41b).[29]

(40) a.



b. $[\![[\text{-est C}]_i\ [d_i\text{-high mountain}]]\!] = \lambda x.\forall y \in C\ [y \neq x \rightarrow \max\{d\text{: x is a d-high mountain}\} > \max\{d\text{: y is a d-high mountain}\}]$

(41) a.



b. $[\![[\text{-est C}]_i\ \text{climbed}\ [d_i\text{-high mountain}]]\!] = \lambda x.\forall y \in C\ [y \neq x \rightarrow \max\{d\text{: x climbed a d-high mountain}\} > \max\{d\text{: y climbed a d-high mountain}\}]$

[28] To account for cases where the licensor is a (wh-)predicate, as in the partitioning environments discussed in the previous section, the contribution of focus marking needs to be taken into account. See especially Heim (1999) for discussion. However, since the effects of focus on the interpretation of superlatives are not central to the paper, I will ignore complications that might arise here.

[29] I ignore the presupposition here to keep the denotations readable.

The salient difference between (40b) and (41b) is that in the former the comparison class represented by C contains all (contextually relevant) mountains while in the latter C contains all (contextually relevant) individuals. This difference implies that the predicate denoted by [[-est C] d-*high mountain*] is true of the highest mountain (i.e. Mount Everest if all mountains are contextually relevant), therefore representing the absolute reading of *highest mountain.* The predicate [[-est C] *climbed a* d-*high mountain*], on the other hand, will be true of an individual that climbed a mountain that is higher than any other mountain climbed by somebody in C, therefore representing the relative reading of *highest mountain*.

When this analysis is applied to d-*many mountains* the denotations in (42) are predicted.

(42) a. $[\![[\text{-est C}]_i\ [d_i\text{-many mountains}]]\!] = \lambda x.\forall y \in C\ [y \neq x \rightarrow \max\{d\text{:mountains}(x) = 1\ \&\ |x| \geq d\} > \max\{d\text{: }|y| \geq d\}]$

b. $[\![[\text{-est C}]_i\ [\text{climbed}\ [\varnothing\ d_i\text{-many mountains}]]]\!] = \lambda x.\forall y \in C\ [y \neq x \rightarrow \max\{d\text{:}\exists z\ [\text{mountains}(z) = 1\ \&\ |z| \geq d\ \&\ x \text{ climbed } z]\} > \max\{d\text{:}\exists z\ [\text{mountains}(z) = 1\ \&\ |z| \geq d\ \&\ y \text{ climbed } z]\}]$

The salient difference between (42a) and (42b) is that in the former, pluralities of mountains are compared in terms of how many atomic parts they have, while in the latter, individuals are compared in terms of how many mountains they climbed. In other words, (42b) is true of an individual x if x climbed more mountains than any other salient individual; it therefore represents the relative reading of the superlative of *most.*

The denotation of (42a) depends on the assumption we make regarding the non-identity of pluralities. There seem to be in principle two options: two pluralities could be different if there is at least some non-overlap or if there is no overlap. The stronger condition for non-identity needs to be assumed whenever pluralities are measured in terms of the number of atomic parts they have (e.g. Krifka 1989, 1996; Hackl 2000). This immediately predicts a number of results for *MOST* without further stipulation.[30]

Under the assumption that two pluralities are non-identical (for the purpose of counting) only if there is no overlap between them, (42a) denotes the set of pluralities of mountains whose cardinality is higher than their Boolean complements. For instance, if there are 5 mountains (m_1,…,m_5) under consideration, any plurality of mountains comprised of 3 or 4 atomic mountains (e.g. $m_1 \oplus m_2 \oplus m_3$) will satisfy the condition that there is no plurality of mountains different from it whose number of atomic parts is 3 or 4. Any plurality with 2 or 1 atomic mountain parts (e.g. $m_1 \oplus m_2$) will not meet that condition since there will be pluralities of mountains in C that have two or more atomic parts. Note, furthermore, that the presupposition that there be at least two different individuals in C excludes the maximal plurality of mountains that is comprised of all atomic mountains. If the maximal plurality of

[30] The weaker condition arguably results in trivializing *most* since only the maximal plurality of mountains can have more atomic parts than any other plurality of mountains.

mountains were in C, no other plurality of mountains could be in C because there would always be some overlap. This, I suggest, is the reason why there is no genuine absolute reading for *MOST*, which would be akin to *all*. [31] In addition, it is predicted that *most A B* is necessarily false if there are only two individuals in A, which, arguably, explains why *most* is infelicitous in such circumstances.[32]

(43) ?? John has climbed most of the two mountains in his county.

Yet another consequence of the above observations is that the definite determiner will always be undefined if [-est C] stays inside the *most*-DP because the maximality presupposition of *the* (cf. Link 1983) could only be satisfied by the maximal plurality of mountains, which is excluded by the presupposition of the superlative. Since *the* has to be indefinite whenever *–est* leaves the DP, it follows that *THE* is always indefinite when it caps a *MOST* DP.[33]

To complete the derivation of *MOST* as a proportional determiner, we need to consider the meaning of the entire DP $[_{DP} \varnothing$ [-est C]$_i$ [d_i-many mountains]]. Since such DPs are capped by an existential determiner, we derive truth conditions as in (44), which are indeed identical to those of a proportional determiner.

(44) [[John climbed [$\varnothing$ [-est C]$_i$ [d_i-many mountains]]]] =1 iff
$\exists x$ [John climbed x & $\forall y \in$ C [$y \neq x \rightarrow \max\{d: \text{mountains}(x) = 1 \,\&\, |x| \geq d\} > \max\{d: \text{mountains}(y) = 1 \,\&\, |y| \geq d\}$]]

(44) demands that there is a plurality of mountains that John climbed and that is more numerous than any other plurality of mountains. In other words, (44) is true as long as John climbed more mountains than he didn't climb. Note that the structure that gives rise to proportional truth conditions will not be in competition with a definite comparative anymore since the number of entities that are being compared, i.e. the set of pluralities satisfying *mountains*, is necessarily bigger than 2.

[31] There is an ongoing debate in pragmatics whether a statement of the form *most* A B is necessarily incompatible with a situation where all As are Bs; see, e.g., Ariel (2004), Horn (2005), Papafragou and Schwarz (2006). Since the proposal developed here locates the source of the inference to "not all" in a presupposition (or a conventional implicature) supplied by *–est*, apparent counterexamples to "not all" would be treated as cases of presupposition (conventional implicature) cancellations. It seems to me that this is a rather promising take on the issue, which avoids a number of shortcomings of neo-Gricean proposals and its competitors. However, since this issue is not central to the goal of this paper, I will have to leave it for another occasion.

[32] Whether the account of *most mountains* presented here extends naturally to cases of plural superlative DPs such as *the highest mountains* is a nontrivial issue that I will have to leave for another occasion. Cf. Stateva (2005) for relevant discussion.

[33] Whether this fact stands in the way of explaining why *most* is a "strong" determiner is not immediately clear. For instance, an explanation for the fact that *most* is excluded in the coda position of the existential *there*-construction depends on what type of account one assumes in general for this definiteness effect. The analysis proposed here does, however, seem to be incompatible with a purely denotational account such as Keenan's (2003). Such accounts are challenged also by the acceptability of sentences such as *There are more students in the garden than there aren't*, and by the fact that *more than half* leads to a much weaker DE effect than *most*. See Landman (2004) for discussion. Cf. also Szabolcsi (1997) for evidence that *most* and *more than half* differ in their scope taking properties.

When we apply the same analysis to *FEWEST*, the predicted truth conditions are, interestingly enough, not equivalent to *less than half*. [34] In fact, the truth conditions we derive in (45) can never be met.

(45) $[\![$John climbed $[\varnothing$ [-est C]$_i$ [d_i-few mountains]]$]\!] = 1$ iff
$\exists x$ [John climbed x & $\forall y \in C$ [$y \neq x \rightarrow \max\{d$: mountains$(x) = 1 \& |x| \geq d\} <$
$\max\{d$: mountains$(y) = 1$ & $|y| = d\}$]]

The reason that (45) is always false is that one cannot find a plurality of mountains, however small, such that all disjoint alternatives are more numerous. Assume, again for sake of concreteness, that there are only 5 mountains $m_1,\ldots,m_5$ under consideration. m_1 does not satisfy the condition that all disjoint alternative pluralities of mountains are more numerous since e.g. m_2 does not overlap with but is as numerous as m_1. Likewise, for any larger plurality of mountains different from the maximal mountain plurality, it will be possible to find a disjoint mountain plurality that is smaller in number. Hence, the only plurality that could satisfy the condition in (45) is the maximum, which is excluded by the presupposition of *-EST* that there be at least two distinct elements in C. This means that a DP hosting *FEW* and *–EST* will be pathological in that no plurality can satisfy the condition expressed by [[-EST C] $_i$ [d_i-few mountains]]. [35]

Importantly, movement of [–EST C] into the matrix results in a denotation for *FEWEST* that is not anymore necessarily false for every individual. Recall that when the superlative operator is moved into the matrix, individuals are compared in terms of how few mountains they have climbed rather than the cardinality of various pluralities of mountains per se. As shown in (46), this means that the predicate [[-est C]$_i$ [climbed [$\varnothing$ d_i-few mountains]] is true of an individual x only if the number of mountains that x climbed is smaller than the number of mountains that anybody else climbed. [36]

[34] Since it is not essential to my point, for ease of exposition I simply stipulate that the superlative of *FEW* demands that no alternative plurality has as many or less atomic parts while the superlative of *MANY* demands that no alternative has as many or more atomic parts. See Kennedy (1999), Heim (2001) among others for more sophisticated treatments of polar opposites, which would be compatible with the analysis presented here.

[35] As Michael Glanzberg (pers. comm.) pointed out, for this reasoning to go through, one needs to assume that the pluralized NP, which by assumption comprises C, cannot be suitably restricted so that it contains only, e.g., $m_1 \oplus m_2$ and $m_3 \oplus m_4 \oplus m_5$. It seems, however, that modification of this kind is quite generally not available unless there is sufficient explicit linguistic material in the structure to support it. Arnim von Stechow (p.c.) observes that a general purpose maxim of charity ("Interpret a structure so that it has the best shot at being true!") could do the trick since it would make sure that *NP would always contain only two pluralities, one that is comprised of less than half of the atomic elements in *NP and its complement. Clearly, extensions of this sort would give the structure the best shot at generating a true sentence since only under such *NP denotations could the superlative DP result in a non-pathological meaning. However, to ensure such a denotation, it is essential to determine what half the number of atomic elements is. Applying this constraint, then, would require employing the type meaning (*less than half*) that it is called in to rescue, which seems highly dubious at best. Thanks to Sigrid Beck (p.c.) for this point.

[36] Many thanks to Arnim von Stechow (p.c.) for pointing out that a more standard semantics for the superlative as given in (i) makes the same prediction of unsatisfiability for *FEWEST* even when the superlative moves into the matrix.
(i) $[\![$-EST$]\!]$ (C)(D)(x) = 1 iff $\exists d$ [D(d)(x) = 1 & $\forall y \in C$ [$y \neq x \rightarrow \neg D(d)(y)$]]

(46) $[\![[\text{-est C}]_i\ [\text{climbed}\ [\varnothing\ d_i\text{-few mountains}]]]\!] = \lambda x.\forall y \in C\ [y \neq x \rightarrow \max\{d{:}\exists z\ [\text{mountains}(z) = 1\ \&\ |z| \geq d\ \&\ x\ \text{climbed}\ z]\} < \max\{d{:}\exists z\ [\text{mountains}(z) = 1\ \&\ |z| \geq d\ \&\ y\ \text{climbed}\ z]\}]$

These are, of course, conditions that a given individual could meet. Furthermore, they correspond exactly to the relative-superlative interpretation of the superlative.

(42), (45), and (46) taken together explain why there is a proportional interpretation for *MOST* but no such interpretation for *FEWEST*. $MOST_{prop}$ arises when the superlative morpheme stays inside the DP. This produces a predicate that is true of a plurality that is bigger in cardinality than the biggest non-overlapping alternative. The corresponding structure for *FEWEST*, however, yields a predicate that would be true of a plurality that is smaller in cardinality than the smallest non-overlapping alternative. As we have seen above, no plurality can actually meet this condition, which, i suggest, is fundamentally the reason why $FEWEST_{prop}$ does not exist.

In summary, we have seen crosslinguistic evidence that supports an analysis of *MOST* as superlative, even when it is interpreted as a proportional determiner. The argument, in a nutshell, is that such an analysis can explain why crosslinguistically $MOST_{prop}$ is closely related to the superlative of *MANY* and why its distribution in languages where *MOST* is seemingly ambiguous between a superlative and a proportional determiner is subject to the same constraints as superlatives in general. We have also seen that analyzing $MOST_{prop}$ as superlative yields a principled explanation of why its polar opposite *FEWEST* cannot be used as a proportional quantifier. Within GQT, these facts remain unexplained because GQT treats expressions such as $MOST_{prop}$, *more than half*, and *less than half* simply as unanalyzed lexical items. This makes it impossible to understand why the superlative of *MANY* can express the same meaning as *more than half* while the superlative of *FEW* cannot express the truth-conditional import of the corresponding *less than half*. The compositional treatment of *MOST* and *FEWEST* presented here, on the other hand, offers a principled explanation of these facts.

This concludes the first (language internal) argument in support of a decompositional treatment of *most* and *more than half*. [37] The next section presents language external evidence that shows once again that GQT is too coarse to account for systematic differences between *most* and *more than half*. Specifically, I present experimental studies of verification procedures triggered by *most* and *more than half*, which reveal systematic differences in verification profiles triggered by these two quantifiers. The differences we observe dovetail nicely with the results of the previous section in that they indicate that the particular form in which truth conditions for quantified statements of the form *most* A B and *more than half* A B are stated affects verification strategies in ways that naturally fit with an analysis of *most* as a superlative and *more than half* as a comparative expression of proportions.

[37] Giving a unified, fully compositional treatment of proportional quantifiers such as proportional mass and count quantifiers like *more than half, two out of ten, less than 80% of, exactly three eighths of* (*an inch of*), or frequency quantifiers such as *every third* is a formidable challenge, which has not been attempted as far as I know. See e.g. Landman (2004) for recent discussion of proportional quantifiers as relational degree expressions and Ionin and Matushansky (2006) for a more general discussion of complex numerals.

4. Distinct verification strategies of *most* and *more than half*

Recall that GQT's insensitivity to the form of determiners declares the two definitions of *most* and *more than half* in (47a,b) (repeated from above) to be equally good even though they employ quite different operators.

(47) a. [[most]] (A)(B) = 1 iff |A ∩ B| > |A − B|
b. [[more than half]] (A)(B) = 1 iff |A ∩ B| > ½ |A|

The analysis of *MOST* I have argued for above suggests, on the other hand, that the format of (47a) is preferable for *most* over the one given in (47b) because $MOST_{prop}$ employs operators whose semantic import mimics more closely (47a) than (47b). Of course, the opposite is true of *more than half*, given that *half* likely invokes division by 2.[38]

To see that the treatment of *most* in (47a) mimics closely the analysis of $MOST_{prop}$ I provided in the previous section recall that according to my analysis a sentence like (48a) can be paraphrased as in (48b).

(48) a. It snowed on top of most mountains.
b. There is a plurality of mountains x that is more numerous than the biggest mountain plurality that does not overlap with x and it snowed on top of x.

Using the GQT notation (replacing pluralities of mountains with subsets of mountains) we can represent the truth-conditional import of $MOST_{prop}$ as in (49a). However, since the claim that there is a set of snowed-on mountains that is more numerous than any non-overlapping set of mountains is true iff the number of mountains that it snowed on is bigger than the size of the complement of the snowed-on set, (49a) effectively amounts to (49b), which is, of course, equivalent to (47a).

(49) a. [[most]] (A)(B) = 1 iff ∃X [X ⊆ A & X ⊆ B & |X| > |A –X|]
b. [[most]] (A)(B) = 1 iff |A ∩ B| > |A − A ∩ B|

The question I want to ask in this section is, then, whether there is language external evidence from verification tasks that supports the claim that the truth-conditional import of *most* should be rendered as in (47a) rather than as in (47b). More specifically, the question I want to pursue is whether the difference between the right-hand sides of (47a) and (47b) is indeed cognitively significant in verification tasks and whether the difference is a function of the determiner that is being used.

While both renditions of the truth-conditional import of *most* and *more than half* are equivalent, it is easily conceivable that they are cognitively distinct. In particular, (47b) taken literally calls for determining half the total number of As while (47a) doesn't. Instead, (47a) requires the comparison of the number of As that are Bs to the number of As that are not Bs. Hence, assuming that these descriptions of truth conditions inform verification procedures, we would expect to see different

[38] I use the GQT notation here as a matter of convenience. It should be taken as shorthand for decompositional treatments of *most* and *more than half.*

verification profiles if *most* and *more than half* are associated with different formats for stating the same truth conditions.

To see how one might be able to investigate this issue, consider what natural verification strategies for *most* and *more than half* would be if indeed the former goes with (47a) and the latter with (47b). A natural algorithm triggered by (47a) might be a form of vote-counting where subjects simply keep track of whether for each A that is a B there is also an A that is not a B. If at least one A that is a B can be found that does not have a counterpart A that is not a B, the statement will be true; otherwise it will be false. *More than half*, on the other hand, might trigger an algorithm that is more akin to checking whether the number of As that are Bs is bigger than some criterion n which represents half the total number of As.

To see whether such a difference in verification strategy exists, I employ a new experimental paradigm, *Self-Paced Counting* (SPC). SPC allows one to gather fine-grained timing information about how subjects gather information incrementally in verification tasks that involve counting.

4.1 Self-Paced Counting

Solving a verification problem that involves counting the number of objects in a scene is a complex task with many degrees of freedom, especially when the scene is displayed all at once. This makes it rather difficult to relate an observed difference in verification to a difference in linguistic form. To sidestep this difficulty, SPC reveals a given scene in a step-by-step and self-paced fashion quite similar to the widely used Self-Paced Reading methodology. In a typical trial, subjects hear a sentence such as *Most of the dots are blue* or *More than half of the dots are blue*[39] played over speakers attached to a computer. They will then see two scattered rows of dots displayed on a computer screen. The dots are at first only outlined (Screen 1 in Fig. 1). As subjects press the spacebar the dots are uncovered in increments of two or three, while previously seen dots are masked. Subjects can answer true or false by pressing the appropriate response key on a keyboard at any time during the trial and are encouraged to answer as fast and as reliably as possible.

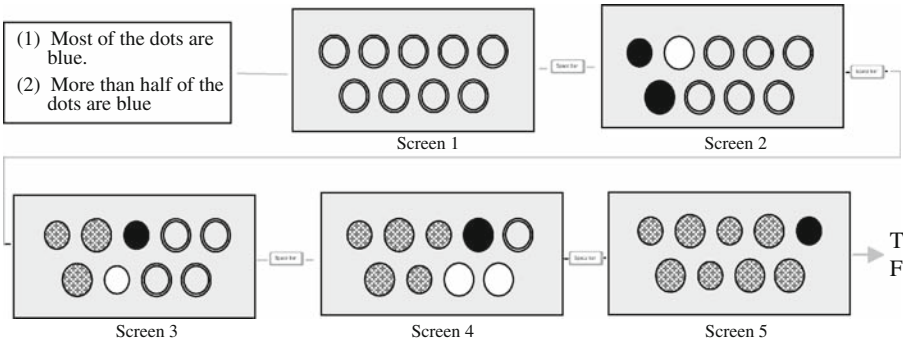


Fig. 1 Sequence of events in Revised Self-Paced Counting

[39] Thanks to Ben Acland, Jorie Koster-Moeller, and Jason Varvoutis for their help with designing and conducting the experiments.

4.2 Experiment 1: *most* versus *more than half*

Methods and Materials. The first study reported here compares sentences like *Most of the dots are blue* and *More than half of the dots are blue.*[40] There were 24 target items, 12 *most* and 12 *more than half* items, with 6 true and 6 false in each group. The difference between true and false was a difference of one dot (e.g. an 11-dot array had 6 dots in the target color for the true case, and only 5 target dots for false). Target items varied in total number of dots, with 4 items of 10, 11, and 12 dots each. Within the first four screens,[41] it was impossible to determine whether the sentence was true or false; none of the screens had dots in only one color and each new set of dots within the first four screens had at least two dots. Furthermore, the size of the dots was systematically varied so that within the first four frames, neither color had a mass advantage. Four different colors were used (red, blue, green, and yellow) and every dot array used only two different colors. Each dot array was used twice, once for a *most* sentence and once for a *more than half* sentence, ensuring that no confounding factors from array design had a differential effect.

Thirty six filler items were used, 18 true and 18 false. Filler arrays ranged from 7 to 12 dots and were paired with sentences of the form *More than 5/only 6/7/many/few/some dots are blue*. Subjects got 10 practice items similar to the filler items.

Stimuli were presented using the Presentation software package from Neurobehavioral Systems on a PC, which recorded the time between successive space bar presses, the time it took to press an answer key, the screen at which the answer key was pressed, and whether the given answer was correct.

Twenty undergraduate students at the Claremont Colleges, all native speakers of English, participated in this experiment. Subjects received either course credit or 5 dollars in cash as compensation.

Results. Only data from subjects whose overall success rate across all items of the experiment was at least 80% are included in the analysis. No subjects were excluded by this criterion.[42] Furthermore, only reaction times from correctly answered trials that were answered after the first four screens were analyzed.

Two broad measures of difficulty—percentage of correct answers and overall reaction times[43]—suggest that subjects treated *most* and *more than half* as equivalent expressions in Experiment 1.

As can be seen in Fig. 2, accuracy rates are high in both cases and not significantly different, and overall reactions times are also not significantly different.

[40] Note that the experimental sentences have an overt partitive structure (*of the dots*). Although the partitive can interact in interesting ways with the superlative, the core semantic properties of *most* are not affected by the partitive structure. Furthermore, the experimental material is designed to sidestep any effects of the partitive.

[41] Note that Screen 1 is the "planning stage," in which the participant has sees the array of empty dots. Screen 2 is the first frame in which colored dots appear.

[42] One subject was excluded after she reported in her debriefing that she consistently counted the total number of dots before she started to uncover the colors. This strategy resulted in much longer RTs for Screen 1, while all other screens were faster than those from other subjects.

[43] Overall reaction time is reported as the interval from starting time (when the participant first sees the opening array of unfilled dots) to answer time (when the participant responds true/false).

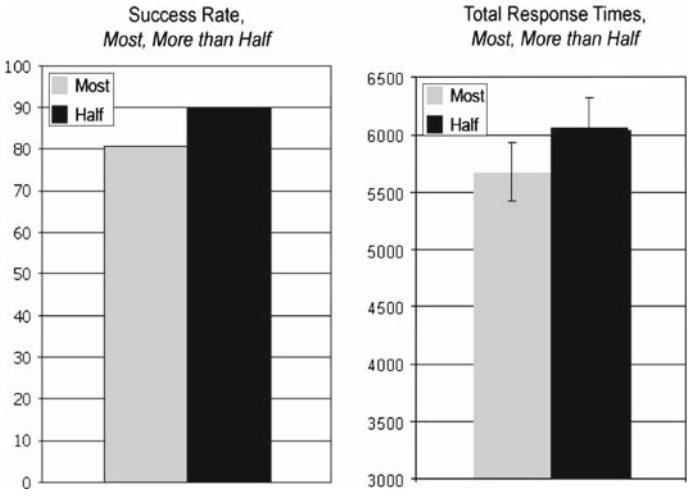


Fig. 2 Accuracy and overall RT for *most* and *more than half*, Experiment 1

Thus, even though *most* and *more than half* are quite different in form, these subjects judged them to be true and false in the same circumstances and making those decisions took them essentially equally long.

To look inside the verification process, RTs between successive space bar presses for Screen 1 to Screen 4 were analyzed using a 2×4 ANOVA crossing Determiner with Screen number. As can be seen in Fig. 3, there is a main effect of Determiner such that *most* is consistently faster for subjects than *more than half* ($F(1,18) = 9.492$; $p = 0.006$) and a main effect of Screen such that RTs increase the farther subjects get into the array ($F(3,54) = 4.785$; $p = 0.005$). No other significant effects were found.

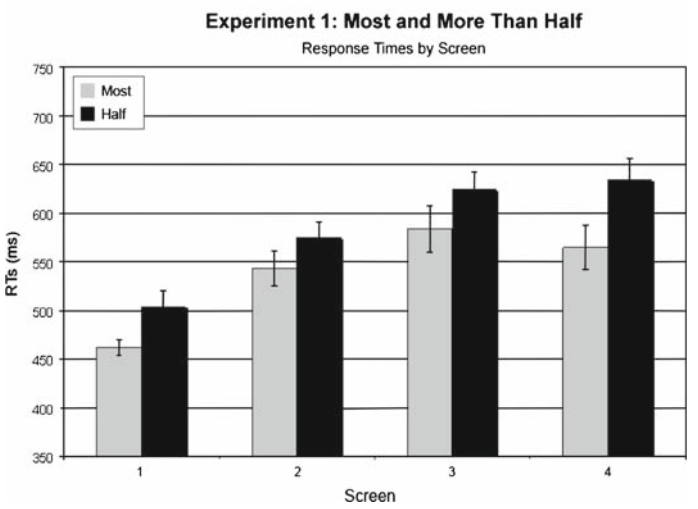


Fig. 3 RTs for *most* and *more than half*, Screens 1–4, Experiment 1

Discussion. We can take the fact that the accuracy and overall RTs for *most* and *more than half* are not significantly different as evidence that participants in Experiment 1 do indeed treat the two expressions as essentially equivalent in the context of the self-paced counting experiment. Given this, the fact that RTs are consistently faster over the first 4 screens for *most* seems puzzling, and suggests that the strategy triggered by *most* is better suited for the way information is uncovered in these screens.[44] Since Screens 1–4 were designed so that each could be easily evaluated as to whether there are more dots in the target color than dots that aren't, this make sense if *most* triggers a type of vote counting algorithm that is accompanied by keeping track of whether the target color leads overall and by how much (lead counting). Counting the total number of dots or even just the total number of dots in the target color is not required by this strategy. *More than half*, on the other hand, seems to trigger a different algorithm, one that might be more similar to counting the number of dots in the target color and comparing it to a criterion—the criterion being (an estimate of) half the number of dots.[45]

To support this perspective and show that SPC tracks the difficulty of counting tasks faithfully, a control experiment (Experiment 2) was conducted that used exactly the same dot arrays but paired them with sentences of the form *more than n* and *at least n + 1*, which clearly require a counting strategy.

4.3 Experiment 2: *more than n* and *at least n+1*

Experiment 2 aimed to establish two things about SPC. First, it is important to show that SPC traces counting difficulties faithfully. To do this counting quantifiers such as *more than n* and at *least n+1* were used, which clearly trigger a counting strategy. Second, it is important to show that the findings of Experiment 1 weren't simply due to superficial (morpho-phonological) differences between *most* and *more than half*. If that had been the case, one might have expected the superlative *at least n* to pattern like *most*, and the comparative *more than n* to pattern like *more than half*.

Methods and Materials. To achieve both goals, the same materials were used as in Experiment 1 except that the *more than half* target sentences were replaced with *more*

[44] Ariel (2004) presents data from questionnaire studies on *most* and *more than half*, indicating that *most* A B is much more intolerant than *more than half* to situations where in fact all As are Bs. However, since in all the experiments presented in this paper the universal statement *All As are Bs* is falsified on the first screen, this difference cannot affect the outcome of the experiments presented here. Additionally, the questionnaires found that *more than half* is used with more confidence than *most* when the total number of As that are Bs is not too far above the halfway mark. This also cannot explain these findings, as it would predict that verifying *more than half* statements should be easier and not harder than verifying *most* statements—the exact opposite of what we saw on Screens 1–4.

[45] After Screen 4, dots were uncovered in such a way that there were as many true as false items. Furthermore, the total number of space bar presses to get to the answer screen was varied. (Note that since the same arrays were used for both determiners, these factors cannot be responsible for the difference on the relative RTs.) These design considerations do make it difficult to compare RTs over frames 5 and 6. However, the fact that *most* and *more than half* take equally long overall implies that processing *most* after Screen 4 must take longer than processing *more than half*. Presumably, this is so because the uncovered dots after Screen 4 are on average harder to process for *most*. This supports the interpretation that the main effect of determiner over the first three frames is due to a difference in verification strategy rather than a more superficial difference between *most* and *more than half*.

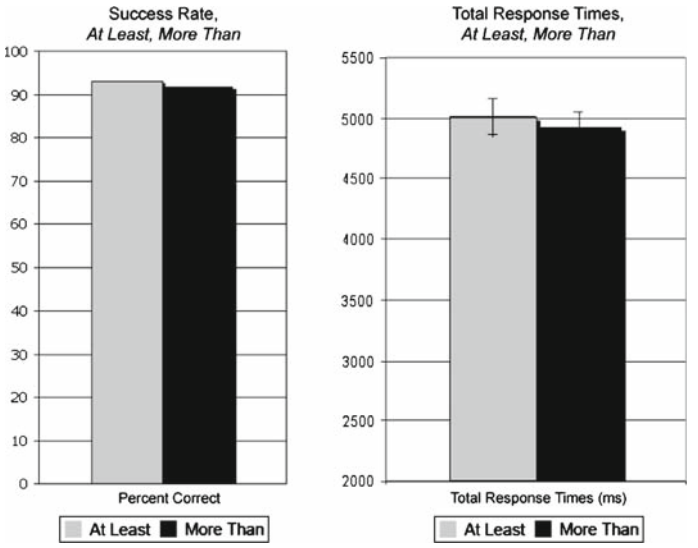


Fig. 4 Accuracy and overall RT for *at least* and *more than,* Experiment 2

than n sentences (n varied between 5 and 6 depending on what half of the given array was) and the *most* target sentences with the equivalent *at least n+1* sentences. Both sentence types clearly invite a strategy of counting the total number of dots in the target color until the criterion is reached. 12 different undergraduate students at the Claremont Colleges, all native speakers of English, participated in this experiment. Subjects received either course credit or 5 dollars in cash as compensation.

Results. Overall success rates were again very high (>90%), so that no subjects were excluded from the analysis, as was the percentage of correct answers for the target items. No significant difference was found. Overall RTs for target items are almost identical as well (Fig. 4).

Looking inside the verification process we see no effect of determiner ($F(1,11) = 0.036$, $p = 0.56$) but a highly significant effect of Screen, such that later screens require more processing time ($F(3,33) = 12.578$, $p < 0.001$). No other effects were significant.

Discussion. The linear increase in RT we observe over the first four screens suggests that SPC is sensitive to difficulties that are inherent to counting tasks. Furthermore, the fact that there is no difference between *more than n* and the denotationally equivalent *at least n + 1* within the first four frames shows that SPC traces verification strategies faithfully and does not simply reflect superficial differences in linguistic form (*at least* being superlative in form and *more than* being comparative in form) (Fig. 5). Both observations support the interpretation of the results of Experiment 1, according to which the difference between the RT profiles of *most* and *more than half* reflects a difference in verification strategies triggered by these two expressions.

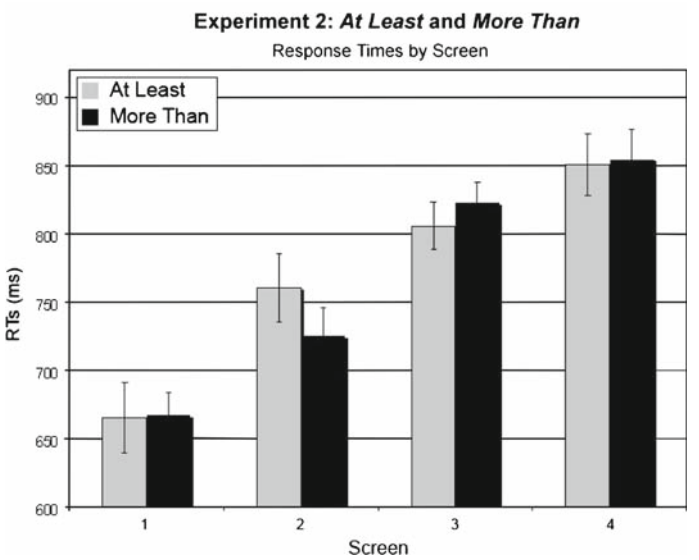


Fig. 5 RTs for *at least* and *more than*, Screens 1–4, Experiment 2

4.4 Experiment 3: distributional asymmetries

The findings of Experiment 1 and Experiment 2 support the hypotheses that *most* and *more than half* trigger different verification procedures that are systematically related to the logical forms projected from these determiners. To provide further support for this claim a third experiment was conducted, in which the dot arrays were constructed so that the verification procedure triggered by *most* was disproportionately affected compared to the verification procedure triggered by *more than half*.

Recall that the advantage of verifying *most* A B over verifying *more than half* A B in Experiment 1 was attributed to the way the dot arrays were designed and uncovered. Specifically, each subset of dots (within the first four screens) that was uncovered satisfied the following two conditions: there were at least two and no more than three dots in any given screen and every screen had at least one dot in each color. These constraints not only guaranteed that the presuppositions attributed to *most* in Sect. 3.3 were met on each screen, they also insured that the difference between dots in the target color and dots in the other color was always small (in fact it was never bigger than 2). These properties minimized the need to engage an explicit counting routine and instead encouraged an algorithm that simply evaluates successive screens in terms of whether the target color leads. Since *most*, by hypothesis, lends itself more straightforwardly to such a verification procedure than *more than half* (which seems to invite a counting strategy where the number of dots in the target color is compared to half the number of dots), it is easier to verify. From this, it follows that if the dot arrays do not satisfy the conditions that favor a lead counting strategy, verifying *most* should get harder while *more than half* should be relatively unaffected.

One way to achieve this is to manipulate the distribution of dots in the target color. In Experiment 3 this was done so that in half the cases, nearly all dots in the

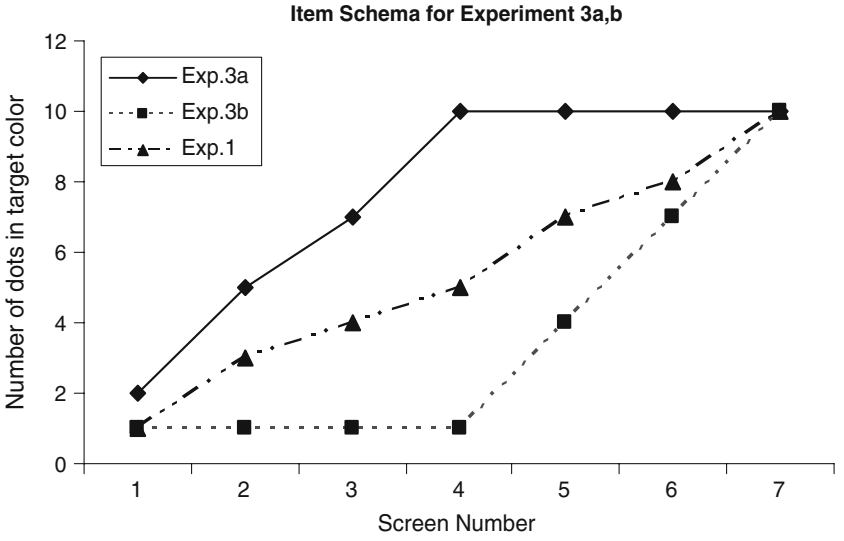


Fig. 6 Item schema of Experiment 3—asymmetrical distribution

target color were at the beginning, while in the other half nearly all dots in the target color were at the end of the array. Figure 6 sketches the distributional properties of dots in the target color in Experiment 1, where the total count of dots in the target color is reached gradually, and in Experiment 3, where the target dot count was skewed to the beginning or the end. Experiment 3a, the "early" condition, has nearly all dots in the target color at the beginning while Experiment 3b, the "late" condition, has them at the end.

Since it is possible that distributional asymmetries in Fig. 6 add general complexity, we derive only a differential prediction: *most*, which by hypothesis triggers a lead-counting algorithm, should be relatively more affected by the early versus late manipulation than *more than half*. This expectation is motivated by the fact that verifying *more than half* but not *most* has a component, namely counting (or estimating) how many half of the dots is, that is constant across all frames, and so should not be affected by the distributional asymmetries at all.

Methods and Materials. To execute this idea it was necessary to modify the basic SPC design in a number of ways. Specifically, an array of three rows with a total of 19 possible slots was used. Each slot was covered by a hexagonal rather than a round mask, which allowed the use of additional shapes. As before, space bar presses uncovered subsets of two or three slots and masked the previously seen subset. However, in the modified design, each uncovered mask could reveal either a colored dot, a colored distractor shape such as a star or a square, or an empty slot. Using empty slots and distractor shapes makes it possible to manipulate the total number of dots without shortening the length of the array. This removes the length of a dot array as potential clue for the total number of dots. Figure 7 is a sketch of a typical target array of Experiment 3.

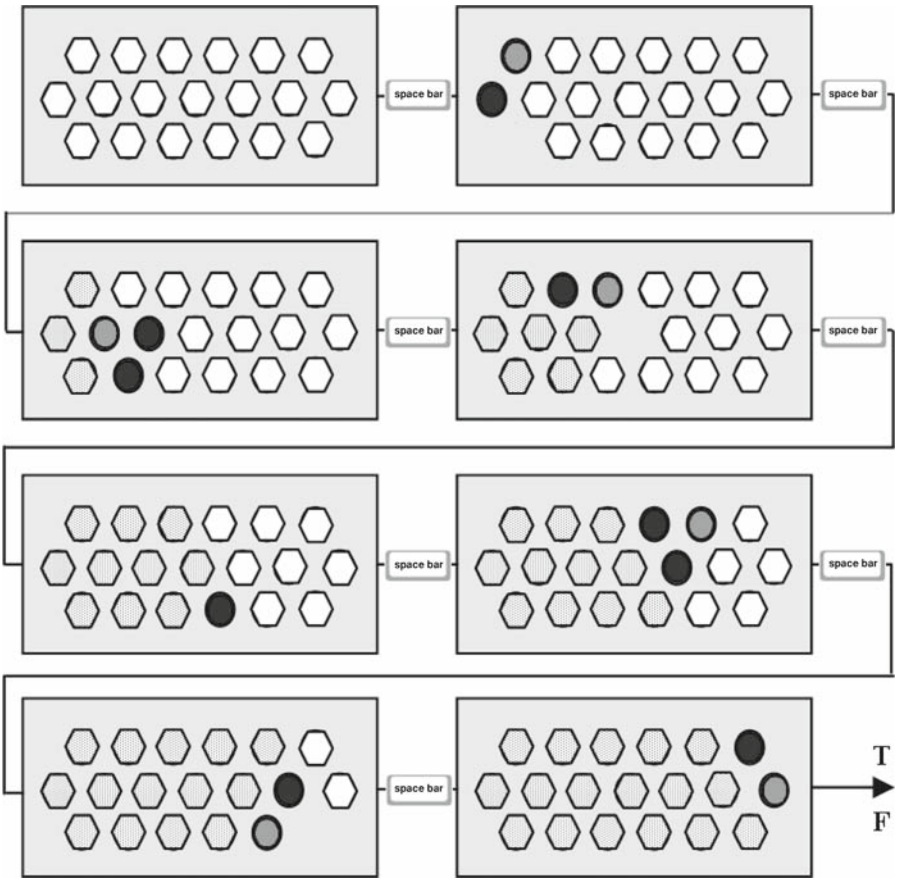


Fig. 7 Sequence of events in Revised Self-Paced Counting trial

Sixteen early and 16 late dot arrays were used, half of them true and half of them false. Each array was used twice, once in combination with a *most* sentence and once in combination with a *more than half* sentence. To ensure the felicity of *most* statements from the start, a dot in the non-target color was included in the opening screen for the early condition and, for symmetry reasons, a dot in the target color in the late condition. Truth or falsity of the items was determined on the last screen, which either contained a dot in the non-target color to falsify the statement, or an empty slot or a distractor object in its place to verify the statement. 128 filler items, which were similar to the filler items used in Experiment 1 and 2 (with both different shapes and empty slots) were used. 32 of the filler items used asymmetric distributions and 64 used gradual distributions of targets. 10 different undergraduate students at the Claremont Colleges, all native speakers of English, participated in this experiment. Subjects received either course credit or 5 dollars in cash as compensation.

Results. Despite the fact that the modified design is more demanding, with empty slots as well as distractor objects, the overall success rate remained high (>80%).

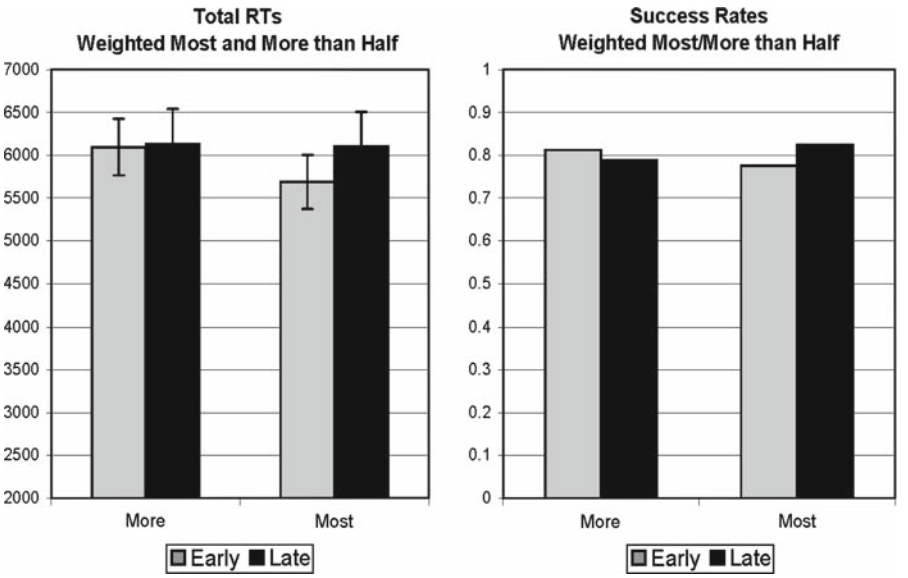


Fig. 8 Success rates and RTs for *most* and *more than half* in Early and Late. Experiment 3

Lowering the inclusion criterion slightly to >75%, none of the subjects needed to be excluded from the analysis. Accuracy for target items was again high and not significantly different across the four target conditions. Likewise, total reaction times did not show any effect of determiner or distribution, as seen in Fig. 8.

Looking more closely at the verification process (Fig. 9), visual inspection reveals two areas where RTs vary as a function of our factors: over the first three screens and over the last two screens. Importantly, RTs for *most* are affected in both areas by the distributional factor (Early/Late) while *more than half* is only affected on Screens 1 and 2. Otherwise RTs for *more than half* run parallel.

This difference between *most* and *more than half* is statistically significant as revealed by a 3-way-interaction (Determiner-by-Distribution-by-Screen) over Screens 2–3 ($F(1,9) = 16.308$; $p = 0.003$) and a 2-way-interaction (Determiner-by-Distribution) over Screens 6–7 [$F(1,9) = 4.366$; $p = 0.066$]. No other relevant effects were significant.

Discussion. As can be seen in Fig. 9, the distributional asymmetries that characterize the target items in Experiment 3 affect the verification strategies used by the subjects. In fact, both verification processes for *most* and *more than half* seem to reflect the distributional patterns of the items.[46] What is important to the discussion

[46] Why this is so is not entirely clear to us. The reason why RTs dip in the middle screens of the verification process is plausible due to the fact that subjects could predict after Screen 3 that the next screens would contain dots in one color only. That is, there were no filler items that mirrored only the beginning of the Late or Early target items and would continue with a random arrangement of dots. Future research will be necessary to assess the effect of that design flaw and determine more generally the extent to which distributional properties affect counting.

here, however, is that *most* is more sensitive to the distributional asymmetries than *more than half*. In particular, *most* requires significantly more time in the Late condition in two phases of the verification process while *more than half* is essentially unaffected by the Early versus Late manipulation. This difference confirms the hypothesis that the verification strategies triggered by these two quantificational expressions are different, and, more specifically, that the verification strategy triggered by *most* is more sensitive to distributional properties of the dot arrays than the verification process triggered by *more than half*. Within the perspective developed earlier, this difference is explained by the hypothesis that *most* triggers a form of lead-counting if we make the additional, natural assumption that lead-counting is harder if the number of dots in the target color falls significantly behind the number of dots in the non-target color.[47] In the case of *more than half*, the verification strategy involves determining how much half of the total number of dots is, which is an aspect of the task that is entirely insensitive to distributional patterns. Hence, it is expected that *more than half* is less sensitive to the Early/Late factor even if we allow that counting the total number of dots in the target color is affected by the distributional asymmetries.

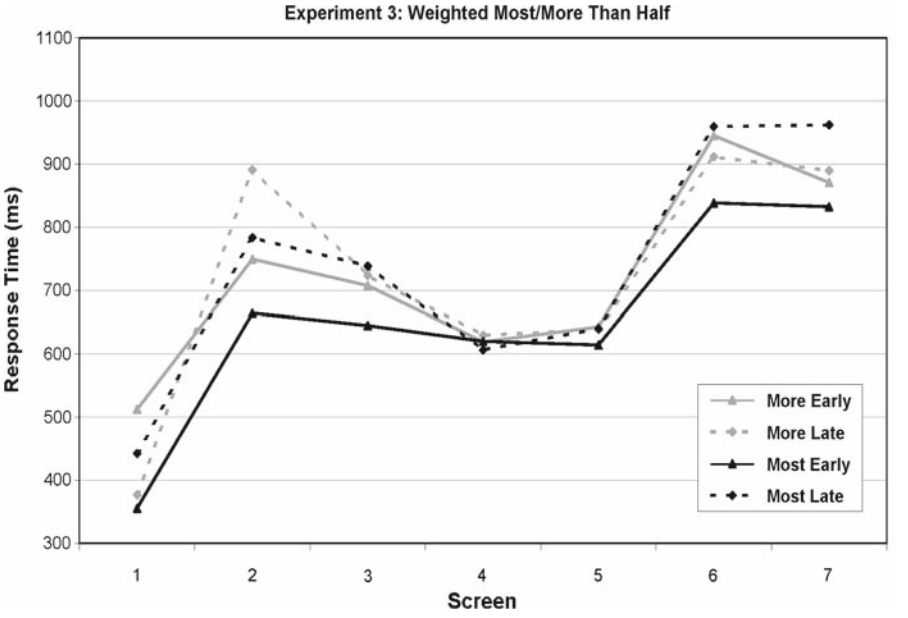


Fig. 9 RTs for *most, more than half* in Early/Late condition for Screens 1–7. Experiment 3

[47] The exception is Screen 2, where *more than half* in the Early condition takes more time than in the Late condition. I suspect that this spike is due to an outlier that could not be statistically excluded, due to the small number of subjects.

4.5 General discussion

The experimental studies presented in this section aimed at complementing the language internal arguments supporting a decompositional analysis of *most* and *more than half*. An analysis of *most* as a superlative and *more than half* as a comparative expression allowed us to generate different logical forms for truth-conditionally equivalent statements of the form *most* A B and *more than half of the* A B. Assuming furthermore that the logical forms (or the structured propositions derived from those logical forms) inform verification strategies, it is not unexpected that the two types of statements trigger different verification procedures, and moreover that these differences in verification correspond systematically to differences in the logical forms. In the comparison of *most* and *more than half*, I focused on the idea that *most* employs a complementation operator (along the lines of 'More As are Bs than there are As that are not Bs'), whereas *more than half* makes reference to half of the As, which is compared to the number of As that are Bs. I then hypothesized verification strategies that reflected this difference in a straightforward way. Specifically, I hypothesized that *most* triggers a form of lead-counting, which does not involve determining half the total number of As or even the total number of As that are Bs, but rather tracks the difference between the As that are Bs and the As that are not. *More than half*, I hypothesized, on the other hand, triggers a form of "counting to a criterion," i.e. the number of As that are Bs is compared to that of a criterion, which in the case of *more than half* is half the number of As.

To test whether *most* and *more than half* did in fact trigger different verification procedures along these lines, I conducted two experiments using SPC. In Experiment 1 the experimental items were constructed in such a way that lead-counting was an effective strategy, whereas determining whether the number of As that are Bs is bigger than half of the number of As was intuitively harder. The fact that *most* was indeed systematically advantaged (over the screens for which lead-counting was favored) supported my hypothesis. In Experiment 3, on the other hand, I modulated the distributional properties of the dot arrays in such a way that lead-counting was expected to be relatively more affected by the manipulation than criterion-counting. This differential prediction was confirmed again by the results, which lends further support to my claims. Experiment 2 verified that SPC is faithful to basic facts of counting, and does not show effects of purely morphological differences.

All three experiments taken together constitute a promising body of evidence suggesting that SPC's access to verification procedures is fine-grained enough to identify distinct verification profiles even if they are triggered by expressions that are truth-conditionally indistinguishable.

5 Summary

Formal semantic analyses restrict their attention to capturing the correct set of entailment patterns associated with a particular expression. They usually do not

concern themselves with comprehension or verification in real time. However, this does not relieve them of their responsibility to furnish the pieces that processing theories require to draw systematic distinctions that occur during real time comprehension.

In the case of quantification, fulfilling this obligation hinges on what type of semantic primitives one assumes for quantification in natural language. A compelling example is provided by the pair *most* and *more than half*, which are standardly treated as truth-conditionally equivalent quantifiers. I presented experimental evidence from real time verification studies that differentiates these two expressions in ways that seem to correspond to specific differences in their form – the former being a superlative and the latter a comparative expression of proportions. Observations of this sort call for a theory of quantification that exploits the internal make-up of complex determiners such as *most* and *more than half*. Generalized Quantifier Theory, which maintains that determiner quantifiers denote semantic primitives, is too coarse to do that and therefore falls short of providing the means to explain differences in verification profiles. The alternative perspective on *most* and *more than half* that I developed in this paper is motivated by crosslinguistic generalizations about the inventory of proportional quantifiers and supplies the necessary pieces in the form of a compositional analysis of proportional quantifiers.

Specifically, I offer a compositional analysis of *MOST* as the superlative of *MANY*, arguing that the proportional reading is in fact a special case of the superlative reading. Extending the analysis to *FEWEST* offers an explanation for a currently unexplained systematic gap in the paradigm of proportional quantifiers, namely that *FEWEST* cannot be used as a proportional quantifier. Such an analysis presupposes that the set of semantic primitives of quantification includes e.g. degree expressions, measure phrases, and comparative and superlative operators but not relations between sets as GQT would have it.

Acknowledgements Earlier versions of this paper have been presented at the Faculty Research Seminar in Linguistics and Cognitive Science (Pomona College), Linguistic Evidence 6 (Tübingen), CUNY 2006, the Number Reading Group (Harvard University), the Workshop on Scalar Meaning (University of Chicago), and semantics workshops at Rutgers University, MIT, Bicocca, and Tuebingen. I would like to thank the audiences at these events for valuable comments and suggestions. I also thank Sigrid Beck, Daniel Buering, Jerry Fodor, Danny Fox, Yosef Grodzinsky, Elena Guerzoni, and Arnim von Stechow. Special thanks go to Ben Acland, Jorie Koster-Moeller, and Jason Varvoutis for their help with the experimental part of this paper, to Chris Barker and Michael Glanzberg for their insightful and encouraging commentaries, to Jorie Koster-Moeller for invaluable help during the preparation of the final manuscript, and to two anonymous *NALS* reviewers. This research was funded by NSF Grant 0642748.

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