The semantics of *many, much, few,* and *little*

Jessica Rett

November 2016

1 Introduction

The words *many, much, few* and *little* (and their cross-linguistic counterparts) are quite unusual semantically. They have traditionally been characterized as quantifiers (like *every*) or adjectives (like *tall*); however, these analyses can only account for instances of these terms in which they encode information about an individual or set of individuals, as they do when they occur prenominally (in e.g. *much traffic*). Recent degree-semantic analyses (Rett, 2007, 2008b; Solt, 2014) instead characterize the meaning of these words in terms of scales, or sets of degrees, which can account for their canonical uses as well as uses in which they don't appear to be ranging over individuals (as in their differential use, e.g. *much taller than*).

2 An empirical overview

The semantic status of *many, much, few* and *little* is so indeterminate that there is no standard term for them and their cross-linguistic counterparts. I will settle on the relatively theory-neutral term "quantity words". I will assume that *few* and *little* are the negative antonyms of *many* and *much*, just as *short* and *small* are the negative antonyms of *tall* and *big* (see Lehrer 1985 and Rett 2015 for some discussion and treatment of this difference). I will also assume that the difference between *many/few* on the one hand and *much/little* on the other corresponds to the difference between count and mass nouns, whatever that might be.[1]

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[1] The quantity word *much* is only acceptable under negation in some (e.g. **John ate much rice*) but not all contexts (e.g. *Much attention was paid to this document*). Unfortunately, little research has been done on these idiosyncratic distributional properties of *much.*

Quantity words have a very wide distribution across constructions and categories. The canonical use of quantity words is their prenominal or attributive use, as in (1).

(1)   a.   Many/few guests left.
          b.   Much/little rice was consumed.

It is this use that makes them tempting to classify as quantifiers, given the parallel data in (2-a), although (2-b) shows that adjectives can occur in this position as well.

(2)   a.   All/some guests left.
          b.   Tall/short guests left.

Quantity words in this prenominal position can be modified by determiners like *that*, *how* and *what*, exemplified in (3). *Many* and *few* can additionally be modified by the determiner *the* (4), and *few* and *little* can additionally be modified by the indefinite determiner *a*. Quantity words share this ability with adjectives, but not with canonical quantifiers, as demonstrated in (4).

(3)   a. *John didn't meet that all/some guests.
          b.   John is not that tall/short.
          c.   John didn't each that much/many cookies.

(4)   a. *The all/some guests left.
          b.   The tall/short guests left.
          c.   The many/few guests left.

Also like adjectives, but unlike quantifiers, quantity words can occur in predicative position, as shown in (5), although the mass quantity words *much* and *little* are generally reported to be less acceptable in this position.

(5)   a. *John's regrets are all/some.
          b.   John's children are tall/short.
          c.   John's regrets are many/few.

There are other canonically adjectival positions in which quantity words can occur: those described by Bresnan (1973) as involving degree quantifiers like the equative *as*, the excessive *too*, and *so*.

(6)   a.   John is as tall as Sue.
          b.   John has as many regrets as Sue.

(7)   a.   John is too irresponsible to be an assistant.
       b.   John has too much experience to be an assistant.

(8)   a.   John is so clumsy that he can't play tennis.
       b.   John has so few suitcases that he had to borrow mine.

Two other constructions that fit in this paradigm are the comparative morpheme *-er* and superlative morpheme *-est* (Heim, 2000; Schwarzschild, 2008). While the forms of these constructions involving *few* are transparently constructed from quantity words, the other forms (*much, most* and *less, least*) very clearly involve suppletion (Bresnan, 1973; Bobaljik, 2012). It should be clear that standard quantifiers like *all* and *some* cannot occur in these positions.

From the discussion so far, quantity words pattern with quantifiers in only one configuration: prenominally. But they pattern with adjectives in several (prenominally; predicatively; with overt determiners; and with degree quantifiers). Quantity words are, however, acceptable in three additional configurations which admit neither quantifiers nor adjectives: the modification of verb phrases (VPs); preposition phrases (PPs); and comparatives, demonstrated in (9)–(11) below.

(9)   a.   John doesn't go to the movies much.
       b.   John sleeps little.

(10)   a.   The car drove much/little over/under the speed limit.
       b.   The picture isn't much above the mirror.

(11)   a.   John is much/little taller than Sue.
       b.   John drove much/little faster than Sue.
       c.   The desk is much/little farther away than the couch.

These distributional patterns are summarized in Table 1.

In what follows, I will be making a single distinction within the contexts in which quantity words can occur. 'Individual uses' of quantity words are those in which they appear to be ranging over individuals (or sets of individuals). This category includes the prenominal and predicative contexts, as well as prenominal uses of quantity words in degree quantifier constructions. In these cases (e.g. *(the) many guests, The guests were many, as many friends as*) we have an intuition that the quantity word encodes information about the measure of an individual or a plurality of individuals.

In contrast are the 'non-individual uses' of quantity words, in which we have an intuition that the quantity word doesn't encode information about an individual. When they function as VP modifiers, quantity words

		quantifiers (e.g. *all*)	adjectives (e.g. *tall*)	quantity words (e.g. *many*)	examples
individual	prenominally	✓	✓	✓	(1)-(2)
	with a determiner	×	✓	✓	(4)
	predicative position	×	✓	✓	(5)
	degree quantifier	×	✓	✓	(6)–(8)
non-ind	VP modifier	×	×	✓	(9)
	PP modifier	×	×	✓	(10)
	comparative modifier	×	×	✓	(11)

Table 1: The distribution of quantity words in English

encode information about the measure of an event (Doetjes, 2007), e.g. its duration or frequency. When they function as PP modifiers, quantity words encode information about the size of a vector (Zwarts, 1993). And when they function as comparative differentials, quantity words encode information about the size of a differential interval along some dimension of measurement (Schwarzschild, 2006a), e.g. height.

To summarize: quantity words are available in a number of different configurations. Their prenominal use, often treated as canonical, has lead some to analyze quantity words as quantifiers, and others to analyze them as adjectives, but they pattern like neither in their overall distribution. The rest of this article outlines semantic treatments of quantity words as quantifiers (§3) and as adjectives (§4), and argue that these distributional differences mean that neither sort of theory can accurately characterize the behavior of quantity words. The details are interesting, but the overall point should be clear, given Table 1: analyzing quantity words as quantifiers predicts that they have the same distribution as quantifiers do, which they don't. And analyzing quantity words as adjectives predicts that they have the same distribution as adjectives do, which they don't. In particular, they incorrectly predict that quantity words only have individual uses.

§5, presents recent analyses of quantity words in which they range over scales, or sets of degrees. It additionally argues that these accounts work well for the diverse data reviewed here because the framework of degree semantics allows for a variety of different semantic objects (individuals, events, etc.) to be associated with sets of degrees corresponding to their measure in a given context.

3 Quantificational accounts of quantity words

One interpretation of the word *quantifier* describes expressions that involve counting or measuring. This certainly characterizes quantity words. But there is a specific use of the term wherein it describes expressions that denote relations between sets of individuals, as it does in Generalized Quantifier Theory (GQT). In this section, I'll argue that quantity words cannot accurately be analyzed as quantifiers in this more specific sense.

In GQT (Barwise and Cooper, 1981; Keenan and Stavi, 1986; Greer, 2014), quantifiers like *all* and *some* are analyzed as denoting relations between sets of individuals, as (12) shows.

(12)　　a.　$[\![\text{all}]\!](A)(B) \leftrightarrow A \subseteq B$
　　　　b.　$[\![\text{some}]\!](A)(B) \leftrightarrow A \cap B \neq \emptyset$
　　　　c.　$[\![\text{many}]\!](A)(B) \leftrightarrow |A \cap B| \geq d$, d a large number

(12-a), for instance, predicts that a sentence *All ants boogied* is true iff the set of ants is a subset of the set of individuals that boogied. An equivalent way of writing these truth conditions is with an overt logical quantifier ranging over individuals, as in (14) for the quantifier *some*.

(13)　　$[\![\text{some}(A)(B)]\!] \leftrightarrow \exists x[A(x) \wedge B(x)]$.

In GQT, and in many logic traditions, quantity words like *many* are analyzed in the same fashion, although (as (12-c) shows) they require additional machinery. In particular, the GQT treatment of *many* incorporates the cardinality operator $|.|$ and the contextually valued free variable d. (12-c) predicts that a sentence *Many ants boogied* is true whenever the cardinality of the intersection of the set of ants and the set of individuals that boogied is greater than or equal to some large number d, which can receive different values depending on the context. This appropriately characterizes quantity words as context-sensitive; what counts as *many* or even as *many ants* can vary quite a bit from context to context.

Romero (1998) and then Hackl (2000) propose an updated analysis of quantity words as quantifiers, based on their observations about the behavior of quantity words in *how many* questions (Romero, 1998) and in comparatives like *more* (Hackl, 2000). Both (see also Romero, 2015) analyze quantity words as 'parameterized determiners': quantifiers with an additional degree argument d, as in (14), making them a hybrid between a quantifier and a gradable adjective in degree-semantic analyses (which will be discussed in more detail in §4).

(14) $[\![\mathrm{many}]\!](d)(A)(B) \leftrightarrow \exists x[A(x) \wedge B(x) \wedge |x| = d]$

Although the parameterized determiner analysis was proposed in contrast to the GQT analysis, the two have in common that they analyze quantity words as encoding existential quantification (or its set-theoretic equivalent) over individuals. They therefore predict that quantity words are defined only when they range over individuals. Quite simply, these accounts incorrectly predict that quantity words are undefined in the non-individual uses described above (e.g. the differential use).

At the very least, then, adopting a quantifier-based analysis of prenominal quantity words requires a separate treatment for their other uses, which suggests that it's an accident prenominal quantity words are homophonous with e.g. differential ones. But there are still more strikes against quantifier-based approaches. They cannot account for predicative uses of quantity words, for example. And they incorrectly predict that prenominal quantity words cannot be modified by overt determiners like *the*, which are also analyzed as ranging over individuals. (If *many* did in fact bind the individual argument of *guests* in *The many guests left*, we would predict that argument to be unavailable to *the*, resulting in vacuous quantification.)

There are still more problems with quantifier approaches to quantity words, as detailed in Rett (2008b) and Solt (2014). Quantity words are optional in *how many* questions in several Balkan languages (Rett, 2007), but quantifier treatments predict that they're necessary to bind the individual variable introduced by the nominal. And Romero implements her analysis of quantity words to explain the amount/object ambiguity in *how many* questions, which she analyzes as a scopal ambiguity: in a *how many* question like *How many books must John read?*, the object reading results from a wide-scope quantity word, and the amount reading results from a narrow-scope quantity word. But, contrary to this account, the amount/object ambiguity in French tracks the position of the nominal (e.g. *de livres* in *combien de livres*), not the *wh-* or quantity word (i.e. *combien*), suggesting that the existential quantifier binding the individual variable should be more closely associated with the nominal than the *how many* phrase.

These issues raise the question: if quantity words aren't quantifiers, are they better analyzed as adjectives?

4   Adjectival accounts of quantity words

Table 1 suggests that quantity words and adjectives mean the same sort of thing, at least some of the time. This perspective has a modest history of

support in linguistic semantics (Bresnan, 1973; Cresswell, 1976; Hoeksema, 1983; Grosu and Landman, 1998), based on the fact that quantity words can "...form comparatives and superlatives, they can be modified by degree expressions like *too* or *very.... Many* and *few* can also be used in predicative position (*his sins were many, his virtues were few*)" (Hoeksema, 1983, 65).

If quantity words are adjectives, they are gradable adjectives like *tall* (as opposed to non-gradable ones like *polka-dotted*). A gradable adjective is characterized by its ability to be modified by intensifiers like *very* and to occur with degree quantifiers like the comparative, crucially without semantic coercion to some related scale (as the non-gradable *pregnant* is often coerced to a temporal scale in e.g. *very/more pregnant*; Cruse, 1986). Quantity words pass both tests (as demonstrated by *very few* and *fewer*).

Beginning with Cresswell (1976), degree semantics treats gradable adjectives as differing from non-gradable ones in taking a degree argument.[2] Degrees are semantic primitives in this approach, ranging over points on scales that correspond to different dimensions of measurement, like height, happiness, etc. From this perspective, the difference between gradable and non-gradable adjectives is one of valency, similar to the difference between transitive and intransitive verbs, demonstrated in (15). Furthermore, in degree semantics, intensifiers and degree quantifiers range over degrees, which explains why they can't modify non-gradable adjectives.

In adjectival accounts of quantity words, they, too, take an individual and a degree argument, as in (15-c).[3]

(15)   a. $[\![\text{polka-dotted}(x)]\!] \leftrightarrow x$ is polka-dotted
        b. $[\![\text{tall}(x)(d)]\!] \leftrightarrow x$ is d-tall
        c. $[\![\text{many}(x)(d)]\!] \leftrightarrow x$ is d-many

According to (15-b), the gradable adjective *tall* holds of an individual x and a degree d (e.g. John and 6ft) whenever x is tall to degree d. Similarly, (15-c) states that *many* holds of the same arguments whenever x is d-many (in other words, whenever the cardinality of x is d).

In these degree-semantic accounts, gradable adjectives combine first with their individual argument (in predicative position, the denotation of the subject). Some adjectives can then combine with an overt measure phrase, if present, to value their degree argument (e.g. *John is 6ft tall*).[4] In the absence

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[2]See Schwarzschild (2008); Morzycki (2015) for an introduction to degree semantics.

[3]These are the definitions for adjectives in predicative position; those in attributive position are assumed to have a related, type-raised definition that includes a set of individuals P as an argument, e.g. $[\![\text{tall}(P)(x)(d)]\!] \leftrightarrow x$ is P and d-tall.

[4]Quantity words cannot occur with overt numerals or measure phrases (cf. **6 many*

of an overt measure phrase, the extra degree argument is generally assumed to be bound by a null operator (e.g. '*pos*') or to undergo existential closure; these processes are additionally assumed to add to these constructions the restriction that the degree be significantly high in the context of evaluation, as depicted in (16) and (17).

(16)   John is tall.
  a. combination with subject: $[\![\text{tall(John)}(d)]\!] \leftrightarrow$ John is d-tall
  b. with evaluativity: $\exists d[$John is d-tall and d is high$]$

(17)   The guests are many.
  a. combination with subject: $[\![\text{many(the-guests)}(d)]\!] \leftrightarrow$ the-guests are d-many
  b. with evaluativity: $\exists d[$the-guests are d-many and d is high$]$

Importantly, these accounts don't analyze gradable adjectives or quantity words as lexicalizing the requirement that the individual instantiate the predicate to a significantly high degree because not every sentence containing these words is evaluative. The comparative *John has as many shoes as Bill* doesn't entail Bill has many shoes, and neither does the *wh*-clause *John knows how many shoes Bill has*. The distribution of evaluativity is actually quite complex (Rett, 2008a). Standard degree-semantic accounts, beginning with Cresswell (1976), encode it instead in a null operator *pos*, although there is reason to believe it is better treated as a conversational implicature (Rett, 2015). Crucial for the present discussion is that, again contrary to the GQT account, the requirement that the degree in question exceed a contextually valued standard should not be made part of the lexical semantics of quantity words because only some occurrences of quantity words carry this requirement.

It should be clear from the discussion above that adjectival accounts, like quantificational accounts, define quantity words in terms of their individual argument. In (15-c) (and its attributive counterpart), the quantity word *many* takes an individual argument, and the semantic contribution of the quantity word is to associate this individual with a degree argument corresponding to its measure. In these adjectival accounts, quantity words are undefined if they do not take an individual argument. They therefore cannot naturally extend to the non-individual uses of quantity words, which do not encode information about an individual. In the comparative *John*

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pizzas), but neither can the vast majority of gradable adjectives (cf. **$20 expensive*). The difference is generally treated as a lexical rather than semantic one (Schwarzschild, 2005).

is much taller than Sue, for instance, the quantity word *much* intuitively measures the difference between John's height and Sue's height, not John or Sue themselves. As with the quantificational accounts, since adjectival accounts cannot extend to these non-individual uses of quantity words, they are forced to claim that it is an accident that the same word is used in English to measure individuals and non-individuals. Worse, they cannot predict that quantity words have this multiplicity of meaning across languages. What Table 1 suggests is that we need an account of quantity words in which their distribution is less semantically restricted.

5   Scale-based accounts of quantity words

If quantity words are neither quantifiers nor adjectives, what are they? Scale-based accounts of quantity words take the perspective that if the non-individual uses of quantity words can't be properly treated in individual-based accounts, then the individual uses of quantity words should be treated in degree or scale-based accounts that are well-suited to treat the non-individual uses. In other words, instead of considering the prenominal or predicative instances of quantity words to be canonical (like the quantifier and adjectival accounts do, respectively), scale-based approaches treat the differential instances as canonical.

Two similar proposals analyze quantity words as encoding information about a scale, or a set of degrees, rather than an individual or a set of individuals. The underlying intuition is this: in the differential comparative *John is much taller than Sue*, quantity words measure the size of the gap between John's height and Sue's height. This gap is modeled in degree semantics using a scale, i.e. a set of degrees representing points along a single dimension of measurement (Schwarzschild, 2006a), as illustrated in Figure 1 below.
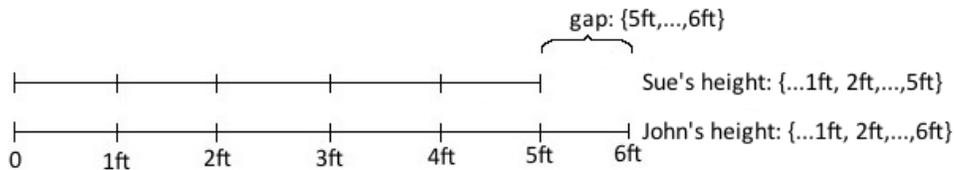

Figure 1: Scales and gaps in degree semantics

There are two different formal implementations of the scale approach; the first treats quantity words as degree modifiers, denoting relations between a set of degrees D and its measure d, as in (18) (Rett, 2007, 2008b, 2014).

(18) $[\![\text{much}(D)(d)]\!] \leftrightarrow$ the salient measure of D is d

The relevant dimension of measurement is supplied contextually. In Figure 1, for example, the measure of the set of degrees {5ft,...,6ft}, representing the gap between John and Sue's heights, is 1ft. (Dense scales are measured by subtracting the lower bound from the upper bound.)

The second implementation is similar, differing most notably in treating the degree of scale measurement d as a free pragmatic variable rather than an argument of the quantity word itself, as in (19) (Solt, 2009, 2014).

(19) $[\![\text{much}(D)]\!] \leftrightarrow$ the salient measure of D is d

Treating quantity words as a degree modifier, as in (18), correctly predicts that quantity words can be iterated, like other modifiers can (e.g. *many, many guests*), but it relies on existential closure (Heim, 1982) or some other mechanism to bind the internal degree variable in constructions in which it is not overtly bound (by e.g. the degree quantifiers *so* and *too*), modified (by e.g. the *wh*-word *how*), or valued (by e.g. the demonstrative *this*). In direct contrast, the approach in (19) must rely on other mechanisms to allow quantity words to be bound, modified, or valued, and therefore cannot account for iteration, but extends straightforwardly to constructions in which the degree variable is not overtly bound or valued.

In each analysis, as in the adjectival approach discussed above, the evaluativity of these constructions (i.e. the requirement that the measure d exceed a contextually salient standard) is assumed to be provided by some other means, e.g. the null operator *pos* (Cresswell, 1976), or conversational implicature (Rett, 2015). The reasons for divorcing evaluativity from the lexical meaning is the same for quantity words as it is for gradable adjectives like *tall*: certain constructions in which some of these words occur lack evaluativity (e.g. *John is as tall as Sue*; *John has as many regrets as Sue*).

I will first demonstrate how a scale-based approach accounts for differential instances of quantity words; I will then show how it treats individual uses of quantity words.

A transparent instance of quantity words modifying scales is their use as differentials in comparatives like (20).

(20)   John is much taller than Sue.

A typical assumption in the degree-semantic literature is that a clausal comparative sentence like (21-a) has the logical form in (21-b), and the comparative morpheme therefore denotes a degree quantifier (type $\langle\langle d,t\rangle,\langle\langle d,t\rangle,t\rangle\rangle$),

as in (22).[5]

(21)   a.   A is P-er than B.
        b. $-er([\text{Op}_{d'}$ B ~~is P to d'~~$])([\text{Op}_d$ A is P to $d])$

(22) $[\![\text{-er}]\!](D)(D') = \exists d[d$ is on the scale $D' \wedge d$ is not on the scale $D]$

However, a treatment of differential comparatives requires that the comparative morpheme be associated with an additional degree argument, as in (23), which allows the semantics to range over (rather than bind) the set of degrees that are in the scale associated with the matrix subject but not the scale associated with the embedded subject, i.e. the gap between the measures of the two subjects.

(23) $[\![\text{-er}_{\text{diff}}]\!](D)(D')(d) = d$ is on the scale $D' \wedge d$ is not on the scale D

It is this degree argument that quantity words like *much* modifies in scale-based approaches: in a sentence like (24), *much* measures the size of the gap between John and Sue's height, and external forces (*pos* or some other treatment of evaluativity) ensure that this measure is relatively large in the context of evaluation. (See Rett, 2008b, for details).

(24) $[\![$John is much taller than Sue$]\!] \leftrightarrow$
        The salient measure of the set D of degrees that are on the scale corresponding to John's tallness but are not on the scale corresponding to Sue's tallness is d

Just as the semantic treatment of differential comparatives requires the representation of an additional degree argument (i.e. the switch from (22) to (23)), the treatment of individual uses of quantity words requires the representation of a degree argument associated with the measure of the relevant individual. To treat these cases, scale-based approaches exploit existing mechanisms in degree semantic theories that use null operators or type-shifters to associate an individual with a degree corresponding to some salient measure of that individual.

In standard degree-semantic accounts, numerals and measure phrases

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[5]This is a version of the 'A-not-A' analysis, which has its origins in Ross (1969); Seuren (1973); McConnell-Ginet (1973); Kamp (1975); Hoeksema (1983); Seuren (1984) and is reviewed in Schwarzschild (2008). It assumes that each clausal argument of the comparative denotes a set of degrees (Bresnan, 1973), and it analyzes the comparative morpheme as requiring that there be a degree on the scale D' associated with the matrix subject's measure that is not on the scale D associated with the embedded subject's measure.

denote degrees. Without further innovation, this would result in a type clash in phrases in which numerals modify nouns, like *five guests*, as nouns traditionally denote sets of individuals. A standard solution, beginning with Cresswell (1976), is to allow nouns to be optionally associated with a degree denotation (via a null operator or a type-shifting mechanism), as illustrated in (25-b).[6]

(25)   a.   ordinary denotation of *guests*: $\llbracket \text{guests(x)} \rrbracket \leftrightarrow x$ is a guest
        b.   degree denotation of *guests*: $\llbracket \text{guests(d)(x)} \rrbracket \leftrightarrow$
              x is a guest and d is the salient measure of $\{y: y$ is a guest$\}$

The relevant dimension of measurement is assumed to be valued contextually (allowing for sentences like *The board is 3 feet* to measure e.g. length or width, depending). In the case of *five guests*, or any numeral phrase, the salient dimension of measurement is quantity. In a context in which the maximal set of guests contains 5 individuals, the set of degrees corresponding to the quantity of guests will be $\{1,2,3,4,5\}$, with each degree representing the quantity of each subset of the set of guests (minus the empty set, which isn't in the noun's extension).

Scale-based approaches use this innovation to provide a semantics for quantity words in contexts, like the prenominal use, in which they intuitively modify individuals. (26) provides an example using the analysis of quantity words in (19) and the degree denotation of *guests* in (25-b).[7]

(26) $\llbracket$Many guests ate cake$\rrbracket$
        $\leftrightarrow$ There are some individuals x such that x is a guest and ate cake and there is some degree d such that d is the salient measure (i.e. quantity) of the set of salient measures (i.e. quantities) of $\{y: y$ is a guest and ate cake$\}$

A typical assumption is that existential quantification over the individual argument and (and, for degree modifier approaches like (18), the degree argument) comes about via existential closure. The reasoning is similar to that in Heim (1982), the origin of the mechanism: the words that introduce these arguments – in this case, nouns and quantity words, respectively –

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[6]While many contexts don't require a noun be associated with a degree, there are a variety of contexts that do; see Rett (2014) for an overview.

[7]There is a superficial type mismatch in applying scale-based characterizations of quantity words directly to degree denotations of nouns: the former is looking for an argument that denotes a set of degrees (type $\langle d, t \rangle$), but is applied to something of type $\langle d, \langle e, t \rangle \rangle$. This can be addressed in standard compositional semantics by temporarily suppressing the individual argument of the noun.

occur only optionally with quantifiers that can bind them overtly. Instead of building quantification into these elements (as the quantificational approaches do for quantity words), and incorrectly predicting they can't occur with overt quantifiers, it seems best to assume that they can be bound in the absence of overt quantifiers.

The size of a set of measures is equivalent to the maximal member of that set; in a context in which there are 5 guests who ate cake, the set of degrees D will be $\{1,2,3,4,5\}$ and the measure of that set will be 5. This correctly predicts that quantity words are incompatible in constructions with downward-monotonic predicates (like *be enough*) or other monotonicity requirements (Rett, 2007, 2014).

As with other constructions with free degree arguments (like the positive construction *John is tall*), this theory will need to be supplemented with some treatment of evaluativity to ensure that (26) requires that the degree d exceed some contextually relevant standard (Rett, 2015). Such accounts will need to – and many are designed to – prohibit evaluativity from other constructions involving quantity words, such as *John knows how many shoes Bill owns*.

To sum up: quantificational and adjectival accounts treat quantity words as contributing information about individuals; a sentence like *Many guests left* asserts that the guests' cardinality is large. In contrast, scale-based accounts treat quantity words as contributing information about scales, or sets of degrees; a sentence like *John is much taller than Sue*, asserts that the set of degrees representing the gap between John and Sue's height is large. The former do not seem to be able to extend to instances of quantity words in which they don't appear to be measuring individuals. But the latter are able, using standard innovations from degree semantics, to account for instances of quantity words in which they appear to be measuring individuals.

6   Other issues in the study of quantity words

This section briefly reviews some additional semantic issues raised by quantity words.

The cardinal/proportional ambiguity   As discussed in Milsark (1977); Westerståhl (1985) and Partee (1989), prenominal quantity words are ambiguous between a cardinal and at least one proportional reading. This is demonstrated in (27), where L denotes the set of linguists and W the set of women.

(27)   Many linguists are women.

   a. $|L \cap W| \geq d$ *cardinal*
   b. $\frac{L \cap W}{|L|} \geq d$ *proportional*

In (27-a), the number of female linguists is understood to be large, generally, in a given context. In (27-b), the number of female linguists is large relative to linguists generally. Partee (1989) likens the proportional reading to a partitive one, as in the sentence *Many of the linguists are women.* This difference can be treated in the scale-based account by taking advantage of the context-sensitivity of the dimension of measurement associated with the degree type-shifter (Rett, 2008b); it has also recently been addressed in the parameterized determiner account (Romero, 2015).

van Benthem's Problem   van Benthem (1983) noticed a potential pitfall for semantic theories of negative quantity words like *few* and *little*: accounts which don't incorporate a maximality operator or something equivalent can predict that these words are much weaker than they are. This is demonstrated by two apparently interdefinable versions of the GQT account in (28).

(28)   a. $[\![\text{few}_1]\!](A)(B) \leftrightarrow |A \cap B| \leq d, d$ a small number
        b. $[\![\text{few}_2]\!](A)(B) \leftrightarrow \exists x[A(x) \wedge B(x) \wedge |x| < d], d$ a small number

The version of the GQT account in (28-b) with the existential quantifier is problematic, van Benthem observed, because its truth conditions don't require that the plural individual being measure by *few* be the maximal individual. It incorrectly predicts that any prenominal use of *few* is trivially satisfied, because any plurality x, no matter how large, has some subplurality whose quantity would be considered small in the context of utterance.

    van Benthem's Problem does not, however, extend to quantificational accounts whose quantity words are defined in terms of a maximality operator or some equivalent (Buccola, 2015). (28-a) represents this sort of account: the cardinality operator in (28-a) ensures that d is the measure of the maximal plurality of individuals that are A and B. Romero (2015) also argues that her parameterized determiner theory also avoids van Benthem's Problem.

    There are reasons to think that negative quantity words can be tricky for other reasons: the analysis proposed in Hackl (2000) requires a (null) positive quantity word *many* in every case in which a noun must be associated with a degree corresponding to its measure. As a consequence, he predicts

that even nominal comparatives formed with *few* (e.g. *John has fewer shoes than Bill*) contain a covert *many* in addition to an overt *few*.

Monotonicity of measurement   In a paper on the semantics of measure phrases, Schwarzschild (2006b) explains that dimensions of measurement can differ with respect to whether or not they are monotonic on the relevant part-whole structure of the individual being measured. If the measure of an individual along a dimension $\mathscr{D}$ is larger than the measure of a subpart of that individual, $\mathscr{D}$ is a monotonic dimension of measurement.

Schwarzschild further argues that syntax attends to this difference. (29) illustrates that the same measure phrase (MP) can be interpreted with respect to two different dimensions of measurement, depending on the construction it occurs in.

(29)   a.   two-inch cable   attributive MP; width (non-monotonic)
         b.   two inches of cable   partitive MP; length (monotonic)

Relevant to the topic at hand, Schwarzschild observes that while quantity words like *much* can be associated with a variety of different dimensions of measurement (e.g. volume, weight, density), they can only be associated with monotonic dimensions, regardless of the construction they occur in; for instance, the quantity word in *much rice* can measure volume but not stickiness. He accounts for this monotonicity restriction on quantity words syntactically, in parallel with his treatment of the difference in (29). In contrast, Rett (2014) argues that this restriction can be attributed to the core assumption of the scale-based approach, that quantity words measure scales: they are only informative with downward monotonic dimensions of measurement, in which the measure of the scale corresponds to the maximum element in the scale.

***Much*-support**   While quantity words can modify a wide variety of lexical or phrasal categories (Table 1), they cannot modify adjectives (cf. **John is much tall*). This fact must receive an independent explanation in the adjectival and scale-based accounts outlined above, as both predict gradable adjective modification to be possible, at least in principle. Doetjes (1997) provides such an account in terms of a lexical competition with adjective-specific intensifiers like *very*.

However, Corver (1997) observed an interesting idiosyncrasy of *much*: while it is prohibited from modifying lexical adjectives in degree quantifier constructions, as shown in (30-a), it is required in those same construc-

tions to modify the proadjective *so* (30-b). Corver dubbed this phenomenon '*much*-support'.

(30)   a.   John is too (*much) intelligent.
       b.   John is intelligent and Sue is too *(much) so.

Corver's account of *much*-support is syntactic, comparable to 'last resort' treatments of *do*-support. The proposal in Solt (2010, 2014), which invokes a scale-based treatment of quantity words, also offers a syntactic explanation, arguing that quantity words are blocked in certain configurations by (overt and covert) degree quantifiers. In contrast, Rett (2014) argues that the quantity words are associated with different dimensions of measurement in the constructions in (30), and are required or prohibited based on the monotonicity of the relevant dimension.

Experimental studies and quantity words   There are a number of papers testing semantic differences between the phrases *most* and *more than half*: Hunter et al. (2008); Pietroski et al. (2009); Lidz et al. (2011); Hackl (2009); Kotek et al. (2015); and Solt (2016). While these papers do not address the semantics of quantity words per se, a number of morphological and semantic treatments of these phrases characterize them as being composed of or synonymous with quantity words, so they may prove useful for an investigation of the meaning of quantity words in isolation.

Crosslinguistic studies of quantity words   Relatively little work has been done on the meaning of quantity words across languages, with a few exceptions. Doetjes (2007); Burnett (2012) study the meaning of *beaucoup* in French and notice that it differs semantically in subtle ways from the English *much*, especially in its event interpretation.

Rett (2007, 2008b) discusses the behavior of quantity words in Balkan languages; she observes that they are optional with the *wh*-word *how many*, as demonstrated in (31) for Romanian. When present, they effect subtle semantic differences (among other things, they function as a maximality operator, making (31-b) incompatible with upward-monotonic predicates). The behavior of quantity words in these languages is one of many additional motivations for the scale-based approach discussed above.

(31)   a.   Cîte   femei   cunoaște?
            how.many-F.PL women know-3.SG

b. Cît de multe femei cunoaste?
   how.many of many-F.PL women know-3.SG
   'How many women does he know?

Recent work has revealed some Slavic languages have more than one quantity word, even setting aside distinctions of polarity and count/mass. Krasikova (2011) argues that the Russian adverb *mnogo* can only receive a cardinal interpretation, while the adjectival *mnogie* can only receive a proportional interpretation. Stateva and Stepanov (2016) present an in-depth look at the Slovenian quantity words *precej* and *veliko*. They argue that, contrary to Russian, the words do not differ in terms of the cardinal/proportional distinction, but rather in their distribution: both can modify NPs or the superlative, but only *precej* can modify adjectives, adverbs, or PPs. The authors analyze both as degree modifiers in the spirit of Rett (2007), and explain the differences in distribution and meaning pragmatically. Finally, Culinovic (2016) argues that Serbo-Croatian has two quantity words, one behaving like a quantifier in the GQT sense, and the other behaving like a degree modifier. While these analysis may work for the specific languages they were proposed to treat, the differences between the three Slavic languages raise more questions about the cross-linguistic variation in the semantics of quantity words that call out for additional research.

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