On the (non-)cumulativity of cumulative quantifiers

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Abstract

This paper investigates some differences between partitive and non-partitive count quantifiers with respect to their ability to participate in cumulative readings and their compatibility with collectively interpreted mixed main predicates. An analysis of quantification is adopted in which a quantifier takes an individual as its first argument. The type of this individual argument together with some independent assumptions is argued to be responsible for the observed data. The analysis is subsequently expanded to a related set of facts concerning partitive and non-partitive mass quantifiers: their (in)compatibility with non-homogeneous main predicates.

1 Introduction

The main focus of this paper will be on quantifier phrases of the form [Q (of) [the NP]] and [Q NP], where Q stands for a quantificational expression like e.g. *some*, *many*, *most* and *all*. An instance of a partitive count quantifier is parenthesized in (1-a), while (1-b) contains a non-partitive count quantifier.

(1) a. [Some of the students] came on time
    b. Sue dislikes [many flavors of chocolate]

We will investigate the distribution of these expressions with respect to non-distributive plural predication. The first set of data that will be studied involves sentences containing collectively interpreted mixed predicates. An example of a mixed predicate is the VP in (2) (cf. Dowty 1986, for classification). On a collective interpretation, the sentence in (2) denotes a set of situations in which there is a single carrying of a piano and the sum of Stan and Olio is the sole collective agent of this carrying, i.e. neither Stan nor Olio carried a piano by themselves (cf. Landman 2000). The sentence in (2) can also be interpreted distributively: it can describe situations in which Stan and Olio each carry a piano.

(2) Stan and Oliver carried a piano

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The second set of data that will be featured in our discussion involves cumulative interpretations of sentences with count quantifiers. For example, on a cumulative interpretation, the sentence in (3) describes situations in which there are Jane, Mary and four babies and each of the two women gave birth to at least one of the four babies and all of the four babies were born to one of the two women (cf. Beck & Sauerland 2000). As in the example (2), a distributive reading of (3) is also possible: Jane and Mary each gave birth to four babies.

(3) Jane and Mary gave birth to four babies

Partitive and non-partitive count quantifiers pattern differently in examples containing the main predicates from (2) and (3). While the partitive count quantifiers do allow a collective interpretation of their mixed VP argument, this is not the case for the non-partitives. Furthermore, only the partitive count quantifiers permit cumulative interpretations of sentences in which they occur. That is, the main predicate has the option of being interpreted distributively or non-distributively only when it occurs with a partitive count quantifier; with non-partitives it is always interpreted distributively.

An arguably related set of data is found with partitive and non-partitive mass quantifiers. As the name suggests, the NP in these quantifiers is mass and not count; the quantificational head is in most cases the same as in count QPs (*some*, *most*; *much*). Two examples of partitive and non-partitive mass quantifiers are parenthesized in (4).

(4) a. John drank [all of the beer]
    b. [Most tap water] is as healthy as bottled water

The distinguishing characteristic of main predicates which we will use to delineate the different behavior of partitive and non-partitive mass quantifiers is (in)homogeneity. A predicate is homogeneous if it is both distributive (divisive) and cumulative (Lønning 1987, and others). For example, the predicates in parentheses in (5-a) satisfy these properties: if something is wet then all its relevant parts are wet, and if two substances solidify then their sum solidifies as well. The predicate in (5-b) is neither distributive nor cumulative, i.e. it is non-homogeneous: an object that contains exactly 4g of protein cannot be split into two parts, each of which would contain exactly 4g of protein, and the sum of two objects containing exactly 4g of protein contains exactly 8g of protein. If the modifier *exactly* is left out of the VP in (5-b), the predicate becomes cumulative but remains non-homogeneous – it is namely still non-distributive.

(5) a. Water [is wet] and sometimes it [solidifies]
    b. This Snickers bar [contains exactly 4g of protein]

The empirical generalization, finally, seems to be that the partitive mass quantifiers can combine with non-homogeneous predicates, while the non-partitives cannot. In this respect, mass quantifiers pattern like count quantifiers – non-distributive predication is available only with the partitives.

We propose that the asymmetry between partitives and non-partitives in both the count and mass cases mentioned above follows from the general properties of quantificational phrases. The architecture for quantification that we thereby assume treats the quantificational head as taking an individual as its first argument in both partitives and non-partitives (Matthewson 2001). If this individual is a kind individual (an individual concept), which is the case in non-partitives, an independent pragmatic principle conditions the interpretation of the main predicate – it can only be interpreted generically. Genericity then gives rise to the distributivity effect. No analogous condition is imposed with the partitives where the argument of the quantifier is a regular plural individual denoted by the definite description.

Section 2 describes the basic asymmetry between partitive and non-partitive count quantifiers with respect to their compatibility with different types of plural predicates. Section 3 elaborates and further develops the analysis of quantifier phrases proposed in (Matthewson 2001). Section 4 derives the facts described in Section 2. Section 5 characterizes partitive and non-partitive mass quantifiers with respect to their compatibility with non-homogeneous main predicates and it extends our analysis to the mass domain to account for the observed facts. Section 6 concludes.

2 Count quantifiers

2.1 Collectivity

The first set of data relates to the compatibility of count quantifiers with collectively interpreted mixed predicates. Mixed predicates include VPs like *carry a piano, lift the box* and *write a book* and can besides the collective also receive a distributive interpretation. A collective interpretation of a sentence like *Three boys lifted a piano* entails that there was a single lifting of a piano performed jointly by a collection of three boys; a distributive interpretation entails that there are three boys such that each of them lifted a piano by himself.

It has been observed by Nakanishi & Romero (2004) that partitive and non-partitve *most*-phrases exhibit distinct properties when combining with mixed predicates (cf. Brisson 1998, for a related observation concerning *all*-phrases). On the one hand, if the quantifier phrase is partitive, the mixed predicate can be interpreted collectively. That is, the sentence in (6-a) is a felicitous description of the scenario sketched in (6). This is not the case for the non-partitive quantifiers (6-b)/(6-c); these sentences can only be interpreted distributively. For example, (6-b)/(6-c) can only describe situations in which more than half of the boys have the property of being a single boy who lifted the piano by himself.

(6) [Scenario: Seven out of the ten boys at the party together lifted the piano once; there were no other liftings of the piano.]

a. Most of the boys at the party lifted the piano

b. #Most boys at the party lifted the piano

c. #Most boys who were at the party lifted the piano

2.2 Cumulativity

The second set of data involves cumulative interpretations of sentences containing count quantifiers. As a reminder, a cumulative interpretation of (3) can be rendered by a 'polyadic distributivity' paraphrase in (7).

(7) Everyone of Jane and Mary gave birth to a baby and everyone of the four babies was born to either Jane or Mary

It has been observed that non-partitive count quantifiers do not allow cumulative interpretations (Zweig 2008). However, this does not seem to extend to partitive count quantifiers. This asymmetry is illustrated in (8): only the sentence with the partitive quantifier (8-a) can be used in the described scenario. The non-partitive sentence (8-b) can only be interpreted as assigning irrational behavior to voters (voting for two opposing parties).

(8) [Scenario: Almost every US voter will vote either for the Democrats or the Republicans in the next election; only few will vote for a third party candidate.]
a. Most of the US voters will vote for just two parties
b. #Most US voters will vote for just two parties

This contrast is even clearer in ditransitive constructions where the quantifier is generated in the direct object position, while the other plural NP is in the *to*-PP. Accordingly, the situation in (9) can be described by using (9-a) but not by using (9-b).

(9) [Scenario: The Catholic Church sent one third of its missionaries to Asia and a different third of its missionaries to Africa.]
a. The Church sent most of its missionaries to two continents
b. #The Church sent most missionaries to two continents

To summarize, partitive and non-partitive count quantifiers exhibit distinct patterns when it comes to non-distributive interpretations: only the former occur in sentences where the mixed main predicate receives a collective interpretation and, again, only the former occur in cumulatively interpreted sentences.

2.3 A brief note on plurality

There are different ways of capturing formally the collective readings of mixed main predicates (cf. Brisson 1998, 2003, Nakanishi & Romero 2004, for precise implementations) and cumulative readings. We will for the sake of concreteness adopt the approach to plurality developed by Kratzer (2002) where the verbs are inherently plural (cf. e.g.

Beck & Sauerland 2000, for an alternative). For perspicuity, we will occasionally indicate that the verbs are pluralized by attaching a *-operator to the verb and we will not incorporate into our simplified representations the thematic role predicates like *agent*, which are also inherently plural.

In the system that we adopt, then, the sentence *Three boys lifted a piano* is true on a collective reading of the mixed predicate if the denotation of the VP *lift a piano* contains a pair of a sum of three boys and a lifting-a-piano event, i.e. if there is a piano-lifting event in which a plurality of three boys is the collective agent; the sentence is true under the distributive reading if the VP denotation contains three pairs of (different) boys and piano-lifting events, i.e. if there are three boys such that each is the sole agent of some piano-lifting event. Furthermore, the sentence in *Jane and Mary gave birth to four babies* is true on a cumulative reading if the denotation of the sentence contains a sum of two birthing events whose cumulative agents are Jane and Mary (each one is an agent of a different birthing event) and in which a total of four babies are born (say, two babies are born in Jane's birthing event and two babies are born in Mary's birthing event).

3 Quantification

3.1 Syntactic ingredients

This section succinctly summarizes the approach to quantification advocated by Matthewson (2001). The starting point of Matthewson's analysis of quantification is the nature of quantificational expressions in St'át'imcets (Northern Interior Salish). (10) contains prototypical examples of St'át'imcets quantifiers: the heads of the quantificational phrases in parentheses are *all* and *many* and they c-command full-fledged determiner phrases without any intervening partitive prepositions. The contrast between (10) and (11) indicates that the complement of the quantifier head *must* be a determiner phrase.

(10) a. léxlek [tákem i smelhmúlhats-a]
intelligent all DET.PL women-DET
'All the women are intelligent'

b. [cw7it i smelhmúlhats-a] léxlek
many DET.PL women-DET intelligent
'Many of the women are intelligent'

(11) a. *léxlek [tákem smelhmúlhats]
intelligent all women
'All women are intelligent'

b. *[cw7it smelhmúlhats] léxlek
many women intelligent
'Many women are intelligent'

Matthewson captures these facts by assuming that all St'át'imcets quantifiers have the structure in (12): the quantifier head selects for a DP complement. Accordingly, at the level of interpretation, the first argument of the quantifier is the (plural) individual denoted by the DP; there is no intermediate steps of predicativization.

(12) $[_{QP}$ $[_{Q}$ tákem$]$ $[_{DP}$ $[_{D}$ X...a$]$ $[_{NP}$ smelhmúlhats$]]$

This proposal is extended to English and other languages. The core underlying assumption is thereby that quantifiers take individual arguments and that the partitive preposition is semantically vacuous. The individual arguments can thereby either be extensional (regular individuals), which is the case in partitive quantifiers where the individual is provided by the definite description, or intensional (kind individuals), which is the case in non-partitive quantifiers where the individual is provided by the bare plural (cf. Chierchia 1998). We subsume these two different sorts of individuals under the disjunctive `i`-type ($D_i = D_e \cup D_{se}$).

(13) a. $[_{\langle\langle i,st\rangle,t\rangle}$ $[_{\langle i,\langle\langle i,st\rangle,t\rangle\rangle}$ most$]$ (of) $[_{i}$ the NP$]]$ $[_{\langle i,st\rangle}$ VP$]$
b. $[_{\langle\langle i,st\rangle,t\rangle}$ $[_{\langle i,\langle\langle i,st\rangle,t\rangle\rangle}$ most$]$ $[_{i}$ NP$]]$ $[_{\langle i,st\rangle}$ VP$]$

Matthewson draws some of the support for the assumption that a kind individual is the first argument of the non-partitive quantifier (13-b) from the contextual unrestrictedness of the non-partitive quantifiers in English and their tendency to occur in generic environments. Both of these characteristics are left unexplained in the standard generalized quantifier approaches where a quantifier takes a (contextually restricted) set of individuals as its first argument (Barwise & Cooper 1981). The first property is illustrated in (14): the discourse in (14) can be continued by (14-a) where the universal quantifier is restricted to the hundred linguists at the party, and it can also be continued by (14-b) where the definite description picks out the linguists at the party. The continuation using a non-partitive quantifier (14-c), however, is infelicitous; the sentence may have at most the unintended interpretation that the majority of all the linguists in the world visited New Zealand.

(14) There were hundred linguists and hundred philosophers at the party. We asked everyone, and we found out that...
a. Every linguist went to New Zealand for Christmas last year
b. Most of the linguists went to New Zealand for Christmas last year
c. #Most linguists went to New Zealand for Christmas last year

Matthewson further cites observations by Cooper (1996) and Brisson (1998) that indicate that the non-partitive quantifiers are dispreferred in episodic environments (15).

(15) a. Most of the students arrived late for the bus
b. #Most students arrived late for the bus

To summarize, Matthewson (2001) argues for an extension of her analysis of St'át'imcets quantification to English. In particular, she proposes that both partitive and non-partitive quantifiers take as their first argument an individual: in the former case this individual is an e-type object, while in the latter case it is an se-type object. We follow her proposal in this paper.

3.2 Semantic ingredients

In this section we equip our structural assumptions concerning partitive and non-partitive quantifiers with a basic semantics. We primarily adopt and expand the semantics sketched in Matthewson (2001) for partitive quantifiers. Moreover, Matthewson's treatment is supplemented by an explicit analysis of non-partitive quantifiers. The section is structured in the following way: we begin by looking at the individual arguments featured in quantifier phrases; subsequently, we describe our assumptions about parthood and measurement; finally, the lexical entries for count quantifiers are provided.

As we have pointed out above, the two kinds of objects that quantificational heads like *some* and *most* take as their first argument are either e-type or se-type; together these objects form the domain of i-type individuals. We naturally assume that this selection property of quantifiers obtains also in cases where the bare plural complement of the quantificational head is modified by, say, a finite relative clause, e.g. *most boys who came to the party.* In such cases, the bare plural needs to be type-shifted to be able to combine with the modifier since the modifier denotes a predicate. A further type-shift is then required to be able to combine with the quantifier that selects for individuals. All this is achieved by inserting into the structure operators that shift predicates into kinds and vice versa. These are defined in (16) (Chierchia 1998): (16-a) shifts a kind to its corresponding (two-place) predicate and (16-b) shifts a predicate to its corresponding kind. A quantifier containing a modified bare plural thus has the syntactic representation along the lines of (17); the switching between the i- and e,se-type notation is for perspicuity.

(16) a. $[\![\, \sqcup \,]\!] = \cup = \lambda x_{se}.\lambda s_s.\lambda y_e.\ y{\leq}x(s)$
b. $[\![\, \sqcap \,]\!] = \cap = \lambda P_{\langle s,et\rangle}.\lambda s_s.\ \sum P(s)$

(17) $[_{\langle\langle i,st\rangle,st\rangle}$ most $[_i \sqcap [_{\langle s,et\rangle}\ \lambda$s $[[_{et}$ s $[_{\langle s,et\rangle} \sqcup [_{se}$ students$]]][_{et}$ who came$]]]]]$

Thus, even in the cases of bare plurals modified by finite relative clauses, which at least initially do not seem to have a kind-like denotation, a uniform approach to quantification does not have to be abandoned, as long as the standard type-shifting operations are adopted into the analysis. Let us now proceed to the characterization of the tools that we will utilize in our lexical entries for quantifiers.

The two main ingredients required by our analysis are the part-relation and the measurement function. Both of these need to be defined for different sorts of individuals – regular and kind individuals. The regular individual part-relation is defined as in (18-a) where '+' stands for the sum operation on individuals; some of the parts of the sum of John and Peter are given in (18-b).

(18) a. $x \leq y$ iff $x + y = y$
b. Example: John $\leq$ John+Peter, Peter $\leq$ John+Peter, John+Peter $\leq$ John+Peter

An extension of the part-relation to kinds is straightforward (19): a kind x is a part of a kind y iff every realization of the kind x is also a realization of the kind y. For example, dogs with pointy ears is a subkind of dogs since for every situation, the maximal plurality of dogs with pointy ears in that situation is a part (in the regular individual sense) of the maximal plurality of dogs in that situation.

(19) a. $x \leq y$ iff for any s, $x(s) \leq y(s)$
b. Example: dogs with pointy ears $\leq$ dogs

The definition of measurement of regular individuals is given in (20): we relativize it to situations and to what the relevant atoms in the situation are. The first relativization is not crucial in the case of regular individuals but the second one is: in measuring the sum of John and Peter we get different results if we consider the relevant atoms to be limbs or persons. We will for the sake of simplicity assume that the context appropriately determines what the relevant atoms are in the respective situation (cf. Moltmann 1997).

(20) a. $\mu_s(x) = \mu\{y \mid y \leq x \wedge AT(y)\}$
b. Example: μ_s(John+Peter) = 2

Unlike the extension of the part-relation to kinds, this is not as straightforward with the measurement function. Namely, it is hardly clear how one should measure kinds qua individual concepts. Accordingly, as with regular individuals, we relativize the measurement of kinds to situations: this effectively means that we measure (in the regular individual sense) the realizations of a kind in the respective situations. It is also possible to measure kinds with respect to the number of their (natural) subkinds, though we will not discuss this option further in this paper.

(21) a. $\mu_s(x) = \mu\{y \mid y \leq x(s) \wedge AT(y)\}$
b. Example: μ_s(cats) = 7 iff there are seven cats in s

All the ingredients that we require to provide lexical entries for count quantifiers are now given. (22-a) contains the lexical entry for *most*: it takes an individual x and a property P as its arguments and returns a set of situations in which there is a part y of the individual x that measures more than half of what x measures in that situation and the property P holds of y. The meaning of *some* is analogous (22-b): it takes an individual and a property argument and returns the set of situations in which there is a part of the individual argument of which the property holds. The same holds for *all*, though in this case the verifying part of the individual argument is not a *proper* part of the individual argument in the respective situation (22-c).

(22) a. $[\![\text{most}]\!] = \lambda x_i.\lambda P_{\langle i,st\rangle}.\lambda s_s.\ \exists y{\le}x\ [\ \mu_s(y){>}\ \frac{1}{2}\mu_s(x) \wedge P(y,s)\ ]$
b. $[\![\text{some}]\!] = \lambda x_i.\lambda P_{\langle i,st\rangle}.\lambda s_s.\ \exists y{\le}x\ [\ P(y,s)\ ]$
c. $[\![\text{all}]\!] = \lambda x_i.\lambda P_{\langle s,it\rangle}.\lambda s_s.\ \exists y{\le}x\ [\ \mu_s(y){=}\mu_s(x) \wedge P(y,s)\ ]$

Although a further decompositional analysis of some of the entries provided above is possible, we will not pursue it here (cf. Hackl 2009). Furthermore, we have glossed over various complexities involved in the interpretation of *all* (Brisson 1998); this will be rectified at a different occasion.

3.3 An application and some consequences

The lexical entries introduced in the previous section are put to use in this section: we compute truth-conditions of simple sentences containing partitive and non-partitive *most*-phrases and strictly distributive main predicates. It is shown that an additional semantic mechanism needs to be employed for the sentences with the non-partitive quantifiers to be interpretable.

We begin with the partitive quantifiers (23): the sentence in (23-a) has the structure in (23-b). The *-operator represented in the structure indicates that the verb is pluralized, i.e. the VP on its own denotes a set of (sums of) situations in which Mary is kissed; in (23-c), S stands for the denotation of *the students* and ⟦*kiss Mary⟧(y,s) obtains iff, very roughly, every single student part of y is an agent of a kissing-Mary situation part of s and s is a sum of kissing-Mary situations whose agents are the respective students in y. The predicate over situations attained by applying the quantifier to the individual and the property denoted by the VP is existentially closed.

(23) a. Most of the students kissed Mary
b. $[_{\langle\langle i,st\rangle,st\rangle}$ most (of) $[_i$ the students]] $[_{\langle i,st\rangle}$ *kissed Mary]
c. $[\![\text{(23-b)}]\!] = [\lambda x.\lambda P.\lambda s.\exists y{\le}x[\mu_s(y){>}\ \frac{1}{2}\mu_s(x){\wedge}P(y,s)]]\ (S)\ ([\![\text{*kissed Mary}]\!]) =$ 1 iff $\exists s.\exists y{\le}S.[\mu_s(y){>}\ \frac{1}{2}\mu_s(S) \wedge [\![\text{*kiss Mary}]\!](y,s)]$

The interpretation of the corresponding sentence with a non-partitive quantifier should proceed in a parallel fashion: (24-a) has the structure in (24-b). However, a problem pops up when composing the quantifier with the property denoted by the VP. Namely, the composition of the quantifier with a kind individual and the fact that only kind individuals qua individual concepts can be parts of kinds prohibit the application of the quantifier to the property denoted by the VP – there is a sortal (or type) mismatch. That is, although the property denoted by the VP is ⟨`i,st`⟩-type, it is only defined for a subset of `i`-type individuals – the regular individuals.

(24) a. Most students kissed Mary
b. $[_{\langle\langle i,st\rangle,st\rangle}$ most $[_i$ students]] $[_{\langle i,st\rangle}$ *kissed Mary]
c. $\#[\![\text{(24-b)}]\!] = [\lambda x.\lambda P.\lambda s.\ \exists y{\le}x[\mu_s(y){>}\ \frac{1}{2}\mu_s(x) \wedge P(y,s)]]([\![\text{students}]\!])([\![\text{*kissed}$

Mary⟧) = [λs. $\exists y_k \leq$ ⟦students⟧[$\mu_s(y_k) > \frac{1}{2}\mu_s$(⟦students⟧) ∧ ⟦*kissed Mary⟧(y_k,s)]]

This issue is standardly alleviated in neo-Carlsonian approaches to bare plurals by generating a mediating operator on the VP. This can either be a generic operator or a derived kind predication operator (Chierchia 1998). The meanings of these operators are given in (25): y≤x(s) means that y is a realization of the kind x in the event s; C denotes a set of relevant situations (see below for discussion). The meaning of the VP is thus shifted by these operators so that it can apply to kind individuals, i.e. the `i`-type argument of these operators can be a kind individual. The two interpretable structures that the sentence (24-a) may thereby have are in (26).

(25) a. ⟦DKP⟧ = $\lambda P_{\langle i,st\rangle}.\lambda x_i.\lambda s_s.\ \exists y[y \leq x(s) \wedge P(y,s)]$
b. ⟦GEN_C ⟧ = $\lambda P_{\langle i,st\rangle}.\lambda x_i.\lambda s_s.\ \forall y \forall s'[y \leq x(s') \wedge C(s') \rightarrow P(y,s')]$

(26) a. [$_{\langle\langle i,st\rangle,st\rangle}$ most [$_i$ students]] [$_{\langle i,st\rangle}$ DKP [$_{\langle i,st\rangle}$ *kissed Mary]]
b. [$_{\langle\langle i,st\rangle,st\rangle}$ most [$_i$ students]] [$_{\langle i,st\rangle}$ GEN_C [$_{\langle i,st\rangle}$ *kissed Mary]]

Let us now look at the meaning of (26-a): the sentence is true iff there is a situation s and a subkind of the kind students that measures in s more than half of what the kind students measures in s and this subkind has a realization in s – i.e. a student – that kissed Mary in s.

(27) ⟦(26-a)⟧ = [λx.λP.λs. $\exists y \leq x[\mu_s(y) > \frac{1}{2}\mu_s(x) \wedge P(y,s)]$](⟦students⟧)(⟦DKP [*kissed Mary]⟧) = 1 iff $\exists s.\exists y_k \leq$ ⟦students⟧.[$\mu_s(y_k) > \frac{1}{2}\mu_s$(⟦students⟧) ∧ $\exists z[z \leq y_k(s) \wedge$ ⟦*kissed Mary⟧(z,s)]]

These truth-conditions are very weak. Namely, they subsume any situation that contains at least one student that kissed Mary. This is demonstrated by the following reasoning: first, the kind students is a trivial subkind of students; second, the kind students clearly measures in any situation more than half of what the kind students measures in that situation; third, a single student qualifies as a realization of the kind students; thus, in a situation with one student kissing Mary the truth-conditions in (27) are satisfied. That is, the truth-conditions in (27) are equivalent to (28).

(28) ∃s.∃x.[x≤ ⟦students⟧(s) ∧ ⟦*kiss Mary⟧(x,s)]

The same state of affairs is found with other quantifiers. For example, the structures in (29) both have the same truth-conditions as (26-a): this is trivially so for *some*; in the case of *all*, the reasoning is the same as with *most* described above.

(29) a. [$_{\langle\langle i,st\rangle,st\rangle}$ some [$_i$ students]] [$_{\langle i,st\rangle}$ DKP [$_{\langle i,st\rangle}$ *kissed Mary]]
b. [$_{\langle\langle i,st\rangle,st\rangle}$ all [$_i$ students]] [$_{\langle i,st\rangle}$ DKP [$_{\langle i,st\rangle}$ *kissed Mary]]
c. ⟦(29-a)⟧ = ⟦(29-b)⟧ = 1 iff ∃s.∃x.[x≤ ⟦students⟧(s) ∧ ⟦*kiss Mary⟧(x,s)]

We capture the intuition that such systematically weak truth-conditions should be precluded by imposing a pragmatic restriction on the use of scalar items (30) (cf. Spector 2007). Since *some*, *most* and *all* are scalar items on the same scale, the structures in (26-a), (29-a) and (29-b) are scalar alternatives. Accordingly, the equivalence of their meanings, $[\![(26\text{-a})]\!] \equiv [\![(29\text{-a})]\!] \equiv [\![(29\text{-b})]\!]$, is in violation of (30).

(30) Do not use a scalar item if its host sentence is equivalent to all its alternatives where the scalar item is replaced by a scale-mate.

Thus, since the structure (26-a) for the sentence in (24-a) is ruled out, the only viable parse of the sentence in (24-a) is (26-b) with the generic operator on the VP. The truth-conditions of (26-b) are computed in (31): the sentence is true iff there is a subkind of students that measures more than half of what the kind students measures in s and every minimal realization of that subkind kissed Mary in the contextually-determined situations. It is obvious that due to the universal quantification invoked by the generic operator, the truth-conditions in (31) are not equivalent to those of the scalar alternatives of (26-b). The condition in (30) is thus satisfied.

(31) $[\![\text{[most students] GEN}_C \text{ [*kiss Mary]}]\!] = [\lambda\text{x}.\lambda\text{P}.\lambda\text{s}.\ \exists\text{y}\leq\text{x}[\mu_s(\text{y}) > \frac{1}{2}\mu_s(\text{x}) \wedge \text{P(y,s)}]]\ ([\![\text{students}]\!])\ ([\![\text{GEN}_C \text{ *kissed Mary}]\!]) = 1 \text{ iff } \exists\text{s}.\exists\text{y}\leq [\![\text{students}]\!].[\mu_s(\text{y}) > \frac{1}{2}\mu_s([\![\text{students}]\!]) \wedge \forall\text{z}\forall\text{s'}[\text{z}\leq\text{y(s')} \wedge \text{C(s')} \rightarrow [\![\text{*kiss Mary}]\!](\text{z,s'})]]$

Let us elaborate on what is meant by the contextually-determined situations. Although Matthewson observed that there is a tendency for non-partitive quantifiers to occur in generic environments and to receive contextually unrestricted interpretations, this tendency seems to be suspended if the quantifier contains a post-nominal modifier (Matthewson 2001), an effect resembling subtrigging facts with free choice *any* (cf. Dayal 1998, and many others).

(32) a. Most men who came to the party left early
b. Most people at yesterday's rally were Democrats

More precisely, it seems that the markedness of episodic sentences with non-partitive *most*-phrases disappears if the NP complement of *most* has a sufficiently restricted denotation. This does not present a problem for our analysis: the episodic nature of such sentences can in our system be encoded in the resource domain variable argument of the generic operator. It is a well-known fact that such event-like restrictions are available in generics (cf. Greenberg 2003, von Fintel 2004).

(33) a. Italian restaurants are closed tonight
b. In the 1950's, women never wore blue jeans

Thus, even in the cases of seemingly episodic sentences, the generic operator may still be present in the structure, though it is contextually restricted to a particular temporal interval. For example, the domain of GEN in the sentence *Most students at the party kissed Mary* may be restricted to events, say, occurring at the time of the party. The truth-conditions that we then predict for this sentence are the following: it is true iff the sum of students at the party, each of which kissed Mary at the party, is bigger than half of all the students at the party.

To summarize, in this section we applied the semantic machinery introduced in the previous two subsections to simple sentences containing non-partitive quantifiers and strictly distributive main predicates. It was shown that such sentences need to be generated with a mediating operator on the VP since a sortal mismatch otherwise obtains. Furthermore, it was shown that this mediating operator can only be a generic operator.

4 Analysis

In this section the semantics that we have developed above is shown to derive the asymmetries described in Section 2. The crucial factor in the analysis is the obligatory presence of a (temporally restricted) generic operator in sentences with non-partitive count quantifiers. GEN is effectively a distributivity operator, i.e. it precludes non-distributive interpretations of the main predicate.

The partitive count quantifiers can combine with collectively interpreted mixed main predicates; they also allow cumulative interpretations of sentences in which they are contained. (34) illustrates how the first fact is derived in our system: the sentence in (34-a) with the structure in (34-b) has the interpretation in (34-c): the sentence simply states that there is a plurality of students that is a part of the students and measures more than half of the students and this plurality jointly lifted the piano. The sentence may also have a distributive reading: it is true under a distributive reading if the VP contains enough pairs of single students and lifting-the-piano events, i.e. the majority of students has to be such that each student in the majority is an agent of his own lifting-the-piano event.

(34) a. Most of the boys lifted the piano

b. $[_{\langle\langle i,st\rangle,st\rangle}$ most (of) $[_{i}$ the boys$]]$ $[_{\langle i,st\rangle}$ lifted the piano$]$

c. $[\![$(34-b)$]\!]$ = $[\lambda x.\lambda P.\lambda s.\ \exists y \leq x\ [\mu_s(y) > \frac{1}{2}\mu_s(x) \wedge P(y,s)](B)([\![\text{lift the piano}]\!])$ $= 1$ iff $\exists s.\exists y \leq B.[\mu_s(y) > \frac{1}{2}\mu_s(B) \wedge [\![\text{lift the piano}]\!](y,s)]$

The derivation of a cumulative interpretation of a sentence containing partitive count quantifiers is illustrated in (35). The sentence in (35-a) has the structure in (35-b) where the verb is pluralized; the PP applies to the pluralized verb to yield a set of sums of voting events in which two parties are voted for; a plurality of voters that measures more than half of the voters must then be a cumulative agent of one of such sums for the sentence to be true. That is, the truth-conditions are compatible with events in which none of the voters voted for more than one party, as long as two parties together got the majority of votes.

(35) a. Most of the voters voted for two parties
b. [most (of) [the voters]] [*vote for two parties]
c. $[\![$(35-b)$]\!]$ = 1 iff $\exists$s.$\exists$y$\leq$V.[μ_s(y)>$\frac{1}{2}\mu_s$(V) $\wedge$ $\exists$z[$[\![$parties$]\!]$(z) $\wedge$ μ(z)=2 $\wedge$ $[\![$*vote$]\!]$(y,z,s)])

It has been shown in the previous section that if we adopt Matthewson's analysis of quantification, the predicative argument of the non-partitive quantifiers has to be generic. Since genericity involves universal quantification over all the (minimal) realizations of a kind that satisfy certain restrictions, this amounts to having a distributivity operator generated in the structure. We illustrate this by first deriving the obligatorily distributive readings of mixed predicates with non-partitive count quantifiers:

(36) a. Most boys at the party lifted the piano
b. [$_{\langle\langle i,st\rangle,st\rangle}$ most [$_i$ boys]] [$_{\langle i,st\rangle}$ GEN$_C$ lifted the piano]
c. $[\![$(36-b)$]\!]$ = [λx.λP.λs. $\exists$y$\leq$x [μ_s(y)>$\frac{1}{2}\mu_s$(x) $\wedge$ P(y,s)]($[\![$boys$]\!]$)($[\![$GEN$_C$ lift the piano$]\!]$) = 1 iff $\exists$s.$\exists$y$\leq$$[\![$boys$]\!]$.[$\mu_s$(y) > $\frac{1}{2}\mu_s$($[\![$boys$]\!]$) $\wedge$ $\forall$z$\forall$s'[z$\leq$y(s') $\wedge$ C(s') $\rightarrow$ $[\![$lift the piano$]\!]$(z,s')]]

The non-availability of cumulative readings is a consequence of the layered quantification structure as well: the sentence in (37-a) is true in s iff there is a subkind of voters in s that measures more than half of what the voters in s measure and each individual realization of this subkind – i.e. each individual voter – votes for two parties.

(37) a. Most voters voted for two parties
b. [most voters] GEN$_C$ [vote for two parties]
c. $[\![$(37-b)$]\!]$ = 1 iff $\exists$s.$\exists$y$\leq$$[\![$voters$]\!]$.[$\mu_s$(y) > $\frac{1}{2}\mu_s$($[\![$voters$]\!]$) $\wedge$ $\forall$z$\forall$s'[z$\leq$y(s') $\wedge$ C(s') $\rightarrow$ $[\![$vote for two parties$]\!]$(z,s')]]

To summarize, the obligatory presence of a generic operator in sentences containing non-partitive count quantifiers explains the distributivity pattern observed in these sentences. The collectivity and cumulativity in sentences with partitive count quantifiers are derived in the standard way.

5 Mass quantifiers

5.1 Homogeneity

It is a well-established fact that mass quantifiers tend to combine only with a certain kind of main predicates (cf. Lønning 1987, Moltmann 1991, Higginbotham 1994). A generalization describing this pattern is in (38), whereby an expression is homogeneous iff it is cumulative and distributive.

(38) Homogeneous Constraint (Lønning 1987)
Mass noun phrases combine only with homogeneous expressions to form sen-

tences.

The sentences that are usually used to illustrate this constraint contain non-partitive mass nouns. Lønning's examples are in (39): *boil* is clearly a homogeneous predicate since if a certain amount of water boils then all its parts boil (distributivity), and if two amounts of water boil then their sum boils as well (cumulativity); *weigh two grams*, on the other hand, is not homogeneous since it is not distributive. The pattern in (39) thereby roughly resembles the pattern found with non-partitive count quantifiers whose predicate argument cannot be interpreted non-distributively.

(39) a. Much water boiled
b. *Most water weighed two grams

However, the constraint in (38) does not seem to extend to all occurrences of mass quantifiers: partitive mass quantifiers have been observed to be able to combine with non-homogeneous predicates. An example is in (40) (Bunt 1985, Moltmann 1997).

(40) [Scenario: There are gold bars on the table; each contains 2 g of copper.]
All the gold (in front of me) has 2 g of copper in it

We further illustrate this asymmetry with *most*-phrases in (41). In particular, there are different possible non-distributive readings that a sentence with a partitive mass quantifier may have, i.e. (41-a) can be used to describe both of the scenarios given in (41). A non-partitive mass quantifier is illicit in any sentence containing a non-homogeneous main predicate (41-b) (see below for a qualification).

(41) [Scenario #1: There are five bottles of water on the table. 6 ml of poison is poured into each of three of those bottles.]
[Scenario #2: There are two containers of water (A and B) – A has 10 liters of water in it; B has 2 liters of water. We pour 6 ml of poison into the container A.]
a. Most of the water (in front of me) contains 6 ml of poison
b. *Most water (in front of me) contains 6 ml of poison

5.2 Analysis

The approach developed above for count quantifiers naturally extends to the mass case. The only modification that is required involves the measurement function: in measuring substances, we are not measuring the cardinalities of their atoms but certain physical characteristics that they have; in our examples, we measure the volumes of the respective water amounts. A computation of the meaning of partitive quantifiers with non-homogeneous main predicates is illustrated in (42): the sentence simply states that there exists a part of the relevant water amount that contains 6 ml of poison.

(42) a. Most of the water (in front of me) contains 6 ml of poison
b. $[_{\langle\langle i,st\rangle,st\rangle}$ most (of) $[_i$ the water]] $[_{\langle i,st\rangle}$ contains 6ml of poison]
c. $[\![$(42-b)$]\!]$ = 1 iff $\exists$s.$\exists$y$\leq$W.[μ_s(y)$>\frac{1}{2}\mu_s$(W) $\wedge$ $[\![$contain 6 ml of poison$]\!]$(y,s)]

The sentence with a non-partitive mass quantifier is analyzed in (43). The truth-conditions of the sentence are problematic and lead to infelicity. Namely, since it is vague what the atoms of water are (Chierchia 2009), the sentence would have to be true in every precisification to be (Super-)true. However, this is not possible since the main predicate is not distributive.

(43) a. *Most water contains 6 ml of poison
b. $[_{\langle\langle i,st\rangle,st\rangle}$ most $[_i$ water]] GEN$_C$ $[_{\langle i,st\rangle}$ contains 6ml of poison]
c. $[\![$(43-b)$]\!]$ = 1 iff $\exists$s.$\exists$y$\leq[\![$water$]\!]$.[μ_s(y) $>$ $\frac{1}{2}\mu_s$($[\![$water$]\!]$) $\wedge$ $\forall$z$\forall$s'[z$\leq$y(s') $\wedge$ C(s') $\rightarrow$ $[\![$contain 6ml of poison$]\!]$(z,s')]]

This analysis makes an immediate prediction: if the atoms of a mass noun denotation are known (e.g. as is the case with *furniture*), then the non-partitive mass quantifiers should be able to combine with non-homogenous predicates but still pattern with non-partitive count quantifiers. This prediction is borne out: the sentence in (44) is acceptable but only has the strictly distributive reading.

(44) Most furniture weighs more than one kilogram

To summarize, this section extended our analysis to mass quantifiers which are in their non-partitive instantiations incompatible with non-homogeneous main predicates. We have argued that this incompatibility is due to two factors: the universal quantification triggered by the presence of the generic operator in the structure and the vagueness of what realizations of substances we are quantifying over. If either of these two factors is missing, the status of the sentences with non-homogeneous main predicates improves.

6 Conclusion and outlook

The partitive and non-partitive count quantifiers exhibit distinct patterns when it comes to sentences with mixed main predicates – only in sentences with partitives can the mixed predicates be interpreted collectively – as well as in allowing cumulative readings of sentences in which they occur – only sentences with partitives allow cumulative interpretations. These facts were derived by relying on Matthewson's approach to quantification. In particular, we have shown that the sentences with non-partitives involve a layered quantification structure, which effectively leads to strictly distributive interpretations. Finally, the analysis was extended to mass quantifiers where a similar pattern of behavior by partitives and non-partitives has been observed with respect to their compatibility with non-homogeneous main predicates.

There are several issues that we have left aside in the current paper. For example, (i) we have not studied the semantics of sentences with kind main predicates (*be* *widespread*), (ii) we have not looked at the behavior of weak quantifiers (*three boys*), (iii) we have avoided the discussion of the compatibility of partitive and non-partitive quantifiers with genuinely collective and essentially plural main predicates (*be a team, meet*) (cf. Winter 2001, Hackl 2002), and (iv) we did not explore the similarities between the non-partitives and free choice *any* concerning subtrigging. We hope to deal with these and other related issues in the future.

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