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COUNTING AND MEASURING: A THEORETICAL AND CROSSLINGUISTIC ACCOUNT

ABSTRACT: In this paper, I show that expressions like *two glasses of wine* are ambiguous between counting and measuring interpretations, and that each interpretation is associated with a different semantic representation. In each interpretation, *glasses* has a different function. In the counting interpretation, *glasses* is a relational noun, while in the measure interpretation, *glasses* is a measure head analogous to *litre*. This difference leads to a number of grammatical contrasts which can be explained by differences in the grammatical structure. I discuss whether these differences are only semantic or also expressed in the syntactic representation. The assumption that syntax directly reflects semantic interpretation leads to assigning counting NPs and measuring NPs two different syntactic structures: counting NPs are right-branching with *two* modifying *glasses of wine*, while in measure expressions the numeral and the measure head form a measure predicate *two glasses* which modifies the N. I show that in Modern Hebrew and Mandarin counting structures and measuring structures clearly do have different syntactic structures, reflecting the semantic differences between counting and measuring. While the evidence in the case of English is less strong, the assumption that syntax directly reflects compositional syntactic structure results in the same basic syntactic contrasts in English as well.¹

1. INTRODUCTION

This paper explores expressions of counting and measuring in natural languages, in particular English, Dutch, Hungarian, Modern Hebrew and Mandarin Chinese. We start by exploring the idea that counting and measuring are two different operations used to assign quantity properties to sums of individuals or chunks of stuff. Look at the examples in (1) and (2).

- (1) There are two apples on the table.
- (2) There are two kilos of apples on the table.

On the surface, it looks as if *two* has the same role in both examples. In (1) *two* tells you how many apples there are on the table, and in (2) *two* tells you how many kilos of apples there are on the table. However, this formulation misses a crucial point: different operations are used to tell how many apples there are and how many kilos of apples there are. In order to make the assertion in (1) we count the individual apples, while to make the assertion in (2) we measure the overall sum of apples. This means that (1) and (2) do not give you the same kind of information. If you know that (1) is true, you know that the sum of apples on the table is made up of two individual atomic apples, but you don't know anything about the quantity of apple-stuff (since they may be big apples or small apples or even one of each kind). If you know that (2) is true, you know something about the whole sum of apples on the table, namely its weight, but nothing about the number of apples which make up the sum. The different informational content of expressions of counting and measuring correlates with a difference in how counting and measuring are normally carried out practically. Counting requires identifying the individual apples on the table, by sight, by touch or some other method, and counting them. Measuring doesn't require this: I can put a brown paper bag of apples on a scale and find out how big a quantity of apples there is in the bag in terms of weight without seeing the apples or knowing anything about how many individual apples are involved.

In this paper, I shall argue that the informational difference between counting and measuring is reflected in the grammar. In the next section, I will review some of the discussion about counting and measur-

ing in the semantic literature. In section 3, I will discuss the linguistic evidence that counting and measuring are two different types of assertions, focusing on English. In section 4, I will propose an analysis and discuss its pros and cons, in particular the issues that it raises for matching between syntactic structure and semantic interpretation. In section 5, I will discuss in turn data from Hungarian, Modern Hebrew and Mandarin Chinese which suggest that the semantic differences between measuring and counting are reflected in syntactic differences. In section 6, I will discuss agreement in measure constructions. While some of the ground covered in this paper overlaps with Rothstein (2009, *in press*), the focus of the discussion here is different. We will be primarily interested in the issue of compositional interpretation crosslinguistically, rather than focusing on one particular language (as in Rothstein 2009) or on the semantics of measurement (as in Rothstein *in press*).

2. SOME BACKGROUND ON COUNTING AND MEASURING

In typical mass/count languages, numeral modifiers modify count nouns directly. In many languages, a noun is marked as plural when it is modified by a numeral greater than *one* (3a) vs (3b). Numerical expressions modify mass nouns via explicit measure heads like *kilo*, *litre* (3c). These can also occur with plural count nouns (3c). There are also classifier expressions such as those in (3d).

- (3)
- a. three flowers, four books.
 - b. #three flours, #four muds, #five furnitures
 - c. three kilos of flour, two litres of wine, three kilos of books, fifty kilos of furniture
 - d. three boxes of books, three bottles of wine

The numerals in examples like (3) are used to construct quantity expressions. But (3) illustrates two different uses of numerals. In (3a), the noun is directly modified by a numeral, and the resulting phrase is a counting phrase, expressing how many objects of type N there are: *three boys*, *five books*, *six apples*, *1003 apple trees* and so on. As the contrast with (3b) shows, this is possible only with count nouns. (3c) shows a different construction, in which the numeral precedes a measure head. The whole nominal phrase expresses how much stuff of type

N there is in terms of a unit of measure: *three litres of water*, *five kilos of flour*, *five kilos of apples* and so on. While in (3a) the numeral *three* directly modifies the N, I shall argue that in (3c), the numeral combines with the measure head to give a measure predicate, e.g. *three kilos* and that this predicate modifies the N that follows it. *Three kilos of apples* denotes sums of apples that together weigh three kilos, or, put differently, it denotes a collection of apples which has the property of weighing three kilos on a dimensional scale of weight. The examples in (3d) will be the focus of the paper. These examples look superficially like (3c), but the numeral precedes an ordinary noun instead of an explicit measure word. These nouns are termed *classifiers* and are, as we will see, ambiguous between a counting and measuring interpretation. In counting nominals, the numeral modifies the expression *boxes of N* and *bottles of N*, expressing how many boxes and bottles of stuff there are. As measure expressions, *boxes* and *bottles* are reanalyzed as measure heads. The measure expressions *three boxes* and *three bottles* are then used analogously to *three kilos* and *three litres* to express a quantity property of the stuff denoted by N, here books and wine.

Given that counting and measuring are two ways of determining quantity, an obvious question is what is the relation between them? There are three plausible approaches.

First, measuring could be a form of counting, in which units are counted instead of objects. *Kilos* and *boxes*, often called 'mensural classifiers' seem to fill a similar grammatical role in (3c) as *boxes* and *bottles* in (3d). So if, in the latter case, *three* counts boxes and bottles, in (3c), *three* should be counting kilos and litres. This approach is taken for example by Lyons (1977), who suggests that "a mensural classifier is one which individuates in terms of quantity" (p. 463), while Gil (2013) writes that "Mensural classifiers provide nouns of low countability with a unit of measure by means of which they may then be counted". This approach posits individuable units of stuff, which can then be counted. But, as we shall see below, this does not use any well-defined notion of counting. Counting denotes individuable discrete units, while *two kilos of apples* can, for example, denote three apples each weighing less than a kilo, with no three discrete individuable units available to be counted.

Second, counting could be a form of measuring. This is the approach taken in Krifka (1989, 1995). Krifka argues that if *two kilos of*

flour gives the quantity of flour in terms of kilo units, *two cats* should be treated as giving the quantity of cat in terms of natural units. Technically, this works much better than the first option, but does not take account of the difference in operations involved in counting and measuring.

The third possibility is that measuring and counting are two independent operations, using two different mechanisms to assign different kinds of quantity properties. In this paper, I will argue for this third possibility, showing that counting and measuring give different information about the quantity of sums and pluralities under discussion and that expressions of counting and measuring have different grammatical properties.

We begin with a simplified semantics. Counting answers in English the question *how many?* In *three apples*, *three* gives the quantity or size of the sum of apples in terms of the number of individual apples out of which the sum is made up. When we count “one apple, two apples, three apples...”, we identify distinct individual apples, and put them in one-to-one correspondence with the natural numbers. *Three apples* denotes a sum of apples constructed out of three distinct apples, a sum that has the property of being ‘three’ or a ‘threesome’. More generally *three* is the property that a plural object N has if it has three atomic N-parts. We assume that *three* (as a modifier) has the denotation in (4). It is an adjective at type $\langle e, t \rangle$, modifying N. *Three* is a cardinality predicate and denotes a cardinal property.

$$(4) \quad \textit{three}: \lambda x. |x| = 3$$

A plural entity has a cardinal property n if the set of its atomic parts has cardinality n :

$$(5) \quad \forall x [|x| = n \leftrightarrow |\{y: y \sqsubseteq_{ATOM} x\}| = n]$$

Thus a plurality of apples counts as “three”, if it is made up of three whole apples.

Cardinal predicates such as (4) modify plural nouns and intersect with plural sets. We assume, following Link (1983) that a singular sortal noun N denotes a set of atoms. The plural set $*N$ denotes the closure of N under sum:

$$(6) \quad *N = \{x: \exists Y [Y \subseteq N \wedge x = \sqcup Y] \}$$

$$*APPLE = \{x: \exists Y [Y \subseteq APPLE \wedge x = \sqcup Y] \}$$

Three apples denotes the intersection of $*APPLE$ and the denotation of *three*. Like all intersective adjectives in attributive position, *three* shifts to the modifier type i.e. $\lambda P \lambda x. P(x) \wedge |x| = 3$. It then applies to the predicate $*APPLE$, to give the predicate in (7a). If *three apples* is in argument position, it will raise to the generalized quantifier type as in (7b), or be bound by default existential quantification (Kamp 1981; Heim 1982):

$$(7) \quad \text{a. } \textit{three}_{\langle \langle e, t \rangle, \langle e, t \rangle \rangle}: \lambda P \lambda x. P(x) \wedge |x| = 3 (*APPLE)$$

$$= \lambda x. *APPLE(x) \wedge |x| = 3$$

$$\text{b. } \lambda P \exists x [*APPLE(x) \wedge |x| = 3 \wedge P(x)]$$

Thus *three* in counting contexts gives a property of a plural entity in the denotation of N, expressing how many atomic N-parts the plurality has. In contrast, measuring answers the question *how much?* It involves assigning a quantity an overall value on a dimensional scale, for example the scale of weight, volume, height, cost, and so on. *Three kilos* expresses the property of weighing three kilos on the scale on weight, and *three kilos of apples* denotes sums of apples which weigh three kilos. *Three* cannot be a counting expression or cardinality predicate as in the previous example, since there are no atomic kilo units which can be counted. Suppose my set APPLE denoted by the singular count noun *apple* contains atomic apples each weighing three-quarters of a kilo. Then, in the denotation of the plural *apples*, $*APPLE$, there are going to be no entities or sums which weigh one kilo (or two kilos), and there will be no atomic kilo-units to be counted. This means that *three* cannot have the counting interpretation in (3c): the bi-conditional (5) say that an entity has the property *three* if and only if it has three atomic parts. If *three* were a counting expression, *three kilos of apples*, should denote pluralities of kilos of apples with three atomic kilo-of-apples parts, which it doesn't. So, while it is not uncommon to talk about *kilo* as imposing a unit structure on the domain of apples, or picking out the kilo units, and *three* as counting these kilo units, this is not ultimately going to work, because in the set denoted by *apples* there are no such units.² *Three kilos of apples* then, must have an interpretation different

from *three apples*. It must denote the set of pluralities of apples which weigh three kilos, without relying on being able to access any individual kilo-parts. *Three kilos* must be a measure predicate, denoting a property of pluralities without accessing any atomic structure.

Following Landman (2004), Rothstein (2009, in press) and others, we analyse the measure predicate *three kilos* as based on the measure function *kilo*. A measure function, $\text{MEASURE}_{M,U}$ is a function from entities to numerical values on a specified dimensional scale, M , calibrated in units U .

We define 'scale' as follows, following Rothstein (in press):

- (8) A scale $S_{M,U}$ is a partial order $S_{M,U} = \langle N, \geq_{M,U}, \text{MEASURE}_{M,U} \rangle$ where:
 M is a dimension (e.g. volume, weight).
 U is the unit of measurement in the relevant dimension, in terms of which the scale is calibrated (e.g. *litre, kilo*), of the real numbers, depending on the nature of the measure and the fine-grainedness of the measurement.

$\text{MEASURE}_{M,U}$ is a function from objects and world-time indices to values in N defined for a particular dimension, M and a unit U . In this paper, where we will be dealing with purely extensional contexts, we will allow ourselves to ignore the world-time indices. We can now give a semantics for *measure predicates* as follows:

- (9) A *measure predicate* at type $\langle e,t \rangle$ is a predicate of the form $\lambda x. \alpha(\text{MEASURE}_{M,U}(x))$, with α a predicate of numbers, like $\lambda n. n = 2$, $\lambda n. 2 \leq_{M,U} n \leq_{M,U} 4$, etc.
 This gives measure predicates like the following:
 $\lambda x. \text{MEASURE}_{\text{WEIGHT,KILO}}(x) = 2$
 $\lambda x. 2 \leq_{\text{WEIGHT,KILO}} \text{MEASURE}_{\text{WEIGHT,KILO}}(x) \leq_{\text{WEIGHT,KILO}} 4$, etc.

Measure predicates are derived from *measure heads*. As an example, assume the scale $S_{\text{WEIGHT,KILO}}$, where N is the set of positive real numbers. The measure predicate *three kilos* is derived by applying the measure head *kilo* to the number *three*. We follow Rothstein (2013, in press), where cardinal numerals are treated as property-denoting expressions, following Chierchia & Turner (1987). This means that the cardinal nu-

meral *three*, as well as having the predicate denotation at type $\langle e,t \rangle$ as in (4), also has an argument denotation at type n , the type of numbers, where it denotes the individual correlate of the property in (4), an entity which itself is the subject of predication as in, for example, *Three is the smallest odd prime number*.

The measure head *kilo* in (10a) denotes a function that maps a number n at type n onto the set of entities (singular or plural) whose weight-value in kilos is n . It combines with the numeral 3 at type n to give the measure predicate *three kilos* as in (10b), which denotes the set of entities whose weight measured in kilos is 3. Like any other predicate, *three kilos* can shift to the predicate modifier type and can modify a noun at type $\langle e,t \rangle$. In *three kilos of apples*, it applies to *APPLE as in (10c), and denotes sums of apples which measure three kilos, i.e. which have the value 3 on the scale of weight calibrated in kilos.

- (10) a. $\llbracket \text{kilo} \rrbracket = \lambda n \lambda x. \text{MEASURE}_{\text{WEIGHT,KILO}}(x) = n$
 b. $\llbracket 3 \text{ kilos} \rrbracket = \lambda x. \text{MEASURE}_{\text{WEIGHT,KILO}}(x) = 3$
 c. $\llbracket 3 \text{ kilos of apples} \rrbracket = \lambda x. * \text{APPLE}(x) \wedge \text{MEASURE}_{\text{WEIGHT,KILO}}(x) = 3$

3. CLASSIFIER CONSTRUCTIONS AND THE COUNT-MEASURE CONTRAST

The semantic analysis given in section 2 is a plausible account of how to derive counting and measuring expressions semantically in such a way that neither operation reduces to the other. But what linguistic evidence is there to treat counting and measuring as two different operations? And how do the semantic interpretations in section 2 map onto syntactic structures?

Rothstein (2009) shows that classifier constructions such as *two glasses of water* are particularly useful in distinguishing between counting and measuring interpretations, and we now review those results.

As observed by many linguistics (Doetjes 1997; Chierchia 1998; Landman 2004 and others) classifier phrases like *two glasses of water* are ambiguous between an 'individuating' reading in which containers are individuated and counted as in (11a) and a 'measure' reading in (11b):

- (11) a. Mary, bring two glasses of water for our guests!
 b. Mary, add two glasses of water to the soup!

In (11a), the container-counting reading, Mary is asked to bring two objects, glasses, which are filled with water. This requires individuating two objects which are glasses of water. *Two* counts these. In (11b), Mary is asked to add a specific amount of water to the soup, an amount which equals that which could be contained in two glasses. This is the measure reading. *Two glasses* expresses the overall quantity of the water which is required. No glasses need be involved, and Mary can measure the quantity of water any way she likes.³ Rothstein (2009) lists a number of grammatical tests for distinguishing the two readings, including the following.

First, the suffix *-ful* cannot be added to *glasses* when the N is used to denote a container:

- (12) a. Add two glassesful of wine to the soup.
 b. #Bring two glassesful of wine for our guests.⁴

Second, plural pronouns can be dependent on two glasses of wine on its individuating or counting reading, but not on its measure reading:

- (13) a. There are two glasses of wine on this tray. They are expensive.
 b. There are two glasses of wine in this soup. #They are/were expensive.

Third, distributive operators are felicitous with counting uses of two glasses of wine but not with measure uses.

- (14) a. The two glasses of wine on this tray cost 5 Euros each/each cost five Euros.
 b. #The two glasses of wine in this soup cost 5 Euros each/each cost five Euros.

Finally, relative clauses denoting sets of individuals can be headed by *that* or *which*; relative clauses denoting quantities are headed only by *that* (Carlson 1977; Heim 1987; Grosu & Landman 1998). The example in (15a) from Heim (1987) uses *bottle* as a classifier, and is ambiguous between a counting reading involving individuated bottles of wine and

measure reading in which the NP denotes an amount. However, when we change the complementizer of the relative clause to *which*, only a counting reading is possible (15b). If the context only allows a measure interpretation, use of the *which* complementizer results in infelicity, as the contrast between (15c) and (15d) shows.

- (15) a. I would like to be able to buy the bottles of wine that they bought for the party.
 b. I would like to be able to buy the bottles of wine that they bought for the party.
 c. It would take us a year to drink the bottles of wine that they drank that evening.
 d. #It would take us a year to drink the bottles of wine which they drank that evening.

Further discussion of tests which distinguish between count and measure readings can be found in Rothstein (in press).

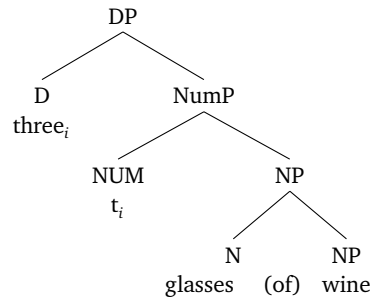
These tests show that the counting and measuring interpretations of NPs like *two glasses of wine* are genuinely different, and must have different denotations. On the count reading, we assume that *two glasses of wine* refers to a plurality consisting of two individuated glasses each filled with wine, while on the measure reading, it refers to a quantity of wine which is measured in terms of units, where a standard unit such as litre or millilitre has been replaced by what Partee & Borschev (2012) call an *ad hoc* measure-unit, *glass*, where one glass-unit is the quantity which can be contained in one glass.

Given these differences between count and mass interpretations of classifier phrases, we need to build interpretations which will allow us to explain these differences. We will follow the proposals in Rothstein (2009), beginning with the analysis of counting constructions. In its counting use, *two glasses of wine* makes reference to two actual glasses, and the NP meaning must thus be constructed from the noun *glass*. We assume that the one-place sortal noun *glass* in (16a) shifts to a two-place relational noun (16b):

- (16) a. GLASS_{N^1} - denotes the property $\lambda x. \text{GLASS}(x)$
 b. GLASS_{N^2} - denotes the relation $\lambda y \lambda x. \text{GLASS}(x) \wedge \text{CONTAIN}(x, y)$

This relational nominal glasses heads the NP in (17):

(17)



Following Landman (2003, 2004) the numerical is treated as a left peripheral adjective, generated in Num, which raises to determiner position. The preposition *of* is treated as a case-marker and does not generate a node in the tree (Chomsky 1981). The relational nominal applies to the NP complement *wine* using NP incorporation, and the resulting NP is modified by the adjective *three* giving (18) as the interpretation of the whole NP (for details see Rothstein in press).

(18) $\lambda x. *GLASS(x) \wedge |x| = 3 \wedge \forall a [a \sqsubseteq ATOM x \rightarrow \exists y [WINE(y) \wedge CONTAIN(a, y)]]$

The measuring reading is more complicated. As we have seen, the plausible semantic account is that in measure phrases, the measure head applies to a number to give a complex predicate. This is indeed what is assumed in Krifka (1989); Chierchia (1998); Landman (2004, 2016) and many others. So in *three litres*, *litres* combines with *three* to form a complex predicate giving the property that a quantity has if it has the value 3 on the volume dimension calibrated in litres. (19) is identical in structure to (10a), but denotes a measure operation on the dimension of volume, instead of weight:

(19) $\lambda x. MEASURE_{VOLUME, LITRE}(x) = 3$

Dimensional scales may be calibrated in many different ways. *Litre*, *decilitre*, *millilitre* are related metric measures on the volume scale, while *fluid*, *ounce*, *pint*, *quart* and *gallon* are related measures on the

volume scale, in the imperial system. *Litre* and *pint* thus denote operations on the same dimension, but involve different units of calibration. But, in addition to standardized units such as these, scales can be calibrated in terms of *ad hoc* units. In this situation, contextually relevant, possibly stereotypical, objects are used to provide a unit of calibration. Thus for example, the cookery writer Elizabeth David frequently expresses a measurement in terms of ‘coffee-cup (after dinner size)’,⁵ clarifying exactly which kind of object is supposed to be used to determine the unit of measure. Different accounts of how objects can be used to determine units of measure can be found in Partee & Borschev (2012) and Rothstein (in press). Note that some measure heads may be ambiguous between standard and *ad hoc* measures. *Cup* for example has a standardized measure value,⁶ but can also be used as an *ad hoc* measure. English allows a relatively free conversion of nouns into *ad hoc* measures, as the list in (20) shows. In some, but not all cases, this conversion is marked by the suffix *-ful* or *-worth*.

- (20)
- "nine tablefuls of guests gathered for a Cantonese-inspired dinner banquet..."⁷
 - ten dollarsworth of gas
 - "you could put three sacks of sand to one sack of cement, or three bucketfuls of sand to three bucketfuls of cement..."⁸

Glass as an *ad hoc* measure head has an interpretation at type $\langle n \langle e, t \rangle \rangle$ as in (21a).⁹ It combines with a numeral such as 3 to give the measure predicate in (21b). This predicate phrase then modifies the N head to give the meaning of *three glasses of wine* in (21c), the set of quantities of wine which are enough to fill three (contextually relevant or standard-in-context) glasses:

- (21)
- $\lambda n \lambda x. MEASURE_{VOLUME, GLASS}(x) = n$
 - $\lambda x. MEASURE_{VOLUME, GLASS}(x) = 3$
 - $\lambda x. MEASURE_{VOLUME, GLASS}(x) = 3 \wedge WINE(x)$

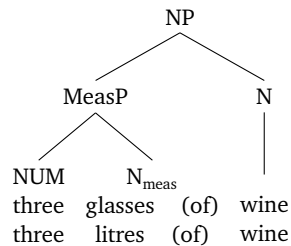
The question is what syntactic structure do *three glasses of wine* and similar phrases have? Unlike the counting cases, where the relation between syntactic structure and semantic interpretation is relatively

straightforward, this question is not so simple. We will devote the next section to this issue.

4. SYNTAX OF MEASURE CONSTRUCTIONS - THE ISSUE

The semantic analysis of measures as in (10) and (21) is relatively uncontroversial (see Krifka 1989, 1995; Chierchia 1998; Landman 2004, 2016; Rothstein 2009). However, the syntax of these constructions is not so straightforward. Rothstein (2009) proposes assigning the structure in (22) to the NP *three litres of wine* as well as to *three glasses of wine* on its measure interpretation:¹⁰

(22)

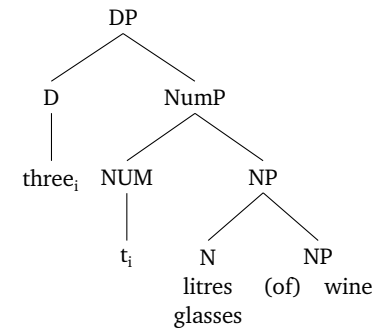


On the surface, (22) can be considered the simplest possible syntactic analysis for measure phrases since the syntax directly reflects the compositional semantic rules. Semantically, the denotation of the measure head applies to a number to give a property, the property in (10b/21b), which then modifies the noun. Syntactically, the measure head at type $\langle n \langle e, t \rangle$ takes a numeral at type n as an argument to yield a syntactic modifier *three glasses/three litres* which modifies the N *wine*. Thus syntactic structure and semantic structure are isomorphic. Since wine is the head of the NP in (22), this structure also expresses nicely the fact that on the measuring reading, *three glasses/litres of wine* denotes wine (to the quantity three glasses), in contrast to the counting structure in (17), where *glasses* is head of the phrase and where the NP as a whole denotes glasses which are filled with wine. What is non-standard about this tree is that it is not right branching, since measure heads such as *kilo*, as well as *glass* on its measure interpretation, combine with arguments to the left (i.e. the numerical, which precedes the head) as

opposed to combining with an argument to the right, as is standard in English. Furthermore, while *three litres/three glasses* looks like an adjective, it is nonetheless separated from the nominal head by the null preposition *of*.

In contrast to (22), Landman (this volume) argues that in measure NPs, the measure head is a noun and heads a right branching NP, as shown in (23).

(23)



Measure noun phrases in Landman's account have the same syntactic structure as the counting phrases in (17), but different semantic interpretations. *Litres/glasses* is an N, and thus the presence of *of* is explained. There is a mismatch between syntax and semantics, since the semantic measure predicate $\lambda x.MEASURE_{DIM,UNIT}(x) = n$ does not correspond to any constituent in the tree. He argues that (23) is the default structure for NPs, and that the simplicity resulting from using this default structure outweighs the complexity resulting from the mismatch. However, while assuming that such a mismatch between syntax and semantics is not the normal case, he does not discuss what factors license such a mismatch. Rothstein (2009, in press) shows that in English, there is little empirical evidence on which to base a choice between (22) and (23). However, there is evidence that in other languages, in particular Modern Hebrew and Mandarin, (22) is the right structure. In the next section I will discuss the crosslinguistic data in English, Hungarian, Modern Hebrew and Mandarin, and suggest that analyses of the latter two languages give some insight into what may be going on in English.

5. CROSSLINGUISTIC CONTRASTS BETWEEN COUNTING AND MEASURING NPS

1. English

Rothstein (2009, in press) considers the data which supports contrasting structures for counting and measuring expressions, and concludes that there is some evidence that measure nominals in English should be assigned the structure in (22), although this evidence is not very strong.

First, in English measure NPs, the numeral is (almost) obligatory, suggesting it is indeed selected by the measure head. Without a numeral, the measure nominal is infelicitous, as in (24a/b), though bare counting nominals are perfectly acceptable (24c).¹¹

- (24) a. #I bought litres of wine.
 b. #We spilled bottles of wine and jugs of water
 c. The waiter did bring bottles of wine and jugs of water, but only very few.

The only context in which bare NPs are acceptable in measure phrases is when the missing numeral is interpreted as a null *many*. (24a) can be interpreted as meaning "I bought many litres of wine". Another example is (25), where *bottles of wine* has to mean the quantity of wine which measures many bottlefuls. It does not have the interpretation that they spilled a small quantity of wine measured in terms of bottles, which was very expensive.

- (25) I will never be able to afford the bottles of wine that they spilled at the party.

If adjectives modify nominal predicates, then counting classifiers, which are relational nouns heading NP predicates should be easily modified by adjectives, while measure heads should not be independently modifiable. This prediction is correct, as shown in (26a/b). As Grestenberger (2015) and Landman (2015) point out, the effect is even stronger when the head is a lexical measure head as in (26c), rather than one derived from a noun.

- (26) a. The waiter brought three expensive glasses of cognac.

- b. #She added three expensive glasses of cognac to the sauce
 c. #I bought three expensive/white kilos of sugar (from Landman 2015)¹²

The measure classifier can be modified by an adjective which qualifies the properties of the unit.

- (27) Add three heaped tablespoons of sugar to the sauce, and a scant teaspoon of salt.

There is a second contrast involving modification. Rothstein (2009) observed that measure predicates like *three litres/three glasses* which are modifiers, can scope under another modifier, as in (28). In contrast, numerals in counting contexts, which are moved to the left-peripheral determiner position, should not be able to scope under another modifier, as shown in (29):

- (28) a. That was *an expensive two litres* of wine!
 b. You spilled *an expensive three glasses* of wine!
 c. We watched as *an expensive three glasses* of wine seeped through the floorboards
- (29) a. #We saw an expensive three glasses of wine on the tray.
 b. #The waiter carried in an expensive three glasses of wine!

Crucially in (28/29) the determiner is indefinite. When the determiner is definite, numerals can always scope under adjective in contrastive contexts, even when the NP has a counting interpretation, as shown in Landman (2003). The contrast between counting and measuring still shows up though, as shown in (30):

- (30) a. The/an expensive three litres of wine made a hole in my restaurant budget.
 b. The expensive three litres/glasses of wine (#each) made a hole in my restaurant budget.
 c. The expensive three glasses of wine were each brought in by a different waiter.

(30a) is a clear measure context, and either a definite or an indefinite determiner is possible. A contrastive interpretation is not required. As

(30b) shows, in this measure context, distribution over the atomic parts of the quantity is infelicitous. (30c), however, is a counting context. The natural interpretation tends to be contrastive, the indefinite *an* is infelicitous, and most importantly, the distributive *each* is felicitous.

Note that in counting contexts, the adjective can scope over the numeral only in definite contexts as the contrast between (31a) and (31b) shows.

- (31) a. The fierce ten lions were sent to Blijdorp, and the meek ten lions to Artis.
 b. #A fierce ten lions were sent to Blijdorp, and a meek ten lions to Artis.

There are cases where numeral + count noun phrases do scope under adjectives in an indefinite phrase as pointed out in Gawron (2002). Gawron's example is (32a); others are given in (32b/c). In all cases, the NP has a quasi-measure reading. In (32a) it is the quantity of home-runs which is a career best, in (32b) it is the number of the successful students which is surprising and in (32c) it is the quantity or number of copies that are found which is amazing. In each case, the italicised NP denotes a salient plurality whose quantity is said to be surprising or amazing.¹³ However, this construction differs from the measure phrases in (30). The choice of adjectives which can occur in these constructions is highly restrictive, as (32d-e). The adjective must be an evaluative adjective, such as *surprising*, *incredible*, *best-ever*, and must express a value-judgement (usually the speaker's) about the quantity denoted by the NP. It cannot distribute over the individual atoms in the denotation of N:

- (32) a. Barry Bonds hit a career-best 73 *home-runs*. (from Gawron 2002)
 b. A surprising *ten students* got full marks on the exam.
 c. I found an amazing/#a dusty/#an expensive 10 *copies of the first edition of "Syntactic Structures"* in second hand-bookshop.
 d. #A successful *ten students* got full marks on the exam.
 e. #I found a dusty/an expensive 10 *copies of the first edition of "Syntactic Structures"* in second hand-bookshop.

So there is a clear difference between the felicitous examples in (32) and the infelicitous examples in (29) and (31) where the adjective scopes over the numerical in counting contexts. In the cases in (29) and (31), the adjective is not evaluative and does not express a property of the quantity. The examples in (32) can also be distinguished from the felicitous measure constructions in (28), where the adjective is not constrained to be evaluative with respect to the quantity. This means that the string *Indefinite determiner + adjective + numeral + N* can be used to distinguish between counting and measuring interpretations of expressions like three glasses of wine.

2. Hungarian

Schvarcz (2014) shows that in Hungarian similar arguments based on adjective placement, can be made for distinguishing counting and measuring expressions syntactically. *Három veg bor* ('three bottles of wine') is ambiguous between a counting reading in which bottles are individuated (33b) and a measure reading (33c). *-nyi* is a suffix which attaches to nominal classifiers and forces a measure reading. As a consequence, while (33d) is felicitous, (33e) is infelicitous, since context forces a counting interpretation and this conflicts with the measure suffix on the *üveg-nyi*.

- (33) a. *három üveg bor*
 three bottle wine
 b. *Három üveg bort bontottunk fel.*
 "We opened three bottles of wine."
 c. *Kiöntöttünk három üveg bort a földre.*
 "We spilled three bottles of wine on the ground."
 d. *Kiöntöttünk három üveg-nyi bort a földre.*
 "We spilled three bottlefuls of wine on the ground."
 e. #*Három üveg-nyi bort bontottunk fel.*
 Intended: "We opened three bottlefuls of wine."

As in English, the distribution of adjectival modifiers supports a syntactic contrast between counting and measuring NPs. If an adjectival modifier follows the numeral but precedes the classifier, only the reading where individual bottles are counted is available, while if the adjective precedes the numeral, the expression has only a measure interpre-

tation. Thus in (34a), where *drága* 'expensive' modifies the classifier, only a counting interpretation is possible, and the measure suffix *-nyi* cannot be suffixed to *üveg*. However, in (34b), only a measure context is appropriate, and the measure suffix can be freely attached to *üveg*.

- (34) a. *három drága üveg(*-nyi) gyenge minőségű bor*
 three expensive bottle(*-NYI) wine
 "three expensive bottles of cheap wine"
- b. Egy *drága három üveg(-nyi) bor* ömött ki/*
 An/one expensive three bottle (-NYI) wine spilled /
 bort bontottunk fel.
 wine was opened.
 "An expensive three bottles of wine was spilled/*opened."

These facts support the same structural contrast that we posited for English, illustrated in (35).

- (35) a. Counting: [három (ADJ) [üveg bor]]
 b. Measuring: [Indefinite [(ADJ)[három üveg] bor]]

For further discussion see [Schvarcz \(2014\)](#).

These tests show that there are clear distinctions between counting and measuring structures, and that grammatical tests like adjective placement can be used to distinguish between them. Measure phrases denote single quantities, which can be modified by a wide range of adjectives, but as (26) and (34a) show, in measure readings, the adjective cannot be placed in its canonical position after the numerical. This suggests that the measure head + nominal phrase following it do not form a constituent. Furthermore, the numerical+measure head can be scoped under another adjective, suggesting that *two litres/two glasses* is treated like a complex modifier.

[Landman \(2016, this volume\)](#) suggests however, that while these data support the claim that measure and counting readings are grammatically distinct, a semantic explanation for the modification facts can be offered. Since the measure head must apply to a numeral, the result of this application is a predicate of the form $\lambda x. \text{MEASURE}_{\text{DIM,U}} = n$, we would expect the numeral to be obligatory and the Num+Meas to have adjectival properties. He argues that counting and measuring nominals both have the structure in (23). The semantic interpretations for

both readings are derived from the same structure, with counting interpretations isomorphic to the syntactic structure in (23), while measure interpretations do not follow the syntactic structure. The contrasts discussed in this section are explained in terms of constraints on semantic operations, and not in terms of syntactic constraints. In the next two sections we look at data from Modern Hebrew and Mandarin which suggests that in these languages the contrasts between the structures shows up at the syntactic level.

3. Modern Hebrew

In Modern Hebrew (as in Biblical Hebrew), nouns are associated with two different forms, a so-called 'absolute' or 'free' form, and a construct form ([Ritter 1988](#); [Borer 1989, 1999](#); [Doron & Meir 2013](#) among many others). Generally, the morphological form of the construct differs from the absolute form only in the feminine singular and masculine plural forms. (36) illustrates the regular case for *xatul* 'cat':

(36)

	Absolute	Construct
masc. sg.	<i>xatul</i>	<i>xatul</i>
fem. sg.	<i>Xatula</i>	<i>xatulat</i>
masc. pl.	<i>Xatulim</i>	<i>xatuley</i>
fem. pl.	<i>Xatulot</i>	<i>xatulot</i>

In addition to the paradigm in (36), there are some idiosyncratic forms, for example, the masculine singular *bayit* 'house', which has the construct form *beyt*. I will mark construct forms N_{CS} .

The absolute form of the noun can appear alone or with a prepositional complement, as in (37):

- (37) a. bayit house. M.SG
 "(a) house"
- b. ha-bayit šel ha-mora
 DEF-house. M.SG of DEF-teacher.F.SG
 "the house of the teacher"
- c. xatula
 cat.F.SG
 "(a) cat "

- d. ha-xatula šel keren
DEF-cat.F.SG of Keren
"Keren's cat"

In contrast, the construct form must occur with nominal complement, the annex, which must immediately follow N. It can never appear bare:

- (38) a. *beyt
house_{CS}
b. beyt ha-mora
house_{CS}.M.SG DEF-teacher.F.SG
"the house of the teacher"
c. *xatulat_{CS}
cat_{CS}
d. xatulat ha-bayit
cat_{CS}.F.SG DEF-house.M.SG
"the house cat"

Phonologically, construct phrases are prosodic words (Borer 2009) formed in the syntax. They have various other distinguishing properties, including a characteristic definiteness marking: while both the absolute head and the complement may be marked definite as in (37b), definiteness in a construct phrase is marked only on the annex, as in (38b). The head can never be marked definite. Another example is given in (39). For further details of the properties of construct phrases, as well as tests to distinguish them from single word compounds, see Borer (2009).

- (39) a. xatulat ha-bayit
cat_{CS}.F.SG DEF-house.M.SG
"the house cat".
b. *ha-xatulat ha-bayit
DEF-cat_{CS}.F.SG DEF-house.M.SG

Classifier expressions in Modern Hebrew can be constructed with absolute nouns as heads as in the so-called 'free genitive' construction in (40a), and with construct state nouns as heads as in (40b):

- (40) a. šloša bakbuk-im šel yayin
three.M bottle-M.PL of wine

- b. šloša bakbuk-ey yayin
three.M bottle_{CS}.-M.PL wine
Both: "three bottles of wine"

(40a), the free genitive, seems to be exactly parallel to the English *glasses of wine* construction, with each word in the Hebrew directly translatable into a word in English, while the construct phrases have a different syntax. However, as Rothstein (2009) shows in detail, when we look at the interpretations, the inverse seems to be the case; the construct phrase is ambiguous between a counting and a measuring reading like the English *three bottles of wine*, while the free genitive in (40a) has only a counting interpretation on which it denotes a sum of bottles filled with wine with the cardinality three. For example, (41a) is a free genitive construction while (41b) is a construct phrase. (All examples here are from Rothstein 2009):

- (41) a. arba'im ve-štain kufsa-ot šel sfar-im lo nixnas-ot
forty and-two box-F.SG of book-M.SG no enter. F.SG
la-madaf-im šelanu.
to.DEF-shelf-M.PL of.us
b. arba'im ve-štain kufsa-ot sfar-im lo nixnas-ot
forty and two box_{CS}-F.SG book-M.SG no enter. F.SG
l-a-madaf-im šelanu.
to.DEF-shelf-M.PL of-us
Both: "Forty-two boxes of books don't fit on our shelves".

While both sentences apparently have the same translation into English, (41a) which uses the free genitive, is making a statement about the number of boxes that don't fit on our shelves and is appropriate if I am discussing storing books in a storeroom or an archive, while (41b) can be used either to make a statement about the quantity of boxes that we have or about the quantity of books. So, if I want to say that we have too many books for our shelf-space, I can only express this using the construct phrase in (41b). Another example illustrating this point is (42). In response to the question "Is there more soup in the pot?", only a construct phrase can be used since the answer is in terms of measure. The answer in (42 A.a) is felicitous, but (42A.b) is infelicitous:

- (42) Q: ha-im yeš od marak b-a-sir?
 Q there.be more soup in-DEF-pot
 "Is there more soup?"
 A: a. ken, yeš od šaloš ka'ar-ot marak b-a-sir.
 yes, there.be more three bowl_{CS-F.SG} soup in-DEF-pot
 "Yes there are three more bowls of soup in the pot."
 b. #ken, yeš od šaloš ka'ar-ot šel marak b-a-sir.
 yes, there.be more three bowl-F.SG of soup in-DEF-pot

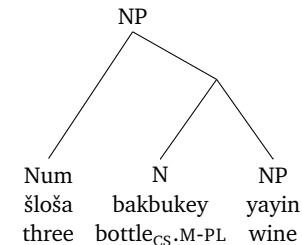
(42b) which uses the free genitive is not ungrammatical, but it is infelicitous in the context described - unless the speaker wants to assert that three bowls each filled with soup are standing in the pot. In a context in which the individual bowls filled with soup are present, such as (43), the free genitive can be used:

- (43) ken, yeš od šaloš ka'ar-ot šel marak 'al ha-magaš.
 yes, there.be more three bowl-F.SG of soup on DEF-tray
 "Yes, there are three more bowls of soup on the tray."

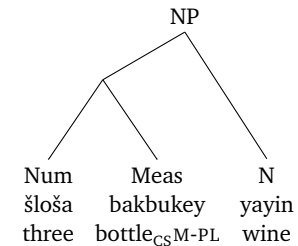
These data present us with two questions: first, why is the construct phrase ambiguous between a counting and a measuring reading, and secondly, why is the measure reading not possible with the free genitive construction.

The answer to the first question lies in the structure of the construct phrase. Rothstein (2012) argues that construct phrases are 'phrasal words' constructed in the syntax out of (in the simplest case) an [N N] string. Crucially, within the syntactic word, different structures are possible. Despite the fact that the first N in the string will always be marked with construct state morphology while the second will always have the grammatical properties of the annex, either can be interpreted as the head.¹⁴ Thus the strings *šloša bakbukey yayin* or *šaloš ka'arot marak*, which are concatenations of the form Num+N+N, can be assigned either a right-branching structure as in (44a) or a left-branching structure as in (44b), analogous to the two possible structures for *two glasses of wine* in (17) and (22). The right-branching structure in (44a) is associated with the count reading (cf 17), while the left branching structure in (44b) is associated with the measure reading (cf 22).

- (44) a.



b.



If this analysis is correct, then we make two predictions. First, if one of the structures in (44) is blocked for independent reasons, then the construct phrase should be unambiguous. This is borne out by definite numerical classifier constructions. Definite numerical constructions in Hebrew are always expressed in a construct phrase headed by a numerical expression which has special construct state morphology. The phrase has all the syntactic properties of construct phrases. The indefinite numerical phrase is given in (45a), and its definite counterpart in (45b):

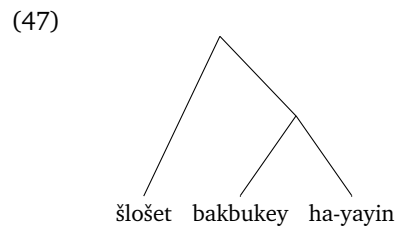
- (45) a. šloša bakbuk-im
 three bottle-M.PL
 "three bottles"
 b. šloš-et ha-bakbuk-im
 three-_{CS.M} DEF-bottle-M.PL
 "the three bottles"

When a construct classifier phrase like (40b), repeated here as (46a), is marked definite, the result is a "double" construct construction, as in (46b). *šloša* appears in its construct state *šlošet*, and heads a construct

phrase. Its complement is the construct classifier phrase *bakbukey ha-yayin*. Definiteness is marked only on the lowest N.

- (46) a. šloša bakbuk-ey yayin (=40b)
 three.M bottle-CS.M.PL wine
 "three bottles of wine"
- b. sloš-et bakbukey ha-yayin
 three-CS.M bottle-CS.M.PL DEF-wine. M.SG
 "the three bottles of wine"

Double construct phrases only allow a right-branching structure in (47):



Because of this obligatory right-branching structure, only the counting reading is possible. The definite measure reading is impossible. While it is a little difficult to construct examples which show the contrast clearly, (48), based on the example in (42) makes the point:

- (48) hizmanti esrim orx-im ve- hexanti esrim
 I invited twenty guest-M.PL and I prepared twenty
 ka'ar-ot marak be-sir gadol.
 bowl-CS.F.PL soup in-pot big
 "I invited twenty guests and I prepared twenty bowls of
 soup in a big pot"
- #rak šiva-asar orxim higu, ve-šloš ka'ar-ot
 only seventeen guests came, and-three_{CS} bowls-CS.F.PL
 ha- marak ha- axron-ot nišaru b-a- sir.
 DEF-soup DEF last-F.PL remained in-DEF-pot.
 Intended reading: "Only 17 guests arrived, and **the last
 three bowls of soup** remained in the pot"

The definite construct phrase cannot be interpreted as denoting a quantity of soup (although (48b) would be felicitous as a description of a situation in which three specific bowls, each of which was filled with soup, were still in the pot). The English gloss giving the intended reading is perfectly acceptable with a measure interpretation, and this shows that there is no inherent semantic difficulty in making reference to a definite quantity. However, the syntactic constraints on definite construct phrases mean that phrases like (46b) can only have a counting interpretation.

The second prediction of our analysis also involves definite measure constructions. If a definite construct phrase only allows the counting reading, then we predict that lexical measure heads should not be allowed to head these phrases, since they should require a measure reading. This is indeed the case. Indefinite construct phrases are acceptable with measure heads such as *kilo* as in (49a), but the definite phrases are not grammatical, as (49b) shows.

- (49) a. xamiša kilo kemax
 five.M kilo kemax.M
 "five kilos of flour"
- b. *xamešet kilo ha- kemax
 five_{CS}.M kilo DEF- flour.M
 Intended reading: "the five kilos of flour"

Thus we see that when a right-branching structure is obligatory, measure readings are not available, and this supports the hypothesis that in measure constructions, the measure head and the numerical combine to form a phrase as in (44b). Geometrically, and abstracting away from the labels assigned to each node in the tree, the left-branching structure in (44b) is the same as the structure posited for English measure phrases in (22).

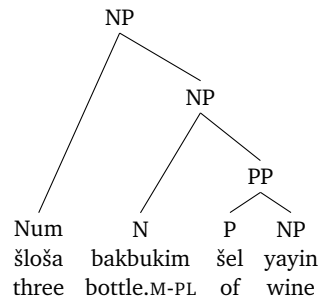
We now turn to the second question that the Hebrew data raises, namely why are the phrases headed by free genitives with PP complements, for example (40a) repeated here as (50), not ambiguous like the construct phrases or the English examples?

- (50) šloša bakbuk-im šel yayin
 three.M bottle-M.PL of wine

"three bottles of wine"

If the ambiguity of the construct phrase occurs only when either a left- or a right-branching structure is possible, then (50) should have only a counting interpretation because only a right-branching structure is possible. We assume, following arguments in Rothstein (2009) that the preposition *šel*, unlike the English *of*, is not a dummy preposition or a case marker, but has semantic content, and heads a prepositional phrase. As Rothstein (2009) shows, *šel* has thematic content, and it is never used as a semantically empty case-marker in partitives or other such constructions. If *šel* heads a full prepositional phrase, then the structure for (50) should be (51):

(51)



If *šel* is a semantically contentful preposition heading a PP, then it must express a relation between its complement and the head that the PP modifies. But this means that *bakkukim* must be a nominal head denoting a set of bottles, and the interpretation of the PP can only be counting.

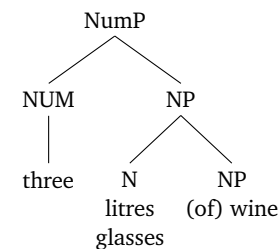
We see then that the ambiguity of the construct classifier phrases and the non-ambiguity of the free genitive constructions can be explained by positing a right-branching structure for counting interpretations of classifier phrases and a left-branching structure for the measure constructions. This is allowed in construct phrases where the absence of internal structure allows for a choice of head and potentially multiple analyses, but not in full NP structures such as (51), where the choice of head and the relation between head and complement is fixed. Note that in the left branching structures in (44b) above, the morphological

head of the phrase, i.e. the N with construct state morphology, is not the semantic or the syntactic head.¹⁵

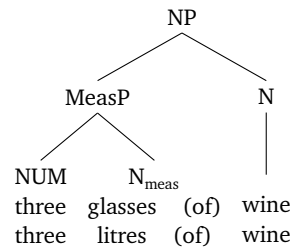
The Hebrew data has interesting implications for the analysis of English. The construct phrases are phrases whose basic form is $[N_1 N_2]$. N_1 is morphologically in the construct state and N_2 the annex, and N_1 determines the categorial status of the whole phrase. This structure allows in principle free internal composition, with either N_1 or N_2 analysed as the lexical head, and either a counting or measuring interpretation is possible. As we saw above, the internal composition is expressed syntactically, and whenever a left branching structure is blocked for independent reasons, only a counting interpretation is possible. Unlike Landman's suggestion that syntax and semantics do not match, measure readings in Hebrew result from a structure in which morphology and syntax do not match, and where the morphological head is not identical with the syntactic or lexical head.

This suggests an interesting possibility for English. Suppose that the right-branching structure in (52) is the unmarked syntactic structure for all nominal phrases in English. (52) is identical to (23), except that the numeral has not raised to D position but remains in NUM. Since *of* does not project a PP, the resulting structure looks very similar to Hebrew construct state phrases. The measure structure in (22), repeated here as (53) is derived as the result of syntactic reanalysis of (23), similar to what happens in the construct state phrase:

(52)



(53)



Under reanalysis, the structure [Num [N_{measure} [NP]]] is rebracketed in the syntax as [[Num N_{measure}] NP]. We can assume that the rebracketing is triggered by the mismatch between syntax and semantics caused by the fact that the measure head is of type <n <et>, i.e. it must combine with a numeral to form a predicate, and the result is a syntactic structure which can be straightforwardly interpreted semantically. What this amounts to is the suggestion that English structures like (52) have something in common with construct phrases: the syntactic strings inside an NP need not under certain circumstances fully determine a unique syntactic structure. The similarities between *two glasses of wine* in English and the Hebrew construct phrases become even more obvious if we consider the implications of the fact that *of* is not a full syntactic preposition and does not project a node in the tree. If we ignore *of* then in *three glasses wine* we have a string which is ambiguous in the same way that the Hebrew construct phrase is ambiguous. Alongside the standard interpretation where *glasses* is a relational nominal taking *wine* as a complement, *wine* can also be analysed as an NP predicate and *three glasses* is in a position where it can directly modify *wine*.¹⁶ If the reanalysis approach is correct, then it suggests that it is the absence of a PP node dominating *wine* which makes reanalysis possible.

This rough proposal is supported by data from Russian, presented in Partee & Borschev (2004, 2012). They show that constructions like *glass of milk* are expressed in one of two ways in Russian. Either a ‘genitive of measure’ construction is used, with the complement of the classifier in genitive case as in (54a) or the classifier has a PP complement, with the P taking an argument in instrumental case as in (54b):

- (54) a. stakan moloka
 glass.NOM.SG milk.GEN.SG
 “glass of milk”
 b. stakan s molokom
 glass.NOM.SG with milk.INST.SG
 “glass of/with milk”

Partee & Borschev (2012) show that while (54a) is ambiguous between an individuating reading in which *stakan* denotes a container, and a measure reading in which *stakan* denotes a measure on the milk, (54b) has only the individuating container reading. Partee & Borschev (2004) and Partee (2008) argue that a genitive-marked N in Russian (where not assigned as a lexical case by a V head) is a predicate nominal of type <e,t>. So (54) suggests that in yet another language, the measure interpretation is possible only if the complement of the measure head is a predicate phrase. If the genitive *moloka* in (54a) is a predicate, then the example looks very like both the Hebrew construct phrase, and the English [Num + N + NP] string where both counting and measuring interpretations are available. The individuating structure in (54b) looks like the Hebrew free genitive, with *s* corresponding to Hebrew *šel*, where no reanalysis is possible. If *s* projects a PP phrase like Hebrew *šel*, then the impossibility of the measure reading in (54b) is explained.

4. Mandarin

In this section, we discuss a fourth language, Mandarin, based on Li (2011, 2013) and Li & Rothstein (2012). Mandarin is a classifier language in which classifiers are obligatory in all numerical constructions. No nouns can be directly modified by a numeral, as shown in (55):

- (55) a. sān #(zhī) gǒu
 three Cl_{small animal} dog
 “three dogs”
 b. sān #(píng) jiǔ
 three Cl_{bottle} wine
 “three bottles of wine”
 c. sān #(jīn) mǐ
 three Cl_{pound} rice
 “three pounds of rice”

Crucially, (unlike English and Hebrew) classifiers like *zhī* and *píng* are not nouns, but functional heads. There is a noun *píng*,¹⁷ but it needs a different classifier to be counted as shown in (56a), (example from Li 2013). Classifiers themselves, cannot be modified by adjectives, (except for the evaluative attitudinal *dà* 'big' and *xiǎo* 'small') as shown in (56c). These contrast with the English examples in (56b/d).

- (56) a. *yí *(gè) píng*
 one Cl_{general} bottle
 b. one bottle
 c. **yì lán píng shuǐ*
 one blue Cl_{bottle} water
 d. a blue bottle of water

Despite these differences between Mandarin and non-classifier languages, Li & Rothstein (2012) show that the structural differences between counting and measuring which occur in Modern Hebrew and also, apparently, in English (and by extension, Hungarian), are also found in Mandarin, as shown in (57). *sān píng jiǔ* "three bottles of wine" demonstrably has the right-branching syntactic structure in (57a) in counting contexts, and the left-branching structure in (57b) when *píng* is used as a measure head:

- (57) a.
- ```

 NP
 / \
 Num Cl
 sān píng
 three bottleCL
 \
 N
 jiǔ
 wine

```

Counting: [Num [Cl N]]

- b.
- ```

      NP
     /  \
  Num    Cl
  sān   píng
  three bottleCL
           \
            N
            jiǔ
            wine
  
```

Measuring: [[Num Cl] N]

I present two pieces of evidence in support of this claim, the first concerns the distribution and placement of the marker *de* and the second concerns the placement of *duō*, 'more'.

Cheng & Rint (1998) point out that when *de* follows a classifier, the classifier must have a measure interpretation. In (58a) *sān wǎn tāng* naturally denotes a plurality of three bowls filled with soup, while in (58b) *sān wǎn de tāng* must denote a quantity of soup which is enough to fill three bowls.

- (58) a. *zhuōzi-shàng yǒu sān wǎn tāng*
 table-top there.is three CL_{bowl} soup
 "There are three bowls of soup on the table."
 b. *zhuōzi-shàng yǒu sān wǎn de tāng*
 table-top there.is three CL_{bowl} DE soup
 "There is enough soup on the table to fill three bowl."

Li (2011, 2013) sharpens this generalization. He shows that while Num+Cl+N+*de* must have a measure interpretation, when *de* is absent, the classifier phrase is ambiguous between a counting and a measure interpretation. In (59), where the context forces a counting interpretation, *de* is impossible, while in (60), where context forces a measure interpretation, *de* is possible but not obligatory:

- (59) a. *wǒ kāi le sān píng jiǔ*
 I open PERF three CL_{bottle} wine
 "I opened three bottles of wine." (XP Li 2011: Ch3 Ex:(62))
 b. **wǒ kāi le sān píng de jiǔ*

- (60) wǒ-de wèi néng zhuāngxià sān píng (de) jiǔ
 my stomach can hold three Cl_{bottle} (DE) wine
 "My stomach can hold three bottles of wine."

In other contexts, *de* is analysed as a marker of modification, which appears at the right edge of a predicate constituent, as argued in e.g. Paul (2016). Li & Rothstein (2012) argue that in post-classifier position, *de* can also be analysed as a marker of modification. If we assume the structures in (54) and the semantic analysis in section 3 above, then in measure classifier phrases, *de* is inserted at the right edge of a measure predicate, as in (61a). In the counting context, a *de* placed after the classifier cannot attach to the right edge of a predicate constituent and the string is infelicitous (61b):

- (61) a. [[[sān píng] de] [jiǔ]]
 b. *[sān [píng de jiǔ]

The second piece of evidence comes from the placement of *duō* 'more', which follows the quantity expression that it modifies. In counting contexts, the quantity expression is the bare numerical, which is a cardinal predicate expressing how many individuals there are in the plurality denoted by CL +N. In measure phrases, there are two grammatical quantity expressions, the bare numerical, which says how many units there are, and the measure predicate itself, which is a quantity expression modifying N. Li and Rothstein show that, predictably, *duō* can only follow the numeral in counting contexts, but can follow either the numeral or the measure predicate in measure contexts:

- (62) a. tā ná le shí (duō) píng (#duō) jiǔ
 he take PVF ten more Cl_{bottle} more wine
 "He carried more than ten bottles of wine."
 b. tā hē le shí (duō) píng (duō) jiǔ
 he drink PVF ten more Cl_{bottle} more wine
 "He drank more than ten bottles of wine."

Li & Rothstein (2012) and Rothstein (in press) give a semantic analysis for these constructions parallel to the analysis given above, but appropriately modified for Mandarin, in which the bare N following the classifier (or classifier-*de*) is a kind-denoting term. In the counting

contexts, the classifier applies to N and gives a set of countable atomic instantiations of the kind, while in measuring contexts, the predicate [[Num Meas](de)] modifies the set of instantiation of the kind.

To summarize this section, then, we have seen that in four typologically diverse languages, there is evidence that measuring is associated with an operation in which the measure head applies to a numeral to form a predicate, while in counting contexts, the numeral is itself a predicate modifier. In Modern Hebrew and in Mandarin, there is syntactic evidence that the syntax of the counting and measuring NPs are different. Measuring is associated with a syntactic structure in which Num + Cl form a syntactic unit denoting a measure phrase, while counting interpretations of classifiers are associated with structures in which classifier+N form a constituent which is modified by a cardinal numerical modifier. In English (and at the moment for Hungarian) we lack strong evidence for the syntactic structure, but the tentative evidence that there is, plus the crosslinguistic parallels, suggest that measure readings are only possible when a syntactic reanalysis of standard NP structure into [[Num + Meas] N] structures is possible.

6. THE PUZZLE ABOUT AGREEMENT

In this section, I want to present some data concerning agreement in counting and measuring phrases. This data shows, I think, a contrast between counting and measuring constructions, although it does not give us contrasts robust enough to form the basis for a theoretical analysis. The data, however, raise interesting questions, and open directions for further research, particularly about agreement.

Before looking at this data, I want briefly to raise the issue of the role of the preposition *of*. I have suggested, uncontroversially, that *of* is a null preposition with no semantic content and that it does not project a PP phrase. The question is, why do we need it at all, especially in measure constructions?

In counting classifier constructions, the classifier is a relational nominal and as such is the head of the NP phrase and the lexical head of the DP in which it occurs if it is an argument. This is illustrated in (63), where the NP *two glasses of wine* is headed by *glasses* and is the complement of the definite determiner *the*.

(63) She carried in [the [two [glasses_N [of wine]_{PP}]]_{NP}]_{DP}

In measure expressions, though, the measure phrase modifies the N, as in (64):

(64) That punch contains $\left\{ \begin{array}{l} \text{[two litres] of [wine]} \\ \text{[two glasses] of [wine]} \end{array} \right.$

In (63), *wine* is arguably a DP complement, and the conventional wisdom is that *of* is needed to assign case, as in *performance of the symphony*, *proud of her daughter*. In contrast, the structure in (64) suggests that the N *wine* is the head of the construction, since *two litres/two glasses* is a modifier, the modifier of the head. If *wine* is the head of this phrase, then it cannot be assigned case, and case-assignment cannot be the reason why *of* is required.

However, there are other constructions in which *of* appears where it does not assign case. These include expressions such as *a dress of green* and *a man of good family*, where *of* is followed by a bare NP which does not require case, and, more relevant here, APs such as *black of heart*, *fleet of foot*.

I suggest that in measure phrases like (64) and in the APs just cited, *of* is a syntactic scope-marker. It indicates that the measure predicate or adjective that precedes it is adjoined to NP and has scope over the whole NP and is not an attributive modifier within the NP modifying N. In an AP such as *black of heart*, *of* indicates that *black* is not a sister of *heart* as it is in *black heart* (though discussing the difference between them is beyond the scope of this paper).¹⁸ In *two kilos of apples* and *two glasses of wine*, *of* indicates that *two kilos/two glasses* is an extensive measure function with scope over the whole NP and not an attributive measure within the NP distributing over atomic parts of N as in *two-kilo apples*.¹⁹

Rothstein (2011), discussing examples like (63) and (64) suggests that there is reason to assume that the substance noun denoting the measured stuff is the head of the construction. While counting classifier phrases behave like count nouns in many respects, measure constructions behave like mass nouns. Rothstein (2011) argues that if the measure phrases *two litres*, *two kilos* and *two glasses* are intersective predicates modifying a mass expression like *wine*, the whole phrase should be the same semantic type as its head. Since *wine* is mass, *two*

glasses/litres of wine should be mass also. In contrast, if counting classifiers are relational count nouns as in (63), then counting classifier phrases should pattern like count nouns. Evidence in support of this comes from contrasts like (65):

- (65) a. Not many of the twenty bottles/#litres of wine that we bought were opened.
b. Not much of the twenty bottles/litres of wine that we bought was left over.

Since *twenty bottles of wine* can have either a counting or a measuring interpretation, both *much of the bottles of wine* and *many of the bottle of wine* should be acceptable in partitives. However, in a counting context such as (65a) (where *litres* is less acceptable as a classifier) *many of* is preferred, and in a measure context such as (65b), *much of* is acceptable. (Note also the singular form of the verb *was* in (65b) contrasting with the plural verb *were* in the counting context in (65a). Plural count nouns in measure contexts seem also to shift to a mass interpretation;

- (66) a. I opened many of the sixteen boxes/#kilos of books that were sent.
b. I read much/#many of the sixteen boxes/kilos of books that was/were sent.

Landman (2016, this volume) suggests that agreement facts in Dutch indicate, contra Rothstein (2011), that in examples like (65b), the head of the subject NP phrase is actually the measure word, *litre*. As Doetjes (1997) pointed out, examples like (67a) show that the measure head in Dutch does not necessarily agree with the numerical in terms of plurality. In (67a), *kilo* is not marked plural (example from Landman, this volume). When the measure expression is marked plural as in (67b), the interpretation shifts from a measure reading to a count interpretation in which individuated portions of the N-stuff measuring a kilo are counted. In (67b) *kilos rijst* denotes individual kilo-packs of rice.

- (67) a. Ik heb twee kilo rijst gekookt.
I have two kilo rice cooked
"I have cooked two kilos of rice."

- b. Ik heb twee kilos rijst gehaald.
 I have two kilo.PL rice fetched
 "I have fetched two kilo-packs of rice."

Landman (2016) points out that verbal agreement in Dutch is apparently dependent on the measure classifier. When the measure word in the subject NP is marked plural, the verb is always plural, as in (68a), but when the measure head is not plural, the verb is in the singular (68b).²⁰

- (68) a. Twintig **liters** water **staan** in de kelder
 Twenty litre.**PL** water stand. **PL** in the cellar
 "Twenty litres (= litre bottles) of water are standing in the cellar.
 b. 12.000 **kilo** aardappels over de weg
 12,000 kilo potato.PL over the road
rolde/rolte
 rolled.**SG.PAST**/roll.**SG.PRES**
 "Twenty kilos of potatoes rolled/are rolling over the ground."

He suggests (pc) that *kilo* is neutral with respect to plurality, thus it does not agree with the number *1200*, nor does it induce plural marking on the V.

Furthermore, as pointed out by Hanna de Vries (pc), determiner selection, which in Dutch is determined by gender, is sensitive to the measure word in measure NPs. The determiner in (69) is *dat* which agrees with the neuter *pond* rather than *die* which would agree with masculine *suiker*:

- (69) (69) Je hebt één pond suiker nodig.
 You have one pound sugar necessary. That
Dat ene pond suiker gaat helemaal op.
 one pound sugar goes completely up
 "You need one pound of sugar. That one pound of sugar will be used up completely."

If the head of the NP phrase is always the element which determines agreement both within the NP phrase and between NP and V, then Dutch agreement facts seem to suggest that the measure word is head of the

phrase. In English however, the facts about subject-verb agreement in measure phrases are less clear-cut.²¹ They do not provide support for a particular syntactic analysis of measure NPs, but what they do suggest is a consistent difference between counting and measure NPs.

The generalisations for subject-verb agreement when the subject is not a measure phrase but an 'ordinary' counting NP seem to be as follows:

- i. When the subject NP is an 'ordinary' counting nominal denoting a plurality and is morphologically marked as plural, the verb is necessarily plural:

(70) Three cats are/#is living in the barn.

- ii. In some cases, subject-verb agreement is semantic: the verb is plural because the subject noun phrase denotes a plurality and not because of any grammatical agreement features. In (71), there is no plural feature in the subject, and yet the V must be plural:

(71) My daughter and I were/*was visiting London last week.

More striking is (72), where the same subject can trigger singular or plural agreement depending on whether the reference is one or two individuals. In (72a), the denotation of the subject is a single individual filling two positions, and agreement is singular, while in (72b), two different individuals fill the two positions, and the agreement is obviously plural.²²

- (72) a. "The Prime Minister and Minister for Finance has made the following regulations."²³
 b. "The Prime Minister and Foreign minister have arrived in Afghanistan for a three-day visit."²⁴

- iii. The plural agreement that we expect in cases like (70) can be neutralized in very specific contexts. The subject must denote a singular quantity, and the predicate is a predicate of quantity evaluation headed by *enough* or *too*. Singular agreement is possible in (73a/b), but not in (73c). (73d) shows that an indefinite determiner + evaluative adjective is not sufficient to trigger singular agreement on the verb, even though the subject is an indefinite expression of quantity:

- (73) a. Five cakes is too many. Buy only four.
 b. "Now," said Mrs. Basset, "they think forty **pupils is enough for one room** but in the olden days I taught eighty."²⁵
 c. Ten students have/#has arrived to help shift books to the new library.
 d. An amazing ten students have/#has arrived to help shift books to the new library.

iv. Plural counting classifier phrases trigger plural agreement just like the count NP in (70). Plural agreement can be neutralized as in (74b), parallel to (73b), but not in (74d), parallel to (73d):

- (74) a. Thirty bottles of wine have/#has to be individually sealed.
 b. Thirty bottles of wine is too much. Twenty bottles of wine is enough.
 c. An amazing thirty bottles of wine have/#has to be individually sealed.

Generalizations about agreement patterns in counting contexts are relatively robust, but this changes when the subject is a measure phrase. There are cases. In the first case the measured N is a mass noun, with singular morphology like *flour*, *wine*, and in the second case, the measured N is a plural count noun like *apples*. We look at each in turn, beginning with the mass-noun case. In (75), the measured N is a mass noun and the measure expression is plural. In these examples, my informants allowed either singular or plural agreement, although singular agreement was preferred.

- (75) a. Two kilos of flour was/were delivered (in one sack).
 b. Thirty litres of water has/have leaked out of this pipe.

These intuitions match the results of a crude google search for *litres/liters of wine was* and *litres/liters of wine were*. Both singular and plural agreement were found, but there were over two and half times as many examples of singular agreement as plural agreement.²⁶

An initial exploration of the data suggests that the choice of agreement is not random, but is highly dependent on context and the choice of the verbal predicate. The passive verb *consumed* overwhelmingly occurred marked plural, as in "Last year 264 million litres of wine were

consumed in Switzerland".²⁷ In contrast, the verb *produced* occurred approximately twice as often with singular agreement as with plural agreement, for example "In 2013, 6.6 million litres of wine was produced in the country".²⁸ *N litres/litres of water was/were needed* was used more than three times as often with the singular verb than with the plural verb (See table in endnote 26).

These data suggest that agreement here is semantic, and determined by the interpretation given to the subject in a given context. When context favours an interpretation in which the subject denotes a singular quantity, the verb is in the singular. When context indicates that the quantity denoted by the subject is regarded as a sum of smaller individuable quantities, agreement is plural. Plausibly, one factor which plays a role is whether the V is understood as denoting a single event or a plurality of events. Consumption of large quantities such as *264 million litres of wine* is spread over a multiplicity of different consumption events. As a result, the nominal is considered to denote a sum of quantities of different sizes which took part in the multiplicity of events denoted by *consumed*, which together add up to *264 million litres*, and agreement is plural.²⁹ In contrast to *consumed*, the verb *produced* triggers either singular or plural agreement, depending on whether the relevant context favours a singular or plural event. (76a) is a description of the yield of a single vineyard, and arguably is referring to a single (extended) event of wine production. Agreement is singular. In (76b), the subject *28 billion litres of wine* denotes an accumulation of wine measuring 28 billion litres where the stress is on the fact that this total is composed from quantities produced by different sources. Agreement is plural. In both cases, the measure word *litres* is plural.

- (76) a. A total of 300,000 litres of wine was produced from 470 tons of grapes³⁰
 b. Last year around 28 billion litres of wine were produced globally...³¹

The situation is more complicated when the modified N, instead of being mass like *flour* or *wine* is plural, like *apples*. In these cases, plural marking on the verb becomes more preferred, indicating that morphological agreement seems to play a role. In (77a), where the subject is *two kilos of apples*, my informants allow both singular and plural agree-

ment on \forall they both preferred plural agreement (to different degrees). There is a strong contrast with the examples in (75) where singular and plural agreement were, for the most part, both acceptable, although singular was preferred. With *one kilo of apples* in (77b), the informant who more strongly preferred the plural in (77a) thought that both singular and plural were acceptable, while the second informant strongly preferred the singular agreement in (77b). Apparently, both informants took into account the agreement markers on both the N and the measure phrase, but gave different weights to each in making their decisions about verb agreement.

- (77) a. Two kilos of apples has/have been delivered (in one box).
 b. One kilo of apples has/have been delivered (in one box).

Singular agreement was allowed in (78b), for both speakers:

- (78) a. Ninety kilos of apples was harvested from that tree.
 b. An amazing ninety kilos of apples was harvested from that tree.

This is in contrast to the counting constructions in (74c), where embedding the count classifier phrase under *an amazing* did not make singular agreement possible.

What governs agreement in these cases seems to be a complex of interacting factors including the morphology on both N and the measure word, and context. In all cases, singular agreement on the verb is much more acceptable when the denotation of the measure phrase subject can be conceived as a single whole, individuated either by a container or by a single event in which it is the participant. One of my informants said spontaneously: "*Ten kilos of apples was delivered* is much better if you can think of the apples as all being delivered in one box or sack."

While these data are not enough of a basis on which to build a theory of singular/plural agreement, what is striking is that this kind of flexibility with respect to verbal morphology is only possible when the subject is a measure phrase and is not possible with counting classifier phrases. In measure phrases, the interpretation of the NP plays a much greater role in determining verbal agreement, although the morphological properties of the N cannot be ignored. But as the contrast between

(75) and (78) shows, the relevant morphology in English is not just the morphology of measure head but also morphology of the modified N which can be mass (i.e. singular) or plural count. This suggests a less rigid syntactic structure than in counting Noun Phrases, in which the morphology of the measure head, the morphology of the modified noun and the interpretation of the NP all play a role. Such flexibility is compatible with the reanalysis account of English measure constructions which I proposed in section 5.

7. CONCLUSIONS

This paper aimed to make two major points. First, classifier NPs can have either counting or measure interpretations, and these two interpretations are associated with two different processes of interpretation, indicating a different compositional make-up. In counting interpretations, cardinals are predicates which modify a nominal expression like *three* in *three apples* or in *three crates of apples*. In these cases, *three* expresses a property of a plural entity that has three atomic parts, and these atomic parts are available for grammatical operations which operate on such atomic parts. For example, in English reciprocals can modify these expressions as in *three crates of apples are standing on top of each other*. Measuring, in contrast, uses measure predicates like *three kilos* as in *three kilos of apples/ three kilos of flour*. Here *three kilos* expresses a dimensional property of an accumulation of apples or flour. Some NPs, for example *three glasses of water*, are completely ambiguous between counting and measure interpretations, and others have primarily counting or primarily measure interpretations (though counting expressions may shift into mass expressions and vice versa, see [Khrizman et al. 2015](#); [Landman 2016](#)).

Second, I have raised the question of whether the grammatical differences between counting and measuring noun phrases is represented in the syntax, or whether the difference lies only in the semantic interpretation. I have argued that in a number of typologically different languages, in particular Mandarin and Modern Hebrew, counting and measuring interpretations are each associated with a different syntactic structure. In these languages, there is clear evidence that counting classifier phrases are 'ordinary' right-branching NPs, headed by a rela-

tional head, and that the cardinal is a modifier of the nominal phrase. In contrast, the measure structures are non-canonical in terms of syntactic structure, with numerical and the measure head combining to form a predicate which modifies the N head. These are left-branching structures which are not usual within NPs. In Mandarin, these structures may be base generated, while in Hebrew, they are licensed within (and by) construct phrases. Crucially, this left-branching structure is the one which allows a compositional interpretation in which the syntactic structure matches semantic representation and maps directly onto it. In English, the evidence that there is a difference in structure is not strong. If one assumes that the syntactic and semantic structures are isomorphic, then the semantic contrasts between measure and count interpretations and the nature of the function denoted by the measure head can be taken as evidence for the left-branching syntactic structure. If one does not want to make this assumption, then the evidence for the contrasts in syntactic structure are slim. I have suggested, however, that in general, the English *N of NP* construction has properties in common with the Hebrew construct state. This opens a new direction for investigation of measure NPs. Instead of comparing them with only counting NPs, this suggests it may be fruitful to compare them with other *N of NP* constructions, in particular those which take bare N complements including those headed by adjectives such as *fleet of foot*, *black of heart*, as well as those headed by nouns such as *book of hours*, *city of bells*, *house of stone*, where the relation between the two constituents is one of modification, but where the direction of modification may be undetermined. Possibly, when we understand more about modification within *N of NP* constructions, we will be able to make further progress in understanding the syntax and semantics of measure NPs.

Notes

¹This paper includes material from Rothstein (2009) but updates it to take into consideration the work on counting and measuring that I have done since then, some of which is discussed in Rothstein (in press). I have presented various versions of this paper in a number of places, including the Humboldt Award Winners conference (Bamberg, March 2015), the English Department Colloquium, RWTH-Aachen (November 2015), the Linguistics Colloquium at Cologne University, (November 2015) as well as at the 11th Symposium on Cognition, Logic and Communication at the University of Latvia, Riga in December 2015. I thank audiences at all these events for their comments. Special thanks

goes to Fred Landman, with whom I have been discussing these issues almost continuously, for the last few years. Some of the discussion in the paper is a direct response to his paper in this volume. An anonymous reviewer also gave helpful comments on the previous version of this paper. This work was partially supported by the Israel Science Foundation Grant 1345-13. I should like to acknowledge the support of the Humboldt Foundation, whose Research Award allowed me to work full time on this material during 2015-2016. I also want to thank Tübingen University for its hospitality during this time.

²The situation is different with mass nouns as in *three kilos of gold*, but we do not want two completely different interpretations of *three kilos* depending on whether the N is a mass noun or a plural count noun.

³As pointed out in Partee & Borschev (2012), container classifiers are more than two-way ambiguous. A third possible reading is the concrete portion reading. On this reading portions of a substance are individuated and can be counted. A classic example is given in (i):

- (i) Goldilocks ate three bowls of porridge, a big one, a medium size one and a small one.

We cannot be using *three bowls of porridge* here with a measure interpretation, since each bowl is a different size. On the other hand, the phrase cannot have a container classifier interpretation since we assume Goldilocks did not eat the bowls but only the portions contained in them. So the expression must denote three concrete portions of porridge, in this case individuated by the bowls that contain them. Khrizman, Landman, Lima Rothstein & Schvarcz (2015) (=KLLRS) show that these portion readings are count readings rather than measure readings (contra Partee & Borschev). They also show that portions can be individuated in different ways. So while in (i) the portions are individuated by the containers which contain them (the so-called ‘contents’ reading), the portions in (ii) are individuated by spatio-temporal discreteness (example = KLLRS: Ex24):

- (ii) The instructions are to pour *three cups of soy sauce* in the brew, the *first* after 5 minutes, the *second* after 10 minutes, the *third* after 15 minutes. I have a good eye and a very steady hand, so I pour *them* straight from the bottle.

KLLRS call these ‘free portion’ readings. See also Landman, this volume. In this paper, I will focus on the contrast between the container classifier and the measure reading. This seems to be the basic contrast, at least when the classifier is a container such as *glass*, since the contents reading and the free portion reading are derived from the container classifier and the measure readings respectively. See KLLRS and Landman, this volume for details.

⁴Note that while the infelicity of suffixing *-ful* indicates a container classifier reading, the felicity of *-ful* does not necessarily indicate measure. In (i), a quotation from a 1671 report by a Jesuit missionary, *handfuls* is naturally interpreted as a free portion reading:

- (i) It consisted of powdered tobacco, of which he took two or three handfuls, one by one, and, as if offering the censer an equal number of times, scattered it over the Crucifix and over me. . . . (for citation details see http://npshistory.com/series/symposia/george_rogers_clark/\1985-1986/sec5.htm, accessed 25.97.2016)

Since the free portion reading of *two or three handfuls* is probably derived from the measure reading (see KLLRS and Landman, this volume), the felicity of the suffix *-ful* is not surprising.

⁵See Elizabeth David, *Italian Food*. Page 35, *Measurements as used in this book*. Revised edition, Penguin Books, 1963, reprinted 2011

⁶In fact several. The metric cup is 250 ml, the US customary cup is 236.5882365 ml, the US legal cup is 240 ml, and the Imperial (UK) cup is 284 ml.

⁷<http://kindlyyours.blogspot.de/2010/09/to-hayley-melbourne-and-more.html>

⁸A. Greer & C.E. Layne. 1988. *CXC Basic Mathematics: a Revision Course*. Stanley Thornes Ltd: Cheltenham, p 43.

⁹For some discussion of the relation in meaning between *glass* as a noun and *glass* as a measure head, see Rothstein (in press), Chapter 9.

¹⁰Gawron (2002) proposes a similar structure, although he does not distinguish between measure phrases such as *two kilos of flour* and so-called quantity readings of count NPs such as *an career-best seventy three home-runs*, see (32a).

¹¹Gawron (2002) suggests that the occurrence of bare Num +N in examples like (i) are also evidence in support of the structure in (22):

(i) The potatoes weighed ten kilos.

This is not a strong argument, since if *kilo* is a noun as Landman suggests, there is no reason for it to be always a relational noun taking a complement. Many nouns have both transitive and intransitive forms and *kilo* need not be any different.

¹²Landman (this volume) points out that examples like (26c) can be found, and that they must be treated as degraded, rather than ungrammatical. He suggests that the preference for the counting interpretation is because of a general semantic constraint that an adjective modifies the expression immediately following it. In the counting interpretation *bottles of wine* is modified by *expensive* while in the measure interpretation the adjective would have to 'skip' the classifier and modify the N complement *wine*. The ban on 'skipping' the classifier also explains contrasts in counting contexts, for example, between the less felicitous (i) and the more felicitous (ii), where is it assumed that *melted* modifies *ice cream* and not *cups (of ice cream)*.

(i) #three melted cups of ice-cream

(ii) three cups of melted ice-cream

Since the ban on skipping is weak, examples like (i) are predicted to be less felicitous than (ii) but not ungrammatical. However, there still remains a clear contrast between examples like (i) and cases where the adjective directly precedes the measure head such as *#three expensive litres of wine*, which are considerably less preferred than (i). Examples which have a possible counting interpretation like *three boiling hot cups of coffee*, *three fragrant bowls of soup* are acceptable, when the N following A is not modified in appropriate contexts. Examples like *#three expensive litres of wine* are not. Interestingly, a Google search revealed 12600 hits for "boiling hot cup of", 683 hits for "fragrant bowl of soup" 615 hits for "melted cup of ice-cream" and only one hit for "expensive litre(s)/liter(s) of wine". This suggests that the explanation for the degradedness of (26c) must be different from the explanation of the contrast between (i) and (ii).

¹³Gawron (2002) in fact suggests that italicised expressions such as those in (32) are all measure phrases, but does not give an analysis of how they measure. Extending the theory of measures proposed above to account for these examples is beyond the scope of this paper.

¹⁴This is particularly striking in construct state phrases headed by numerals as in (i) (which is repeated as (45b):

(i) šloš-et ha-bakbuk-im

three-CS.M DEF-bottle-M.PL

"the three bottles"

Despite the fact that *šlošet* is marked with construct state morphology, *bakbukim* is the head of the phrase. Examples like (i) look rather like English examples like (ii), where *cats* is the head of the noun phrase, and not *number*:

(ii) A number of cats have come into the room

¹⁵I have only discussed the syntax of these constructions in this paper. For a semantic interpretation see Rothstein 2016.

¹⁶There are other similarities between Hebrew construct state phrases and English *N of N* phrases. In particular, adjectivally headed construct state phrases in Hebrew such as (i) have *N of N* counterparts in English. (i) has the somewhat archaic counterpart *strong of heart*. See Rothstein (2013) for discussion:

(i) [amic_A lev_N]
strong_{CS} heart
'brave'

¹⁷In some dialects, for example, Beijing Mandarin, *píng* cannot be used as a noun. In its nominal use, it must be suffixed with the nominalizer *-zi*, giving the noun *píng-zi*.

¹⁸For discussion of these constructions in Hebrew and a semantics which shows the contrast between *black heart* and *black of heart*, see Rothstein (2013).

¹⁹For more on the contrast between extensive measures and attributive measures see Schwarzschild (2006) and Rothstein (in press), chapter 10.

²⁰An anonymous reviewer points out that in (68b), plural agreement is possible too.

²¹We will not discuss agreement within NP in English.

²²(71a) refers to Laurence Gonzi who was Prime Minister and Minister for Finance in Malta at the time that the document cited was issued (2007). (71b) refers to Valdis Dombrovskis and Aivis Ronis, respectively Prime Minister and Foreign Minister of Latvia at the time of the article cited (2014).

²³<http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lp&itemid=19494&l=1>

²⁴<http://www.mfa.gov.lv/en/component/content/article?id=10553:the-prime-minister-and-foreign-minister-have-arrived-in-afghanistan-for-a-three-day-visit>

²⁵<https://www.newspapers.com/newspage/4742442/>

²⁶The exact figures were as follows: (Search carried out 11.04.2016)

...litres of wine was	12,500
...litres of wine were	5040
...liters of wine was	25,400
...liters of wine were	9,020
...litres of wine was consumed	9
...litres of wine were consumed	715
...liters of wine was consumed	0
...liters of wine were consumed	624
...litres of wine was produced	4770
...litres of wine were produced	1650
...liters of wine was produced	3710
...liters of wine were produced	1590
...litres of water is needed	118,000
...litres of water are needed	33,200
...liters of water is needed	223,000
...liters of water are needed	78,100

²⁷http://www.swissinfo.ch/eng/grape-disappointment_wine-consumption-falls-to-record-low/41391462

²⁸https://en.vinex.market/articles/2016/06/16/armenian_wine_production_on_

the_up_while_exports_decline

²⁹This contrasts with examples like (68), where in *twintig liters water* "twenty litres of water", *twintig* is counting individuated quantities of water, of a uniform size.

³⁰<http://www.wine.co.za/wine/wine.aspx?WINEID=30299>

³¹<http://www.rsc.org/chemistryworld/2015/10/grape-pomace-wine-waste-biorefinery>

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