THE ROLE OF DIMENSIONS IN THE SYNTAX OF NOUN PHRASES

Roger Schwarzschild

Abstract. An extended noun phrase may contain an expression that describes some dimension. Weight is described by each of the prenominal expressions in *heavy rock*, *too much ballast*, *2 pound rock*, *2 pounds of rocks.* The central claim of this paper is that the position of these types of expressions within the noun phrase limits the kinds of dimensions they may describe. The limitations have to do with whether or not the dimension tracks relevant part-whole relations. An analogy is made between these constraints and the well-known constraints on thematic relations that are incurred by the position of a noun phrase in a clause. A proposal is made about the meanings of expressions like *too much* and *2 pounds* which explains their common cross-categorial distribution and this informs the analysis of their use in noun phrases. A position is taken on the meaning of the count mass distinction which, in conjunction with the hypothesis about dimensions, explains asymmetries in the distribution of prenominal adjectives with count and mass nouns.

1. Introduction

Much research on meaning is at bottom about the meanings of words and morphemes. Syntax regulates how those meanings combine and project to produce the meanings of phrases but it does not contribute meaning of its own. Investigations of topic and focus are one kind of exception to this picture. These phenomena are put under the rubric of "information structure" on the belief that the pragmatic information comes from the structure itself. The study of thematic relations and argument realization is another domain where the idea of contentful structure is entertained. The chief aim of the present paper is to identify another case in which syntactic structure appears to have semantic content. The empirical domain is extended noun phrases that contain a modifier or quantifier whose interpretation appeals to some dimension, such as weight, length, density or acidity. Examples include *heavy metal*, *sour grapes*, *tons of metal*, and *too much vinegar*. I demonstrate that the syntactic structure regulates the kind of dimension that can be appealed to.

In section 2, I illustrate the linking of syntax and semantics with examples where the dimension comes in with a measure phrase, then in section 5, I do the same with examples where the dimension comes in with an adjective, including a Q-adjective such as *much* or *many*. Section 3 introduces a taxonomy of dimensions and spells out the correspondence between syntax and dimension types. The key factor will be whether the dimension tracks part-whole relations.

Syntax-meaning correspondences are sometimes explained by appeal to a functional head which projects in the structure and which is the locus of the meaning. In section 6, I explore this sort of analysis for one set of cases. I propose an analysis in which a dimension-related θ-role is assigned by a functional head found in partitives and related constructions. The semantics of the functional head encodes the linking between structure and dimension type.

2. Measure Phrases

A "measure phrase" consists of a numeral or other weak quantifier followed by a measure expression like *inches* or *miles per hour*:

(1) 4 pounds   18 karat   5 days
     several inches   a thousand gallons   50 decibels
     one ounce   half acre   12 degrees Centigrade
     an ounce   70 mph (miles per hour)
     a few grams   3 square-feet

Measure phrases appear in a variety of syntactic contexts (Jackendoff 1977):

(2) 4 feet longer

(3) 4 feet long

(4) 4 feet above

(5) walked 4 feet

(6) 4 feet of string

(7) 4 foot pole

Among these contexts, the ones that are of interest here are the two nominal constructions in (6) and (7). (6) is an example of a partitive. Its most obvious feature is the *of* that follows the measure phrase.[1] It contrasts with (7), which has no *of*. As discussed later, there are reasons to think that the measure phrase in (7),

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[1] The distinction between the "true partitive" and the "pseudopartitive" is discussed in section 4.

4 foot, is in the position of an attributive adjective, so I will call such examples attributives. Although the presence or absence of *of* is a reliable guide to the distinction between the partitive and attributive contexts, there are other ways in which they differ. The measure term is marked for number in the partitive but not in the attributive. And the indefinite determiner can be used to form the quantifier of a measure phrase in the partitive context but not in the attributive:

(8) Partitive
     a.   a few ounces of gold
     b.   an inch of string

(9) Attributive
     a.   *a few karat gold
     b.   *an inch nails (cf. one inch nails)

As I will show, the mass/count distinction plays a role in the mediation of syntax and semantics, but it is *not* a feature that distinguishes the partitive and the attributive constructions. Measure phrases combine partitively and attributively with both mass and count nouns:

(10) | | Partitive | Attributive |
      |--------------|----------------------|------------------|
      | Mass | 6 ounces of gold | 18 karat gold |
      | Mass | 3 gallons of water | 20 degree water |
      | Count | 6 pounds of cherries | 6 pound cherries |

The distinguishing characteristics of the partitive context are summarized in (11).

(11) Distinguishing characteristics of the partitive context
     a.   *Of* follows the measure phrase.
     b.   The head of the measure phrase is number marked.
     c.   An indefinite article is allowed in the quantifier in the measure phrase.

Partitives have the external syntax of extended noun phrases. Attributives have the external syntax of nouns or noun phrases. I will refer to them collectively with broad categories such "nominal constructions" or "nominal structures." Eventually, an attempt will be made to say something about their internal syntax. The terms "substance noun" or "substance noun phrase" refer to the part of the construction that excludes the measure phrase; for example, *wax* in *2 kilograms of wax* or *paper* in *20 pound paper.* "Substance noun" is a term that is half syntax and half semantics, but it allows us to remain neutral for the moment on the internal syntax of the two constructions. "Substance" also has to be understood liberally—not restricted to physical substance—as in the discussion of *2 hours of work* or *3 pounds of pressure.*

Having demarcated these two ways in which measure phrases participate in the formation of a nominal structure, we can begin to inquire into the *relative distribution* of various measure phrases in the two contexts. The most basic point is that the distribution is not free in the partitive context, as Krifka (1989) pointed out, nor is it free in the attributive context. Furthermore, the ability to appear in one context often implies the inability to appear in the other, as illustrated in (12)–(16). In the first four cases, it would be sufficient to change a partitive into an attributive or vice versa to make the example felicitous.

(12)   *Jack has a ring that contains 6 ounce gold.

(13)   *Jill spilled 3 gallon gasoline on the carpet.

(14)   *Jack's ring is made of 18 karats of gold.

(15)   *Jill filled the tub with 20 degrees of water.

(16)   *Last year, they constructed 60 mph of highway.

Both partitives and attributives are fussy about the choice of measure phrase they accept. This sort of distribution contrasts with what one finds, for example, in an adjectival comparative. The only restriction there is that the measure phrase has to be semantically compatible with the compared adjective:

(17)   a.   20 degrees hotter   *20 degrees faster
       b.   5 mph faster   *5 mph hotter

To be sure, semantic compatibility matters for the nominal constructions as well; (18) and (19) are clearly cases of semantic incompatibility.

(18)   *20 degree democracy

(19)   *4 pounds of democracy

But unlike with the comparative, semantic compatibility is not sufficient to explain the pattern observed in nominal contexts. Formal characteristics of the measure phrase or of the substance noun are likewise insufficient. The unacceptable *20 degrees of water* illustrates both these points. It is unacceptable despite the fact that *20 degrees* is semantically compatible with *water*—witness their felicitous combination in *20 degree water*. The unacceptability of *20 degrees of water* also cannot be explained on purely formal grounds. If the plural noun *degrees* is replaced with the plural noun *gallons*, acceptability is restored.

The distribution of measure phrases in nominal constructions is not to be explained by appeal to form or meaning alone; instead, the explanation lies in the interface between syntax and semantics. More specifically, the hypothesis is as follows:

(20) Each of the two syntactic configurations distinguished here brings with it a commitment to a particular type of interpretation, and the two configurations have opposing commitments.

The idea is that in *20 degrees of water*, *20 degrees* is incompatible, not with *water*, but with the type of interpretation that is entailed by its use in a partitive with *water*. This type of explanation is analogous to what is often said about data like (21)–(23).

(21) The explosion broke the window.

(22) The window broke.

(23) *The explosion broke.

The subject of intransitive *broke* in (22) and (23) is required to denote an object that bears a particular relation to the event of breaking. The referent of *the explosion* in (23) is compatible with breaking events per se, as (21) shows, but it is not compatible with breaking events in conjunction with the particular type of relation to events invoked by the syntactic configuration in (23). In this case, the verb and the syntactic configuration lead to anomaly. In *20 degrees of water*, anomaly stems from the noun and the syntactic configuration.

It was noted earlier that the ability of a measure phrase to appear in one context often implies its inability to appear in the other. But this is not always true, and cases where a given measure phrase is felicitous in both contexts provide especially clear evidence that the partitive and attributive configurations are indeed semantically loaded. Three such cases are presented in (24)–(26).

(24) a. Jeremy used *2 inch cable* to set up his computer.
      b. Jeremy used *2 inches of cable* to set up his computer.

(25) a. He ate *one pound cherries*.
      b. He ate *a pound of cherries*.

(26) a. Jeremy used *20 pound paper* for his thesis.
      b. Jeremy used *20 pounds of paper* for his thesis.

In (24a) 2 inches is a measure of the diameter of the cable used, whereas in (24b), 2 inches describes the length of the cable Jeremy used. In (25a), one

pound gives the weight of the individual cherries and therefore describes an unlikely scenario. (25b), on the other hand, describes a more likely scenario, because *a pound* describes the total weight of the cherries consumed. In (26a), 20 pounds is a measure of the weight per unit of the paper[2] and so, unlike (26b), (26a) actually tells us nothing about the total weight of the paper Jeremy used. In each of these pairs, the measure phrase containing nominal projections gives rise to different interpretations. And in each case, there is no clue to the choice of interpretation other than those very hallmarks of the partitive and attributive contexts: the presence of *of* in the (b) examples and its absence in the (a) examples, the number marking on *inches* and *pounds* in (24b) and (26b) and its absence in the corresponding (a) examples, and the use of the indefinite article in (25b).

Further evidence that these constructions carry semantic commitments comes from how we interpret examples with novel measure terms:

(27)   a.   He bought two flons of ice cream.
       b.   He bought two flon ice cream.

The intuition is that, unlike (27b), (27a) says something about the amount of ice cream purchased. The following section attempts to make this "amount intuition" more precise.

Examples (24)–(27) show that syntax has a role to play in the interpretation of partitives and attributives. The type of syntactic relation that a measure phrase and noun enter into constrains the sort of interpretation that results. Earlier data showed that the two contexts are choosy about the kinds of pairings they each allow. The hypothesis in (20) puts these two observations together. It says that the choices are made on semantic grounds. The tasks now are to spell out precisely what the semantic properties are of each construction and to show how they explain the acceptability judgments with which we began.

3. Linking Syntax and Semantics

3.1 Dimensions and Monotonicity

A dimension is a kind of property like weight, volume, or temperature that can be had in varying degrees. Examples (24)–(26) illustrated differences in interpretations for several measure phrases. Those differences lay in the dimension being measured. For example, *2 inch cable* and *2 inches of cable* differ by whether the dimension characterized by the measure phrase is length or diameter. Whether an interpretation is possible for a partitive or attributive depends on a particular feature of the dimension that is used in the interpretation. A brief discussion of dimensions will serve to introduce this feature.

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[2] The units are standard reams of paper, where a ream is defined in terms of a specific number of pages of a fixed length and width.

Sometimes a dimension reflects the part-whole structure of the domain of objects it applies to and sometimes not. If you have a pile of cherries, it has a certain weight. Take some of the cherries away, the weight goes down; add some cherries to the pile and the weight goes up. By contrast, you can add cherries without changing their temperature, their weight per unit, or their color. Weight tracks the part-whole relation among groups of cherries. In a similar way, volume tracks part-whole relations in a domain consisting of portions of wine. If a given portion has a certain volume, any proper part of that portion has less volume. Objects can ordered by weight and by volume, as well as by temperature and purity. Events can be ordered by other dimensions, such as duration. In general, a dimension provides a basis for ordering the things it applies to. Part-whole relations similarly provide a basis for ordering, the most natural of which orders an entity above its parts. When one ordering tracks another ordering, it is said to be monotonic on that ordering. An economy in which prices increase with demand is one in which price is monotonic on demand. The discussion of cherries and wine shows that weight and volume are monotonic on the relevant part-whole relations. However, temperature and color (or hue) are not monotonic on those part-whole relations. With this much in place, I can now introduce the following rules linking syntax and semantics:

(28)   When a measure phrase is combined with a substance noun in the partitive, the interpretation is one in which the dimension is monotonic on the relevant part-whole relation in the domain given by the noun.

(29)   When a measure phrase is combined with a substance noun in the attributive, the interpretation is one in which the dimension is nonmonotonic on the relevant part-whole relation in the domain given by the noun.

Given the properties of weight and volume mentioned previously, the rule in (28) explains why the partitive is appropriate for *20 pounds of paper* and *4 liters of petrol*.[3] Conversely, the rule in (29) mandates that the attributive *20 pound paper* cannot be interpreted like *20 pounds of paper*, but it can have an interpretation that uses weight per ream because that dimension does not increase as one accumulates larger and larger portions of paper. Likewise,

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[3] The importance of the relationship between measures and parts is well known in the literature on measurement. It is straightforward to set up a measurement system for weight based on a standard and "multiples" of the standard. As history shows, it is rather more difficult to set up a system of measurement for temperature, because you cannot add together "standards" to define higher temperatures. Measurement that relies on addition is called "extensive" and measurement that does not is called "intensive." See Díez 1997 for details on the properties of measurement systems and the history of measurement. For the relevance of these notions to natural language, and to the partitive, in particular, see Cartwright 1975, Lønning 1987, Krifka 1989, and Nerbonne 1995.

given that temperature is not monotonic on the part-whole relation on water, we get *20 degree water* and not **20 degrees of water*. The measure phrase in an expression like *2 hours of walking* characterizes duration. When we speak of walking, duration is monotonic on the part-whole relation, as required by the partitive. Any proper part of that walking would have had a shorter duration. Spiciness tends not to depend on whether you take a spoonful of sauce or some proper subpart of it. Purveyors of hot sauce have invented a scale for spiciness in which the unit is the Scoville. Having introduced such a scale, the principles in (28) and (29) along with the properties of spiciness require the use of the attributive (*900 Scoville sauce*). The word *karat* has two senses. On one sense it is a measure of purity. Since purity is not monotonic on part-whole relations, you find that sense in attributives like *18 karat gold*. On its second sense, *karat* denotes a measure of weight and occurs in partitives like *34 karats of amethyst*.

I have not said anything about how a particular dimension enters into the interpretation of a given nominal projection. There are several possibilities. Dimensions may arise in the interpretation of the measure phrase, they might be part of the semantics of silent material that intervenes between the measure phrase and the noun, or they might enter in through rules of interpretation as they do in Bartsch's (1976) semantics of adverbials. There are probably other avenues to explore. The choice of any one of them entails a different way of saying how the linking rules in (28) and (29) are encoded in the grammar. This question is addressed in section 6, but for the moment, the focus is on establishing that properties of dimensions are grammatically relevant in the first place.

A comparison of the expressions in (30) and (31) reveals an aspect of the linking rules in (28) and (29) that has not been emphasized to this point.

(30)   2 inches of cable   (length)

(31)   2 inch cable   (diameter)

As noted, length is the dimension at issue in the interpretation of (30) whereas diameter is the dimension at issue in the interpretation of (31). Length is monotonic on the part-whole relation; diameter is not. That tells us something about the relevant part-whole relation. It counts linear segments as parts of a whole, but not, for example, slices taken through the middle of the cable along its length. While the length of any linear segment is less than the length of the whole cable, there are arbitrary subparts of the cable that are just as long as the cable itself. It is easy to see where the linear-segment part-whole relation comes from, given our practices in dispensing and using cable. Either (30) or (31) on its own might have made a weak case for the appeal to relevance. What is critical for exposing the pragmatic aspect of the syntax-semantics interface principles in (28) and (29) is the fact that the language has two constructions and that meanings are assigned to these constructions in a

nonarbitrary way. These examples also show where the role of context has to come in. Our practices do not make a particular dimension salient. For cable, length and diameter are equally relevant. Rather, our practices make the part-whole relation salient, and then monotonicity works on that to pair dimensions with structures: length to the partitive, diameter to the attributive.

The role of relevance in determining the part-whole relation can also be seen in the way people talk about snow and water. In discussions of falling snow, we find partitives such as *2 feet of snow* where the intended dimension is depth. Depth is monotonic on a part-whole relation among portions of snow that treats one portion as part of another if it consists of a sublayer. This part-whole relation arises from the dynamic perspective in which layers of snow grow into larger ones as time goes on. The choice of this part-whole relation accords with the felicitous use of the partitive, but it also explains the infelicity of the corresponding attributive:

(32) *They reported that New York got 2 foot snow last night.

If we now change the context to one where discussion concerns the creation of a line of snow as a boundary between two fields, the relevant parts are now linear segments and in that case *2 feet of snow* has a length interpretation. Length is monotonic on linear segments, relevant in that context, even though it would not be monotonic on layer parts in the falling-snow contexts.

Turning now to water, the Minnesota state website poses the following question:

(33) How many fish can an angler expect to harvest from an acre or two of water?

The use of the partitive here makes sense if one thinks of water as divided up into bodies of water and sections of bodies of water taken by slicing with the knife perpendicular to the ground (you need the whole slice, not just the surface, if you expect to harvest any fish). This is the perspective of the fisherman. From this perspective, surface area, the dimension used in *an acre of water*, is monotonic on the part-whole relation. Two of these slices together have more exposed surface area than each by itself. By the same token, depth is not monotonic from this perspective. If we add together two slices or two lakes, we do not increase the depth of the water. For this reason, a fisherman stands in *5 foot water*. *5 foot* characterizes depth here, and since depth is not monotonic on the part-whole relation in this context, we get attributive syntax. If we now change the perspective, the relevant part-whole relation changes and the syntax changes with it. News reports concerning recent floods in the American South took the dynamic perspective of a victim witnessing the water pouring in. Much like with the falling snow, the part-whole relation connects a portion of water with the layers of water out of which it grew. Depth is monotonic on this part-whole relation, and so the reports contained

expressions like *60 feet of water*. Depth in the fishing context leads to the attributive (in *5 foot water*), but in the flood-water and falling-snow contexts, depth interpretations are expressed with the partitive. The context determines the relevant parts, which in turn affect whether a dimension is monotonic on the part-whole relation and that in turn is reflected syntactically.

In effect, then, there are two ways in which context may enter in to the interpretation of measure-phrase attributives and partitives. It can determine the dimension, and it can determine the part-whole relation. But both of these ingredients are constrained by the meanings of the measure phrase and the noun and by the syntactic relationship they enter into. The noun influences the choice, in part by the sort of extension is has. Since events cannot be weighed, for example, weight is not going to be part of the interpretation of a nominal formed from an event noun. The noun can also have an effect in virtue of a part-whole relation that is associated with its extension (as with the cable examples). And it is this source of influence that allows the count-mass distinction to have an effect on the grammar and interpretation of partitives and attributives. A semantic basis for the count-mass distinction is often given in terms of part-whole relations among elements in a noun's extension.[4] Whereas *a lot of stuff* quantifies over portions of stuff, many of which overlap, *every object* quantifies over elements, no one of which is a part of the other. On this view, count nouns[5] presuppose a restriction on the operative part-whole relation. This restriction is given in (34) using $\leq_{Part}$ to denote the part-whole relation:

(34) $\forall x \forall y \ (x \leq_{Part} y \ \rightarrow \ x \ = \ y)$ (Singular Count Restriction)
       'y has no proper parts'

Given the role assigned to part-whole relations by the linking rules in (28) and (29), we should now expect some interaction between the count status of the substance noun and the kinds of dimensional interpretations available

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[4] Bello (1847:sect. 123), for example, writes: "Los apelativos de cosas materiales o significan verdaderos *individuos*, esto es, cosas que no pueden dividirse sin dejar de ser lo que son, como *árbol*, *mesa*; o significan cosas que pueden dividirse hasta el infinito, conservando siempre su naturaleza y su nombre, como *agua*, *vino*, *oro*, *plata*. Los de la primera clase tienen casi siempre plural, los de la segunda no suelen tenerlo sino para denotar las varias especies, calidades o procedencias." This freely translates as, "Concrete nouns either designate true *individuals*, that is, things that cannot be divided without changing what they are, examples are *tree* and *table* or they designate things that can be infinitely divided preserving their nature and their description, such as *water*, *wine*, *gold*, and *silver*. Those in the first group almost always have a plural form, those in the latter group are not used in the plural except to denote species, origins or qualities."

[5] Some say that the count/mass distinction is lexical, whereas others say it is purely a matter of the syntactic context in which the noun occurs (see Pelletier & Schubert 1989, Borer 2005). "Count noun" will mean different things depending on how this question is decided. I am grateful to Ewa Willim for discussion of this question. The rule in (34) is probably a corollary of a stronger requirement that no two elements in the extension of a count noun overlap. This makes the most sense on the view that "count noun" describes how a particular lexical item is being used. In other words, it is nothing about the concept of, say, *suggestion* that entails nonoverlap; rather it is a presupposition that arises when it is used in an expression like *those suggestions*.

in a given syntactic structure. It is a remarkable fact that when the substance noun of an attributive is a singular count noun, the attributive becomes hospitable to all types of measure phrases regardless of the dimension used in the interpretation. This is illustrated in (35), where felicitous count attributives are paired with closely related, infelicitous, mass attributives. In the final column I indicated the dimension used in the intended interpretation:

(35) 2 hour job   *2 hour work   duration
      2 hour trip   *2 hour traveling   duration
      2 milliliter drop   *2 milliliter blood   volume
      2 pound bean   *2 pound coffee   weight
      2 page poem   *2 page poetry   page count

To explain the promiscuity of the count attributives, we need to turn to the rule in (29) repeated here.

(29) When a measure phrase is combined with a substance noun in the attributive, the interpretation is one in which the dimension is nonmonotonic on the relevant part-whole relation in the domain given by the noun.

As (35) illustrates, the very fact that the substance noun is singular count entails that the dimension, any dimension, is nonmonotonic on the part-whole relation. This happens because count grammar brings with it the restriction on part-whole relations given in (34). In intuitive terms, because there are no proper parts, there is nothing for the dimension to track. One way to spell this idea out is to take nonmonotonic on the part-whole relation to be defined as in (36), where again $\leq_{Part}$ stands for the part-whole relation and $=_{Dim}$ means 'equal with respect to the dimension'.

(36) $\forall x \forall y\ (x \leq_{Part} y\ \rightarrow\ x\ =_{Dim} y)$ (nonmonotonic)
      'all parts of y have the dimension to the same extent as y'

(36) says, in effect, that the dimension is immune to the part-whole relation. Now, if a part relation obeys the Singular Count Restriction in (34), then any dimension will be nonmonotonic with respect to it. All that means is that every element has the dimension to the same extent as itself. This way of spelling out the connection between count semantics and the ability to freely form attributives has an interesting consequence for the mass attributives. In those cases, for each portion of stuff, there are likely to be many proper subparts within the space of a noun's extension. What (36) says is that the dimension appealed to in a given attributive must apply consistently to all the parts of a portion. This means, for example, that any part of any portion of *20 degree water* has the same temperature, namely 20 degrees.

Plural count nouns afford a nice comparison between partitives and attributives. Compare the two situations described in (37) and (38).

(37)   Jack bought 34 pounds of cherries.

(38)   Jack bought 34 pound cherries.

According to (37), Jack bought a quantity whose weight was 34 pounds. According to (38), Jack bought a quantity of cherries, each one of which weighed 34 pounds. The partitive gives rise to what could be described as a collective reading of the measure phrase, whereas the attributive gives rise to a distributive reading of the measure phrase. These two readings can also be described in dimensional terms. The dimension used to interpret (37) is simply weight, while in (38) the dimension is weight per unit or, more specifically, weight per cherry. This switch in the dimension comports with the idea that the extension of a plural count noun includes aggregates of whatever is in the extension of the singular and that these aggregates are related to each other by a part-whole relation. The part-whole relation is just the relation of inclusion (Burge 1977), and it allows for proper parts. If all the cherries in aggregate B are in aggregate A but not vice versa, then B is a proper part of A. In this respect, plural count nouns are more like mass nouns than like singular count nouns, whose extensions lack proper parts. For this reason, the linking rule for attributives has some bite with plural count attributives. Weight is not a possible dimension when the noun is plural count because weight is monotonic on the part-whole relation among aggregates. So, when we have a measure phrase like *34 pound*, the dimension is weight per unit.

This pattern is similar to what happens with *20 pound paper*. The measure phrase itself comes from a system of weight measurement, but it does not in fact characterize a weight here. It couldn't. The attributive would be impossible for that dimension. Instead, you have weight per unit, where the units are given as standard portions of paper (see fn. 2). It is worth dwelling on this point, because it has been a source of confusion obscuring the workings of the linking rules. A measure phrase tends to be associated with a default dimension, *20 degrees* with temperature, *20 pounds* with weight, and so on. But measure phrases can, and often are, used with related dimensions. In *20 degrees of heat*, the measure phrase cannot be characterizing the temperature of the heat, since that makes no sense. More likely, it characterizes an amount of energy, defined in terms of thermometric effects.

The most common "nondefault dimensions" are complex ones that are a product of the default and some other dimension, such as weight per unit as in *20 pound paper*. An amusing example is provided by consumers of a wine produced by Charles Shaw that sells for two dollars per bottle. It is fondly known as *2 buck Chuck*. The dimension here is price per unit with a measure phrase that uses price vocabulary. Geologists similarly use expressions like *$72 oil* to refer to oil that sells for 72 dollars per barrel. Looking at the list in

second column of (35), one can imagine dimensions that would make those examples felicitous. *2 page poetry* can be understood as poetry that takes up 2 pages per poem. The dimension page-count-per-poem was offered by C. Kennedy (p.c.), who adds *10 step therapy* and *10 tree argumentation* as other examples with similar kinds of interpretations. *2 pound coffee* might be coffee that is sold in 2 pound bags or it might be coffee 2 pounds of which is required for a standard amount of water. S. Tomioka (p.c.) offered the example of *2 inch chalk*, which is chalk that comes in 2-inch pieces. A related type of interpretation occurs with collective mass nouns as in *10 pound furniture* and *20 cent jewelry*. These are interpreted in terms of weight-per-piece and price-per-piece, respectively, and they differ from *2 inch chalk* or *2 pound coffee* in not requiring the definition of a standardized unit. One simply takes the "atoms" of the extension of the noun. In this respect, they are quite close to the plural *34 pound cherries*. The common thread in all of these examples is that the complex dimension invoked is nonmonotonic on the part-whole relation. The last dregs of the 2 pound coffee is still coffee that is sold in 2 pound bags.[6]

3.2 Conclusion and Prospects

In section 2, two English constructions, the partitive and the attributive, were described. It was observed that the distribution of measure phrases differs in the two constructions and I pointed to semantic differences between them. In section 3, the interpretive differences were localized in the choice of a dimension whose extent the measure phrase characterizes. The feature "monotonic relative to a part-whole relation" was introduced, and it served as the criterion by which the two constructions were linked to their semantics in (28) and (29). Given that the criterion depends on a relevant part-whole relation, forces that bear on the choice of that relation indirectly affect the syntax via the linking rules. The forces that bear on the choice of the part-whole relation identified here were convention, discourse relevance, and the count status of the substance noun.

   The linking rules make reference to fundamental semantic properties but are parochial with respect to the syntax. Attributive measure phrases represent a specialized construction, one that is not even fully productive. The partitive is better but still fairly specific. Compare that to the semantic conditions employed in the linking rules. Part-whole relations and dimensions are general concepts that have applications elsewhere. To take an example syntactically remote from the constructions discussed so far, consider the use of durational

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   [6] One might suspect that the types of readings one gets in the attributive cases come from the need to interpret the attributive as picking out a kind. It is hard to make this work in all cases. If by "kind" we mean "natural kind" then *200 lb polar bear* should be unacceptable, since there is no such species. If on the other hand, we mean by "kind" something more general, something akin to "property," then it is hard to understand why *20 lb honey* cannot pick out portions of honey that have the property of weighing 20 pounds.

in-adverbials. They combine felicitously with accomplishment predicates but not with activity predicates:

(39)   Jeremy walked to the store in an hour.

(40)   *Jeremy walked in an hour.

Dowty's (1979) influential account of this phenomenon can be couched in terms of dimensions and monotonicity. An activity predicate is one that can have in its extension an event as well as a proper part of that event. Duration is a dimension that is monotonic on that part-whole relation. Accomplishment predicates are like singular count nouns. Their extensions are characterized by a stark part-whole relation, one that obeys the ban on proper parts in (34). An event of walking to the store does not have as a proper part an event of walking to the store. For this reason, duration is nonmonotonic relative to the part-whole relation for an accomplishment predicate. An *in*-adverbial combines with a VP to characterize the duration of an event in its extension only if duration is nonmonotonic on the relevant part-whole relation in the domain given by VP.

   This is just to show that the semantic notions appealed to in the linking rules are at work elsewhere in the grammar.[7] It seems therefore unlikely that the rules as we have them are a true reflection of the grammar as opposed to mere corollaries of the actual rules, rules that match fundamental semantic notions with correspondingly fundamental syntactic ones. To get at the truth then, we ultimately would like to know what those fundamental syntactic notions are.

   The remainder of this paper takes initial steps toward the goal of discovering the crucial syntactic properties of the partitive and attributive that make them susceptible to rules linking them to monotonic and nonmonotonic interpretations, respectively.

   In the coming section, I survey constructions, in English and related languages, that are near relatives of the attributive and partitive and that pattern like their relatives with respect to monotonicity. It will become clear that none of the section 2 hallmarks used to identify attributives and partitives are necessary for deciding the monotonicity features of the interpretation. They are just surface manifestations of the more basic syntactic differences we are after. Next, I turn to the interpretation of adjectives within nominal projections. The linking rules make reference to the dimension used in the interpretation of a nominal construction. The presence of a measure phrase inside a noun phrase entails the use of a dimension in the interpretation of that noun phrase, but the entailment only goes one way. There are attributive adjectives whose interpretation appeals to dimensions, and they too are subject to monotonicity restrictions.

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[7] For a serious attempt at relating verbal and nominal monotonicity effects, see Nakanishi 2004.

4. Partitives, Attributives, and Their Crosslinguistic Kin

Section 4.1 briefly discusses two very closely related constructions that are often lumped together as partitive. It also gives some typological perspective on this construction type. Section 4.2 is a crosslinguistic catalog of constructions similar to the partitive and the attributive. The catalog is limited. Its purpose is to hint at the breadth of coverage of the linking rules.

4.1 Partitives and Pseudopartitives

"Partitive" is a traditional term with several tenuously related uses. It variously names a grammatical case, a type of determiner, a type of pronoun, and a nominal construction. When it is used to name a construction, as I use it here, a further division is often made. Partitives, as in (41), are distinguished from pseudopartitives, as in (42), by the form and meaning of the substance denoting expression. In (41), you find reference to something specific, whereas in (42) you do not.

(41) Partitive
      a. an ounce of that tea
      b. a kilo of the bananas

(42) Pseudopartitive
      a. an ounce of tea
      b. a kilo of bananas

In a recent typology of partitive and pseudopartitive constructions, Koptjevskaja-Tamm (2001) notes that, although *of* is the construction marker for both partitives and pseudopartitives in English, this is by no means universal. She cites the case of Armenian. Her example is in (43).

(43) Armenian (Natal'ja Kozinceva, p.c.)
      a. Partitive
          mi   gavath   ayd hamov surtch-ic
          one cup.NOM that good   coffee.ABL
          'one cup of that good coffee'
      b. Pseudopartitive
          mi   gavath   surtch
          one cup.NOM coffee.NOM
          'one cup of coffee'

In Armenian, the construction marker for the partitive is ablative case on the substance noun, whereas the pseudopartitive has no construction marker. Koptjevskaja-Tamm points out that pseudopartitives with overt markers—in particular, with "genitive"/possessive markers as in English—are typologically

rare. "Thus," she observes, "even in the Sino-Tibetan languages, notorious for their multifunctional possessive/attributive markers, which accompany almost any type of dependents to a nominal, pseudopartitives involve juxtaposition" (p. 560).

Koptjevskaja-Tamm also finds it noteworthy that Armenian uses the ablative and not the genitive or dative to mark the partitive. The ablative is typically used to mark a point of departure and various types of sources in expressions with the general meaning of movement and separation as in (44), cited by Koptjevskaja-Tamm (2001:528).

(44)   Armenian: 'FROM' (Fairbanks & Stevick 1975:44)
       im   yehphayr   amerikha-ic   e   gal-is.
       my   brother-DEF   America-ABL   is   come-PART.IMPF
       'My brother comes from America.'

Koptjevskaja-Tamm discusses a number of languages where the partitive is marked with a case or preposition with the general meaning of separation. The adoption of a special preposition or case to mark the partitive resonates with discussion in the truth-conditional semantics literature where (true) partitive *of* in English is taken to be meaningful, functioning to form a predicate out of a quantifier (Barwise & Cooper 1981) or out of a referential term (Ladusaw 1982, Barker 1998; see Zamparelli 1998 for a different view of the meaning of *of*). On this view, the phrase *of the bananas* in (41) is a predicate whose extension includes every banana and every aggregate of bananas. Once *of* is added to the substance noun phrase (or determiner phrase), we have a set denoting expression and the question of monotonicity arises. The partitive patterns with the pseudopartitive in being monotonic. One can already see this by comparing (41) and (42). The following examples provide further support:

(45)   *Six inches of the snow* had fallen before the trucks arrived. (depth)

(46)   *Jack's ring was made from *18 karats of the gold*. (purity)

(47)   *Jill filled the tub with *20 degrees of the water*. (temperature)

(48)   *Last year, they constructed *60 miles-per-hour of the highway*. (speed)

(49)   I only did *2 minutes of the strenuous exercises*. (duration)

(50)   *I only did *Monday of the strenuous exercises*. (temporal location)

4.2 A Snapshot of Monotonic and Nonmonotonic Constructions

We embark now on a very limited crosslinguistic survey of constructions similar to the English partitives and attributives discussed so far. The key

message from the survey is that the monotonicity linking rules are not language particular. Any language particularity comes about in the expression of the syntactic properties the rules make reference to.

The task here is the opposite of that in sections 2 and 3. There, I distinguished two constructions syntactically and then explored the types of interpretations that each allowed. Now that the crucial semantic parameter is identified, we can ask what syntactic forms are allowed with each type of interpretation. For this kind of inquiry, semantic labels are useful. "Monotonic construction" is used as shorthand for "construction whose interpretation uses a dimension that is monotonic relative to the relevant part-whole relation." Constructions that require a nonmonotonic dimension are called "nonmonotonic."

There are at least three kinds of monotonic constructions, shown in (51)–(53). Nonmonotonic constructions are illustrated in (54)–(57).

(51) Preposition on substance phrase (monotonic)
    dos centimetros de cable   (Spanish)
    2   cm.PL   DE cable   (J. Camacho, p.c.)
    '2 centimeters of cable'

(52) Case marker on substance phrase (monotonic)
    kilogramm   jablok   (Russian)
    kilogram.NOM apple.GEN.PL   (Koptjevskaja-Tamm 2001:(19a))
    'a kilo of apples'

(53) No special case or preposition (monotonic)
    a. 2 Meter Kábel   (German)
       '2 meters of cable' (length)   (T. E. Zimmermann, p.c.)
    b. een centimeter staaldraad   (Dutch)
       one centimeter wire
       'one centimeter of wire' (length)

(54) Preposition on measure phrase (nonmonotonic)
    a. agua   de   dos   grados   (Spanish)
       water DE two degrees   (J. Camacho, p.c.)
       'two degree water'
    b. staaldraad van een centimeter   (Dutch)
       wire   VAN one centimeter
       'one centimeter wire' (diameter)

(55) Genitive marker on measure phrase (nonmonotonic)
    a. fossa   trium   pedum   (Latin)
       trench-NOM three-GEN.PL foot-GEN.PL (Allen & Greenough 1903)
       'a 3 foot trench'
    b. 2 day's journey   (English)

(56)   Adjectival affix on measure phrase (nonmonotonic)
  a. foif-gred-igs Wasser   (Swiss German)
   5-degree-ADJ water   (C. Meier, p.c.)
   '5 degree water'
  b. desiati-gradus-naja voda   (Russian)
   10-degree-ADJ   water (S. Malamud, p.c.)
   '10 degree water'

(57)   No special case or preposition (stress on measure phrase;
  nonmonotonic)
  2 Milliméter Kabel   (German)
 '2 millimeter cable' (diameter) (T.E. Zimmermann, p.c.)

The Swiss German and Russian examples in (56) point to a connection between nonmonotonic measure phrases and attributive adjectives. This connection has been argued to hold even in languages where it is not morphologized. To account for various properties of prenominal as opposed to postnominal adjectives in English, Sadler and Arnold (1994) propose what they call a weakly lexical syntax for prenominal adjectives.[8] A syntactic structure is weakly lexical if it combines and produces only zero-level projections. It is to be distinguished from strongly lexical syntax, which creates words, but the two share properties, including head-finality. Sadler and Arnold's analysis for *long pole* is given in (58).

(58)

$$N^0$$
$$A^0 \qquad N^0$$
$$\text{long} \qquad \text{pole}$$
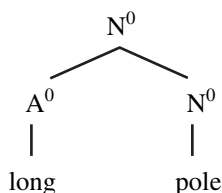
Since weakly lexical syntax trucks only in zero-level projections, it cannot attach a phrasal complement to a prenominal adjective, hence the ungrammaticality of *proud of his father boy*. Another property of lexical syntax, strong and weak, is the absence of agreement. The lack of number marking in attributive measure phrases therefore motivates Sadler and Arnold (1994) to propose a weakly lexical analysis for them as well:

(59)

$$N^0$$
$$N^0 \qquad N^0$$
$$\text{three foot} \qquad \text{pole}$$

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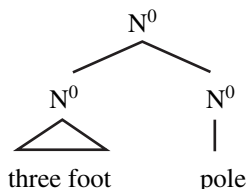
[8] Sigurðsson 1993 is an analysis of this kind for Icelandic.

Unlike in German (see (57)), attributive measure phrases in English do not have compound stress. This is the reason to treat them as weakly and not strongly lexical. In either case, the common external syntax for the measure phrase in (59) and the adjective in (58) is what interests us here. It is the motivation for the term "attributive measure phrase" introduced in section 2.

In Spanish the nonmonotonic measure phrase appears in a prepositional phrase (see (54a)). But these PPs also appear to have the external syntax of attributive adjectives. Measure PPs in Spanish license N′ ellipsis as in the second half of (60).

(60) La   [bolsa de azúcar refinada]$_i$ de 800 gramos
      the-FEM.SG   bag   of sugar   refined   DE 800 grams
      vale   8 córdobas y   la [e]$_i$ de 2 kilos vale
      is-worth   8 cordobas and the-FEM.SG DE 2 kilos is-worth
      20 córdobas.
      20 cordobas
      'The 800 gram bag of refined sugar costs 8 cordobas and the 2 kilo
      bag costs 20 cordobas.'

Measure PPs share this property with other postnominal PPs as well as with postnominal adjectives as (61) shows.

(61) Hoy   visitamos   la   [casa de campo]$_i$ azul, no   la [e]$_i$
      today   visit-1PL   the   country-house   blue   not the
      blanca.   (Sanchez 1996)
      white
      'Today we visited the blue country house, not the white one.'

Ellipsis is impossible when there is no postnominal modifier, as in (62a), even if there is a prenominal adjective, as in (62b).

(62) a. *Ayer   yo vi   la   [casa de campo]$_i$ y   tú   la [e]$_i$.
          yesterday I saw the country-house   and you the
                                                            (Sanchez 1996)
          'Yesterday I saw the country house and you the one.'
      b. *Hoy   atraparon   a   la   verdadera [ladrona de joyas]$_i$
          today catch-3PL-PST to the real   jewelry-thief
          no   a   la   presunta [e]$_i$.
          not   to   the presumed
          'Today they caught the real jewelry thief not the presumed one.'

Sanchez (1996) proposed a common syntax for nonargument postnominal PPs and for adjectives to explain the common ability to license ellipsis as well as a number of other shared properties. Once again, then, the syntax of attributive measure phrases appears to be the syntax of attributive adjectives.

   This brief discussion of various nonmonotonic constructions raises the question of whether the linking rules have anything to say about those adjectives that share a syntax with attributive measure phrases. Let us turn to this question now.

5. Adjectives inside Nominal Projections

5.1 Attributive Adjectives

The adjectives *heavy*, *cold*, *expensive*, and *tall* have meanings that are closely related to the dimensions of weight, temperature, price, and height. For this reason they are often called dimensional adjectives (Bierwisch & Lang 1987; Hamann 1991; Kennedy 1999, 2001 and references therein). When these and other dimensional adjectives are used attributively, the following linking rule applies:

(63)   When a dimensional adjective is combined with a substance noun
        in the attributive, the interpretation is one in which the dimension is
        nonmonotonic on the relevant part-whole relation in the domain
        given by the noun.

But for the substitution of "dimensional adjective" for "measure phrase," (63) is identical to the earlier rule in (29), repeated below.

   The effects of the rule in (63) are easy to miss.[9] To know where to look for them, we need to review some of the discussion surrounding the first nonmonotonic linking rule. That rule is repeated here along with the proposal from (36) for how to understand nonmonotonic.

(29)   When a measure phrase is combined with a substance noun in the
        attributive—the interpretation is one in which the dimension is
        nonmonotonic on the relevant part-whole relation in the domain
        given by the noun.

(36) $\forall x \forall y \ (x \leq_{Part} y \ \rightarrow \ x =_{Dim} y)$ (nonmonotonic)
        'all parts of y have the dimension to the same extent as y'

It is also important to recall from (34) that singular count nouns carry a presupposition that the relevant part-whole relation does not include proper parts:

(34) $\forall x \forall y \ (x \leq_{Part} y \ \rightarrow \ x = y)$ (Singular Count Restriction)
        'y has no proper parts'

Because of (34), the linking rule in (29) has no effect when the substance noun is count and singular. Although weight is generally monotonic, for example, it

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[9] Though they did not escape the notice of Bunt (1985:chap. 9).

is nonmonotonic on any part-whole relation that falls under the restriction in (34). That is why we can say *20 pound rock*, where the dimension is weight. By contrast, when *rock* is replaced by a mass noun, as in *20 pound paper*, the part-whole relation includes proper parts and weight is no longer an option. Instead you have weight per unit, where the units are given as standard portions of paper. The selfsame phenomenon can now be found with adjectives in place of measure phrases. In *heavy rock*, the adjective characterizes a weight, but this is impossible in *heavy paper*, because of the rule in (63). Instead, again you get a weight-per-unit reading. *Heavy oil* is another example where this kind of dimension is used. In this context, *heavy* characterizes density not weight. The list in (64) shows further examples of mass/count pairs. In each case, a dimension, given in the center column, is possible with the count noun but not with the corresponding mass noun.

(64) quick job   duration   *quick work
      short trip   duration   *short traveling
      big drop   volume   *big blood
      long poem   line count   *long poetry

As the *heavy paper*/*heavy rock* pair shows, dimensions have to be compatible with the adjective but they are not determined by it, so often a complex dimension can be found that fits the demands of the rules in (63) (weight per unit) even if it is not necessarily the first choice given the adjective (weight). In (65), measure-phrase examples that were used earlier to illustrate the use of complex dimensions are paired with related adjective-noun examples.

(65) 2 buck Chuck   price per standard unit   cheap wine
      $72 oil   price per standard unit   expensive oil
      10 pound furniture weight per piece   heavy furniture
      20¢ jewelry   price per piece   cheap jewelry

The per-piece dimensions found with collective mass nouns like *furniture* and *jewelry* are similarly found with plural count nouns. In *heavy bottles*, *heavy* describes the weight of individual bottles. Compare this to predicative uses of *heavy*:

(66)   The bottles were heavy.

(66) is ambiguous. It has a collective reading that can describe a situation where there are small, lightweight perfume bottles, but where there are so many of them that the collection is heavy. (66) also has a distributive reading where it reports on the weights of individual bottles. Although *heavy* can be understood collectively and distributively in (66), it can only be read distributively in (67).

(67)   He carried in some heavy bottles.

This is precisely because of the syntactic relation the adjective bears to the noun in (67). Rule (63) applies in this case and demands a nonmonotonic interpretation. The dimension—weight per piece—holds of each bottle and of any group of them.

   The part-whole relation associated with a particular noun is as relevant when the modifier is an adjective as when it is a measure phrase. The judgments in (68) and (69) follow from the same part-whole relations that explained why length is the dimension at issue in the interpretation of *2 inches of cable* whereas diameter is the dimension at issue in the interpretation of *2 inch cable*.

(68)   If you use thin cable, you run the risk of overheating.

(69)   *If you use long cable, you will increase pickup of unwanted signals.

The relevant part-whole relation counts linear segments as parts of a whole. Length is monotonic on linear segments—add two segments and the length increases—and so *long cable* is ruled out by rule (63). This assumes, of course, that we are interpreting *long* with respect to the simple dimension of length and not a complex one, which appeals to standardized units. *Thin cable* is possible in (68) because diameter can be nonmonotonic on the linear-segment part-whole relation. One can have some cable whose diameter is consistent across linear segments.

   Finally, it should be noted that the dimensions that are used in interpreting expressions of natural language are not limited to those for which there are standard measurement systems. This point is hard to see if one is restricted to measure phrase examples but becomes clearer once we have a linking rule that applies to attributive adjectives. The following pair is inspired by Quine (1960:sect. 21):

(70)   a.   *spherical wine
       b.   a spherical drop of wine

When *spherical* is used attributively, the dimension is something like "roundness." The extent of the roundness of some wine is different from the extent of the roundness of its subparts. So, roundness fails to be nonmonotonic (see (36)) on the part-whole relation associated with *wine*. This explains the infelicity of (70a). (70b) is felicitous because the noun that *spherical* modifies is count singular.

5.2 Q Adjectives

There is a small class of adjectives whose syntax differs from the adjectives discussed up to now. This class includes *much*, *many*, *few*, and *little*. They are members of Bresnan's (1973) category Q. Like other adjectives they combine with degree words:

(71) a.   as much water
      b.   that many possibilities
      c.   so few possibilities
      d.   too little information

And there are superlative and comparative words corresponding to the sense of each of them:

(72)   Positive   Comparative   Superlative
       much   more   most
       many   more   most
       little   less   littlest
       few   fewer   fewest

These adjectives can be distinguished from those discussed in section 5.1 by their position in (true) partitives. These adjectives can all precede *of* in a (true) partitive:

(73) a.   too much of the milk
      b.   too little of the wine
      c.   so many of the rocks
      d.   few of the rocks

(74)   *heavy of the rocks

With respect to position relative to partitive *of*, the external syntax of phrases like *too much* and *so many* is similar to that of measure phrases in partitives. This syntactic affinity brings with it a semantic affinity. As I will shortly demonstrate, the interpretations of examples like (73) make use of dimensions as do the pseudopartitives in (75).

(75) a.   too much milk
      b.   too little wine
      c.   so many rocks
      d.   few rocks

These dimensions are constrained by a linking rule, modeled on the rule that applies to measure phrases in partitives:

(76)   When a QP is combined with a substance noun, the interpretation
       is one in which the dimension is monotonic on the relevant
       part-whole relation in the domain given by the noun.

In (76) and hereafter, "QP" includes all of the expressions in (72) as well as phrases such as *as much* and *too few*.

Each of the dimensional adjectives in section 5.1—*heavy*, *cold*, and so on—is associated with a particular family of related dimensions. *Many* and *few* are likewise associated with cardinality-related dimensions. But the remaining Q adjectives are not associated with any particular dimension. Nevertheless, dimensions do have a role to play in their use, as can be seen in examples like those where the dimensions are verbalized.[10]

(77)   a.   Most of the toy was lead, by weight but not by volume.
       b.   I brought as much clothing, by volume, as I did books.
       c.   They are doing less business in terms of global coverage but much more business in terms of volume.

(77) verbalizes just a few of the many dimensions that are possible with QPs. Further types are illustrated in (78).

(78)   a.   so little heat   energy
       b.   more noise   energy
       c.   less wealth   economic value
       d.   more information   informativeness
       e.   too much poetry   line count
       f.   less traveling   time

Although QPs are compatible with a great variety of dimensions, the choice is not unconstrained. The linking rule in (76) limits interpretations to those in which the dimension is monotonic on the relevant part-whole relation. This limitation can be appreciated by considering possible interpretations of the expression *too much gold* in (79).

(79)   He put too much gold in the ring.

Depending on the intended dimension, (79) could have meanings like (80a,b) but never like (81a,b).

(80)   a.   He put some gold in the ring and the *weight* of that gold exceeded some contextually specified limit.
       b.   He put some gold in the ring and the *volume* of that gold exceeded some contextually specified limit.

(81)   a.   He put some gold in the ring and the *color/hue* of that gold exceeded some contextually specified limit.
       b.   He put some gold in the ring and the *purity* of that gold exceeded some contextually specified limit.

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[10] Parsons (1970) observed that dimensions could vary in the interpretation of *most of the gold*. Montague (1973) suggested that contextually supplied dimensions play a role in the interpretation of 'much α Fs' and 'more α F's than G's'.

The permissible dimensions—weight and volume—are monotonic relative to the parts of a portion of gold, whereas the prohibited dimensions—color and purity—are not. The rule in (76) likewise allows (82) to be used to report an excess in volume but not in temperature.

(82)   He used more water than he was told to.

The adjectives *many* and *few* differ from *much*, *little*, and their comparative and superlative relatives in being tied to a cardinality. Cardinality is a special sort of dimension, but it is nonetheless monotonic. An aggregate of cherries has a higher cardinality than any of its proper subaggregates. In other words, the linking rule in (76) does little work in *too few cherries* but is nonetheless obeyed.

   Putting the results of this subsection on monotonic adjectives together with the results concerning nonmonotonic adjectives, we can now make comparisons of the kind we made above with measure phrases in attributive and partitive contexts. *Too much paper* is the opposite of *heavy paper*. The first uses weight; the second uses weight per unit. *I bought too much paper* is inappropriate if what I mean is that I bought 20-pound paper when I should have bought 5-pound paper. The dimensions that are disallowed in the examples **short traveling* and **long poetry* in (64) are allowed in *less traveling* and *too much poetry*. The discussion of snow and water in section 3 echoes adjectivally. Regarding falling snow, recall that the part-whole relation divides the snow into ever-larger layers. In that context, depth is monotonic on the part-whole relation and we get *12 inches of snow*, which reports depth. Similarly, with the Q word *more* we get a comparison based on depth:

(83)   London got more snow last week than New York did.   (depth)

If we now try to use depth in this context to interpret an attributive adjective we get anomaly. (84) below parallels (85).

(84)   *They reported that New York got deep snow last night.

(85)   *They reported that New York got 2-foot snow last night.   (depth)

We get the opposite state of affairs when the perspective changes to one where the snow or water is not accumulating. In that case, the water is divided into vertical chunks, such as lakes or smaller bodies of water. Now the adjective choice flips, and the Q adjective is anomalous:

(86)   She is standing in very deep water.   (depth)

(87)   *She is standing in so much water.   (depth)

5.3 Summary of Discussion

Dimensional adjectives can be divided into those that appear lower in a nominal projection—below the *of* in true partitives, for example—and those that appear higher up, above true partitive *of*. Bresnan (1973) labeled this latter class Q. The linking rules appear now to be impartial to the category of the dimensional expression they apply to. If an XP—be it a QP, AP or NP—is "high" in the projection, the dimension has to be monotonic; if it is low, it has to be nonmonotonic. This raises questions about how the adjectives are lexicalized. Are QPs high in the tree because they trigger monotonic interpretations, or is it the other way around? The same kind of question applies to the non-Q dimensional adjectives. In the latter case, the comparison with predicative contexts (see (66) and (67)) suggests that the syntax is driving the semantics. In other words, syntax forces *heavy* to be low in the nominal projection, and for that reason it must be nonmonotonic.

5.4 Numerals

We now have four linking rules that specify when a dimension needs to be monotonic and when not. Together they show that the lexical category specification of the expression that combines with the substance noun is not a decisive factor. In addition to the cases examined so far, there are a number of expressions whose categorial status is hard to establish. All of the following examples are interpreted in terms of a dimension that has to be monotonic on the substance noun's part-whole relation:

(88) a. a few of the bottles
      b. enough of the snow
      c. gobs of the ice cream
      d. a lot of the information
      e. four of the rabbits

Gobs and *(a) lot* are what Vos (1999, 2002) calls "functional nouns." Löbel (1989) and Mallén (1992) proposed that they are members of category Q. In (88e), the numeral *four* characterizes cardinality and cardinality is monotonic. As a general rule, a numeral could never have the syntax of an attributive adjective as long as it characterizes a pure cardinality, as opposed to a complex dimension based on cardinality. There is one notable exception to this rule. Suppose the substance noun is singular count. In that case, the part-whole relation of the noun allows any dimension to be nonmonotonic. In fact, the only numeral that could both characterize cardinality and modify a singular count noun is the numeral *one*. This means that the syntax of *one* could vary from that of other numerals. Hebrew offers a nice example of this. Numerals in Hebrew agree in gender

like (other) adjectives but normally precede the noun unlike (other) adjectives:

(89) šiša   ban.im   gdol.im
      six.MASC   boy-MASC.PL   big-MASC.PL
      'six big boys'

(90) šeš   ban.ot   gdol.ot
      six.FEM   girl-FEM.PL   big-FEM.PL
      'six big girls'

The numeral *one* is an exception to this rule:

(91) ben   exad
      boy   one.MASC
      'one boy'

(92) bat   axat
      girl   one.FEM
      'one girl'

One of the theses of Koptjevskaja-Tamm 2001 is that the forms that partitives and pseudopartitives take in a given language are the result of influence from numeral constructions in that language. This raises two questions. In what sense are the measure phrases in partitives and pseudopartitives like numerals? And why should this particular similarity have syntactic consequences? To say that the measure phrases are quantificational is not to say very much. Quantificational meanings are found in nearly every lexical and syntactic category. Another option is to say that these measure phrases are like numerals in specifying an amount. This is either wrong or too imprecise to be of use. One of the previous snow examples nicely makes this point. It uses the comparative Q adjective *more*:

(93)   London got more snow last week than New York did.   (depth)

(93) could be true even if the total amount of snow that London got is less than the amount that New York got, simply because London has less surface area than New York. So in fact, *more* does not measure amount nor do any of the related falling-snow monotonic constructions (*2 ft of snow*, *too much snow*, etc.).

   I propose that partitives and pseudopartitives come about when measure phrases are combined with nouns or noun phrases to form a construction with a monotonic interpretation. Such an interpretation entails a particular syntax.

Numerals necessarily have that syntax, for the reasons cited above. So, in striving to bring the partitives and pseudopartitives in compliance with the linking of syntax and semantics, they are of necessity brought closer to the forms allowed for numeral constructions.
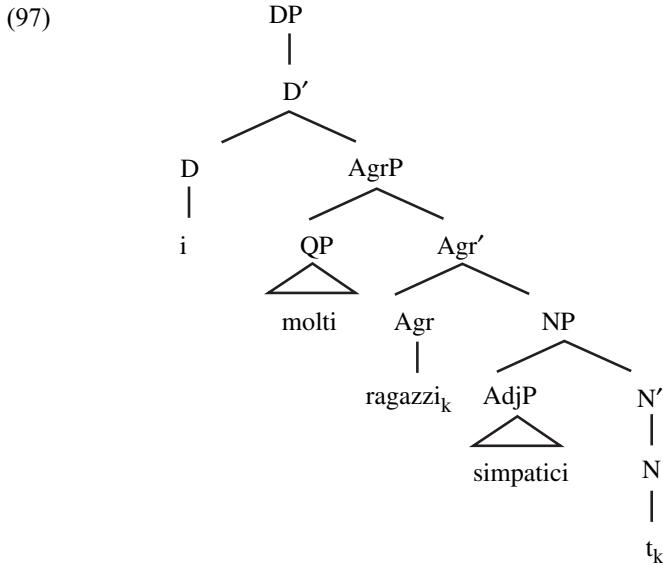
6. Partitives and Monotonicity

6.1 Introduction

In the discussion to this point there has been an implied analogy between monotonicity requirements in extended noun phrases and the role of thematic relations in organizing clause structure. The term "linking rule" is borrowed from discussions of argument realization. I'd like now to make that analogy explicit for the partitive and QP constructions. Following a suggestion of Chris Kennedy's (p.c.), I propose a syntactic head that encodes the linking requirement. Following ideas in Parsons 1970, Abney 1987, and Kratzer 1996, I propose that that head is functional and that it assigns a sort of θ-role to a measure phrase or QP.

6.2 Syntax of Pseudopartitives

Giusti (1997:sect. 4) presents a general discussion of the syntax of quantifiers. Giusti proposes two positions for the Italian quantifier *molti* 'many/much' depending on whether it follows a determiner. Contrasting examples appear in (94) and (95), and Giusti's analysis is depicted in the trees in (96) and (97).

(94)   molti   ragazzi
       many-MASC.PL boys-MASC.PL

(95)   i   molti   ragazzi   simpatici
       DEF.MASC.PL many.MASC.PL boys-MASC.PL nice.MASC.PL
       'the many nice boys'

(96)

```
                          QP
                          │
                          Q′
                      ╱        ╲
                  Q              DP
                  │             ╱  ╲
                molti        ragazzi
```

(97)

```
                        DP
                        │
                        D′
                  ┌─────┴─────┐
                  D          AgrP
                  │       ┌────┴────┐
                  i      QP        Agr′
                       ╱─△─╲    ┌───┴───┐
                      molti    Agr      NP
                               │     ┌───┴───┐
                           ragazzi_k AdjP    N′
                                    ╱─△─╲    │
                                  simpatici  N
                                             │
                                             t_k
```

In (96), *molti* heads a QP and takes the DP as a complement. In (97), *molti* is in a specifier position like the adjective *simpatici* 'nice'. (97) follows the general program of Cinque 1994, in which adjectives occur in specifier positions in a extended nominal projection. In those positions they agree with the noun through specifier-head agreement. (97) also follows Cinque in taking the postnominal position of adjectives in Romance to be the result of movement of the head noun. Giusti finds support for the differential positioning of *molti* in (96) and (97) in the distribution of the clitic *ne*. *Ne* is possible with *molti* but not when *molti* follows the article. The relevant data appear in (98)–(101).

(98) Ho   visti   molti   ragazzi.
      have.1SG seen   many-MASC.PL   boys-MASC.PL
      'I saw many boys.'

(99) Ne$_i$ ho   visti molti t_i.
      of.them   have.1SG seen   many-MASC.PL
      'I saw many of them.'

(100) Ho   visti   i   molti   ragazzi.
      have-1SG   seen   DEF.MASC.PL   many-MASC.PL   boys-MASC.PL
      'I saw the many boys.'

(101) *Ne$_i$ ho   visti   i   molti t_i.
      of.them   have-1SG   seen   DEF.MASC.PL   many-MASC.PL
      'I saw the many of them.'

This difference is explained by the analysis in (96) and (97) along with the assumption that *ne* is a DP.

Giusti argues that Q is a lexical category, not a functional category like D, the category that includes the definite article. She notes, among other things, that while function words tend to embed a unique complement, Q words have nominal complements but they are also found in adjectival phrases such as *molto bello* 'very beautiful'. They are also used in comparatives, as Zamparelli (2000:sect. 3.2F) pointed out:

(102) a. molto di più   'much more'
       b. poco di più   'a little more'

Giusti finds further support for the lexical view of Q words in their ability to appear separate from their complements as in (99) above, unlike function words which tend to be phonologically dependent.

If Giusti is right that Q is a lexical category, then the agreement facts in (94) and (96) are puzzling since lexical heads as a rule tend not to agree with their complements.[11]

The agreement facts would make more sense if instead *molti* was always a QP in the specifier of a functional projection whose head it agrees with as it is in (97) (cf. Zamparelli 2000:sect. 6.3). Pursuing this idea, I propose a functional head called Mon^0. Following the framework of Grimshaw (2000, 2005:chap. 1), I take this head to have a higher F-value than D^0, which means that when they both occur in a single projection Mon^0 must be above D^0, but the presence of Mon^0 does not entail the presence of D^0. This setup allows all three of the analyses in (103).

(103)   a.$[_{MonP}[_{QP}$ molti$]$ $[_{Mon'}$ $[_{Mon}]$ $[_{DP}$ ne$]]$
        b.$[_{MonP}[_{QP}$ molti$]$ $[_{Mon'}$ $[_{Mon}]$ $[_{AgrP}$ simpatici ragazzi$]]$
        c.$[_{MonP}[_{QP}$ molti$]$ $[_{Mon'}$ $[_{Mon}]$ $[_{NP}$ ragazzi$]]$

---

[11] Giusti (1991, 1997) was in part led to the head analysis for Q words by Shlonsky's (1991) account of the following pair of expressions from Hebrew, both of which mean 'all the books':

(i) $[_{QP}$ $[_{Q'}[_Q$ kol$]$ $[_{DP}$ ha-sfarim$]]]$
            all   the-book.MASC.PL

(ii) $[_{QP}$ ha-sfarim$_i$ $[_{Q'}$ kul-am $t_i]]$
        the-book.MASC.PL all.3PL.MASC

Shlonsky's idea is that in going from (i) to (ii), the DP *hasfarim* moves from the complement of Q to Spec,QP thereby triggering spec-head agreement showing up on *kol~kul*. But the number and gender marking on *kol~kul* bears no resemblance to agreement on nouns or adjectives (cf. *zol* 'cheap'/*zolim* 'cheap.MASC.PL, *bul* 'stamp'/*bulim* 'stamps.MASC.PL') but is identical to the pronominal suffixes often found on nouns and prepositions (*axot* 'sister'/*axotam* 'their.MASC.PL.sister', *beyn* 'between'/*beynam* 'between them.MASC'). The affix on *kol* appears to be a resumptive pronoun, a device often used in Hebrew. *Kulam* in (ii) is a floated quantifier with a pronominal argument.

(103c) is consistent with the envisioned phrase structure rules. It will presumably be ruled out by whatever forces the N-movement in (97) to Spec,AgrP. For expository simplicity, I will ignore AgrP. So (103c) will be my starting point for English. Taking QP to always be in Spec,MonP yields an immediate payoff. It correctly predicts that complex Q phrases can appear:

(104) $[_{MonP}[_{QP}$ too much$]$ $[_{Mon'}$ $[_{Mon}]$ $[_{NP}$ salt$]]$

Grimshaw (2005:chap. 1) argues that PPs are extended nominal projections. One possibility then is that Mon^0 has a higher F-value than P^0 and that true partitives have the structure in (105).

(105) $[_{MonP}$ many $[_{Mon'}$ $[_{Mon}]$ $[_{PP}$ of $[_{DP}$ the bananas$]]]]$

Corver (1998) proposes that in pseudopartitives, measure phrases occupy a specifier of a functional projection. I adopt this idea as well:

(106) $[_{MonP}[_{NP}$ one ounce$]$ $[_{Mon'}$ $[_{Mon}$ of$]$ $[_{NP}$ salt$]]$

I have followed Corver (1998) and Zamparelli (2000) in inserting *of* under a functional head. Corver takes this *of* to be a copula. I agree that Mon^0 is a copula in a very general sense, but I do not think it has the semantics of identity because I do not think substance NPs have the same kinds of meanings as measure phrases or QPs. What then is the semantic bond that holds the substance NP together with the measure phrase or QP?

   An interesting answer to this question is suggested by Abney (1987:294–295). He proposed that a noun can assign a Measure θ-role. The content of the Measure θ-role specifies the connection between the stuff being quantified over and the measure-phrase meaning. Though I disagree about the source of this role, I think the analogy with thematic relations is apt.[12] Sentences quantify over events with a verbal event predicate as a starting point. These events are further elaborated by adding participants and saying something about how they participated. Similarly, MonPs quantify over entities with a nominal entity predicate as a starting point. These entities are further elaborated by specifying measures and saying something about what dimension of the entity they measure. θ-roles like Agent and Theme do not specify particular thematic relations; they only constrain or classify them (see Schein 2002 for discussion). To be an agent of a killing is similar to but not the same thing as being an agent of an eating. Likewise, Measure θ-roles do not specify the dimension measured. They only restrict the choices. That's what the linking rules were about. The idea then is that in *2 inches of cable*, *2 inches*

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[12] Apparently, Parsons (1970:sect. 7) thought so, too. "For a catchy parallel," he wrote "read *x measures y* as *x participates in y*" (p. 152).

is related to the cable via the length dimension. This dimension fits the Measure θ-role, which constrains the choice to monotonic dimensions.

Having adopted Abney's idea of a Measure θ-role, we might now wonder about the identity of the assigner of this role. Abney took the assigner to be the noun, making measure phrases in some sense like subjects of substance nouns. Recent discussion of verbal subjects suggests a Measure role assigner different from the noun. Kratzer (1996) relates an argument of Marantz (1984) to the effect that verbal subjects are not truly arguments of the verb. Marantz observed many instances like those in (107) in which a nonsubject argument of a verb triggers a particular interpretation of the verb.

(107)   a.   take a book from the shelf
        b.   take a bus to New York
        c.   take a nap

He claimed that there are few, if any, instances where a verbal subject does the same.[13] Marantz assumes that the verb is the same in each case, but it has a complex meaning that yields different kinds of truth conditions depending on what it combines with. This dependency is part of the meaning of the verb and as such it could only apply to true arguments of the verb (cf. Keenan's [1974] "functional principle"). Verb meanings are impervious to subjects because the subject is not truly an argument of the verb. But if subjects are not arguments of the verb, then there must be some other mechanism by which their denotations come to be associated with the events denoted by the verb. Kratzer proposes that this is the work of a silent head that takes the verb phrase as complement and that assigns a θ-role to the subject. This division of labor goes some way to explaining why Agent θ-roles are so consistently assigned to the subject. It is because Agent is associated with this silent head. Furthermore, because the presence of subjects depends on inflection (e.g., gerunds are subjectless, finite verbs are not), Kratzer reasons that the silent head must be a functional head.

Marantz's arguments about verbs and their subjects apply a fortiori to substance nouns and measure phrases. To begin with, substance nouns do not show any signs of requiring or resisting a measure phrase or of subcategorizing for different kinds of measure phrases. We do not find pairs of nouns with similar meanings but where one goes in a partitive and the other does. And measure phrases do not trigger a particular interpretation of the noun, as in Marantz's verb-object examples. In that case, we have good reason to assume the source for the Measure role is external to the NP. Let us then suppose that the Mon^0 head in (103)–(105) is the source for the Measure role. I assume that the role is indifferent to whether the specifier is occupied by a QP or NP, so long as it has the right kind of semantics. In the next section,

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[13] See O'Grady 1998 for recent discussion of this claim.

I say more about what the right kind of semantics is, and I will fill in some detail on the semantics of Mon^0.

Kratzer's functional head assigns a θ-role to the subject, but it also assigns Case to the object (taken to be in Spec,VP at Case-assignment time). It is tempting to say something similar about Mon^0. I have inserted *of* under Mon^0, and a popular idea is that *of* is there to assign Case to the NP it governs. But there seems to be another or different role for this *of*. Following up on Gawron's (2002) observations, we find the appearance of *of* to be sensitive to whether the head of Spec,MonP is inflected for number.

Consider first the pattern seen in the pseudopartitives in (108).

(108) a. [two million] ducks
         b. [a few million] ducks
         c. [millions] of ducks

In (108a) the head of Spec,MonP, *million*, has no number marking and there is no *of* between the measure phrase and the substance noun. The possibility of using *a few* in (108b) shows that these aren't attributive measure phrases, either. The examples in (108a,b) are fashioned in the same way as German pseudopartitives as in (109) (and the earlier (57)).

(109) zwei Pfund/*Pfunde Salz   (Vos 1999:52)
         two   pound/pounds salt
         'two pounds of salt'

Here too, no number marking on the measure term is paired with juxtaposition of a measure phrase and a substance noun.[14,15] This contrasts with (108c), where the measure term is number marked and where the *of* shows up. Number marking on the head of Spec,MonP is in complementary distribution with *of* in the head of MonP. One finds the same pattern when *million* is replaced with *dozen*, *hundred*, *thousand*, *billion*, *trillion*, or *gazillion*. These are the numerals in English that themselves combine with numerals.[16] Outside of these cases, nouns are inflected for number. This means that if the complementary distribution is preserved, all other measure phrases should require *of* in the pseudopartitive. By contrast, given that adjectives do not inflect for number, none of the QPs should have an *of*. This is indeed what you find:

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[14] It is not obvious how the Case-marking theory of *of* is supposed to work in these cases. The question is what Case-marks the substance noun in (108) and (109) and why that does not work in (108). See van Riemsdijk 1998 for discussion of these issues.

[15] Manfred Krifka (p.c.) pointed out that feminine measure words *Pinte* 'pint' and *Elle* 'ell' do show number marking.

[16] We can say *he has 5 twenties* but then *twenty* is not being used as numeral: **5 twenties* (*of*) *boys*.

(110)   Spec,MonP w/adj head: a little (*of) soap   a few (*of) men
        Spec,MonP w/noun head: a bit *(of) soap   a number *(of) men

Assuming the view of agreement discussed earlier, the *of* appears exactly when there are conflicting demands at the Mon^0 node. In (111), the number feature of the head noun *soap* is passed up to the higher Mon^0 head. By spec-head agreement, Mon^0 is supposed to determine the number of *a bit*, but it is already marked.

(111)
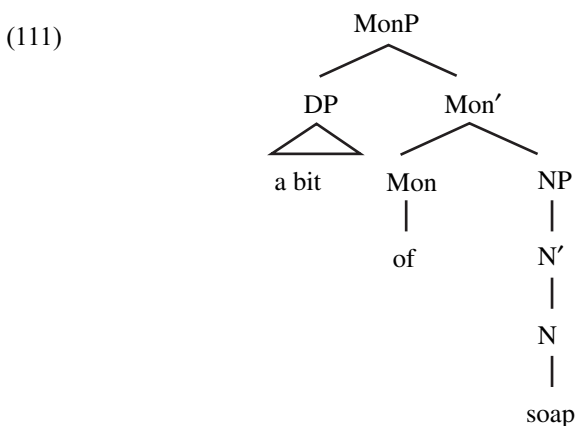
For some reason, the *of* appears when this conflict arises. But how is the conflict resolved? Judging by the external agreement of the MonP, the conflict is resolved different ways, again depending on the occupant of Spec, MonP:

(112)   a.   Lots of soap was put in the machine.
        b.   A lot of bubbles were put in the machine.

(113)   a.   2 gallons of soap were/was put in the machine.
        b.   1 gallon of bubbles were/was put in the machine.

One possibility is that the degree to which the number on Spec,MonP is semantically contentful, it wins and otherwise the marking passed up to Mon^0 wins (see Vos 1999, 2002 for a different analysis of related facts in Spanish and Dutch). The next section addresses in what sense number marking in measure phrases can be understood as contentful. Summarizing, we have three kinds of nouns. *Million* in (108a) is numberless, *lots* is numbered but with no content, and *gallons* is numbered, possibly contentfully. *Of* occurs if there is number marking on Spec,MonP and that number determines the number feature of the whole extended projection if it is contentful.

6.3 Semantics of Measure Phrases and QPs

Section 2 began with the observation that measure phrases occur in a variety of syntactic contexts, the partitive being one of them. QPs were introduced in section 5. They were distinguished form ordinary APs in their ability to replace a measure phrase in a partitive. If we now go back to those other contexts that host measure phrases, we find QPs once again alternating with measure phrases (Jackendoff 1977). The left-hand column repeats examples from section 2 and the right-hand column shows QP counterparts:

(114)   Measure Phrase   QP
        4 feet longer   that much longer
        4 feet above   a little above
        walked 4 feet   walked too much

This pattern of distribution is by no means peculiar to English.[17] It occurs in such diverse languages as Bangla (Bhattacharya 1999), Hebrew, Hindi, Japanese, and Polish.

(115)   Hebrew
      a. harbe yoter yakar
         much more expensive
      b. harbe basar
         much meat

(116)   Hindi
      a. anu raaj-se   bahut (zyaadaa) lambii hai
         Anu Raj-INSTR much more   tall   is
      b. bahut   namak
         a-lot-of salt   (V. Dayal, p.c.)

(117)   Japanese
      a. A-wa B-yori 20-fiito nagai.
              than   feet   long
        'A is 20 feet longer than B.'   (Y. Futagi, p.c.)
      b. John-ga keeburu-o 500-fiito katta.
             cable-ACC   feet buy
        'John bought 500 feet of cable.'

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[17] By contrast, a measure phrase or QP is sometimes possible adjacent to a positive adjective as in *6 feet tall* or Giusti's *molto bello* 'very beautiful'. This option is not robust intra- or crosslinguistically. For details see Schwarzschild, 2005.

(118)   Polish
   a. dużo   bogatszy
       much   richer
   b. dużo   mydła
       much   soap   (B. Rozwadowska, p.c.)

Numeral classifiers may also be used as measure phrases (Kikuchi 2001, Nakanishi 2004).

(119)   John-ga   ringo-wo 3-ko tabeta.
       apple-ACC CL   ate
       'John ate 3 apples.'

(120)   Mary-wa [John-ga tabeta yorimo] [DegP 3-ko [ooku]]
                       ate   than   CL   many
       ringo-wo   tabeta.
       apple-ACC   ate
       'Mary ate 3 more apples than John did.'

It is unlikely that measure phrases and QPs follow each other around the grammar because of an internal syntactic similarity between the two. The similarity must be semantic. Apparently, measure phrases and QPs are pulled from different syntactic categories but they belong to the same semantic category and that semantic category is called for in sundry contexts. We want then to say what that semantic category is and what role it plays in the various contexts. Since the comparative freely allows all measure phrases and QPs, whereas the other contexts are restricted in one way or another, I will use the comparative to say what the semantic category is and then come back to MonPs.

    To fix on an image, consider how we use expressions like *2 inches* to talk about intervals of a ruler (see Figure 1). There are many intervals on the ruler that would elicit the use of the phrase *2 inches*, including the one from 1 to 3 and the one from 6 to 8 and so on. This is how *2 inches* is used when it occurs in a comparative. This idea is also made clear by comparing adverbs of duration as modifiers of *before* clauses as in (121) with measure phrases in comparatives as in (122).

(121)   He shot the sheriff [2 hours] before he shot the deputy.

(122)   Rod A is [2 inches] longer than rod B is.

1	2	3	4	5	6	7	8	9	10	11	12

       ← 2 in.→   ← 2 in.→
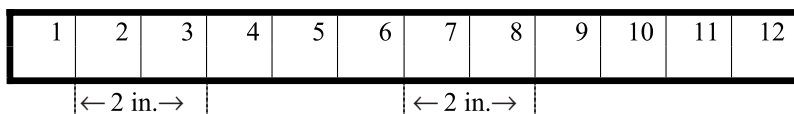
Figure 1: Differences of 2 inches along a ruler

In (121), *2 hours* is predicated of the interval on the time line between the two shootings. In (122), *2 inches* is predicated of the interval on the scale between where B is and where A is. This view extends to QPs as well.

(123)   Rod A is [much] longer than rod B is.

In (123), *much* tells us that the size of the interval on the scale between B's location and A's location is large. On this view, *much* has a semantics like that of *long*. Both adjectives apply to extended entities, with *much* restricted to abstract, scale parts. Because both are gradable, we find *too long*, *so long*, *that long* alongside of *too much*, *so much*, *that much.* And in both cases, when no degree word such as *too* or *that* is present, one gets a "higher than norm" reading.

   This view of measure phrases is based on comparatives. Zwarts (1997) independently came to a very similar conclusion about measure phrases in his analysis of the semantics of prepositions. This accords with the hypothesis I am pursuing—namely, that measure phrases or QPs have the same kind of meaning no matter where they are. Specifically, the claim is that:

(124)   A measure phrase or a QP always denotes a predicate of scalar
        intervals.

Any context where a scalar interval is at play is a context where a measure phrase or a QP will show up. There are a number of observations in the literature on the grammar of measure phrases that support (124).

   Klooster (1972:18ff.) pointed out that the quantifier in a nominal measure phrase has to be weak. We cannot say *most feet taller, **most feet of yarn*, *ran most miles, or **most inches above the painting.* This restriction follows from (124) and the general prohibition on strong quantifiers in predicative noun phrases. Adger (1994) notes that the ban on strong quantifiers extends to arguments of measure verbs (**weighs most ounces*). Adger discusses a number of other properties of the objects of measure verbs that lend further support to the idea that they are predicative. These include Rizzi's (1990) observation that measure phrase arguments are sensitive to weak islands (*What don't you think he saw?* vs. **What don't you think he weigh*s?); the failure of measure phrases to passivize (**2 ounces was weighed by it*); Smith's (1992) observation that measure phrases do not show past participle agreement in French (*les vingt grammes que cette lettre a pesé*(*es) 'the twenty grams that this letter has weighed'); and finally Adger's own observation that in languages like Turkish, measure phrase arguments do not undergo specificity-sensitive scrambling. The weak island and passivization tests apply as well to QPs (**How much don't you think he weighs?*, **too much was weighed by it*).

   (124) invites a compositional analysis of the semantics of measure phrases. Compare the following examples:

(125)   two sections of Rod A

(126)   two inches

We understand (125) to be about two nonoverlapping parts of Rod A delimited in some way. We understand (126) to be about two nonoverlapping parts of a scale, a scale of lengths for example. Each of these two parts is in the extension of *inch*. This analysis shows the sense in which number marking in measure phrases is semantic—a fact tied in the previous section to the occurrence of *of* in pseudopartitives. Likewise, *an inch* is a predicate true of any one of the many inch-intervals on a length-scale. And *several inches* is true of any interval consisting of several such inch intervals.

With (124) in place, the function of Mon^0 becomes clearer. It glues together a predicate of scalar intervals with a substance predicate. Mon^0 introduces some dimension that projects portions of the substance onto a scale yielding an interval and the measure phrase or QP then predicates of that interval. To take a specific example, in *2 inches of thread*, Mon^0 takes us from a bit of thread to an interval that includes zero and all the points up to the length of the thread, giving an interval. This interval is said to have the size 2 inches; in fact, the same size as the interval between Rod A and Rod B in (122). Mon^0 allows for different kinds of dimensions, but it crucially requires that the dimension be monotonic relative to the part-whole structure of the noun.

This analysis of measure phrases and QPs extends to numerals, following ideas in Nerbonne 1995 and Krifka 1989. First note that numerals appear in comparatives (*9 more boys*) the way measure phrases and QPs do (see (114) and (122)). One also finds numerals in excessives. *9 too many* is like *2 pounds too heavy* or *much too heavy*. In these contexts, numerals alternate with *many* (*many more boys*, *many too many*). By the same reasoning as went into (124) we conclude that numerals and *many* are predicates of scalar intervals.[18] Given their semantics we take the scale to be a scale of cardinalities. In *9 more boys than girls*, *9* holds of all the cardinalities between that of the boys and that of the girls. And in the simple *9 boys* or *many boys*, Mon^0 takes us from a plurality to an interval containing all numbers from zero to the cardinality of that plurality and the numeral or *many* applies to the result.

In the previous section, Mon was argued to be a θ-role assigner. Now that we have a clearer idea of its semantic function, it is interesting to compare it with event semantics views on θ-roles. In Davidsonian event semantics, a sentence like (127) is translated something like in (128).

(127)   A boy bought a bike.

(128) $\exists e$ (bought(a bike))$'$ (e) $\wedge$ boy$'$ (Agent(e))
        'There is an event which was a bike-buying and the Agent was a boy.'

_____

[18] Rett (2005) shows that maximality in *how many* questions is a result of the fact that *how many* is predicate of scale-parts.

I am following Kratzer (1996) in translating the subject but not the object with an independent thematic relation predicate. I will now proceed to modify this translation, somewhat idiosyncratically, with an eye on comparison with MonPs.

To incorporate the fact that Agent is really a classification of roles but not the actual role itself, we transform (128) into:

(129) $\exists e \, \exists \text{R{\scriptsize OL}} \, (\text{bought(a bike)})' \, (e) \wedge \text{boy}' \, (\text{R{\scriptsize OL}}(e)) \wedge \text{Agentive}(\text{R{\scriptsize OL}})$
    'There is an event which was a bike-buying and there is a role
    and the individual who played that role in the event was a boy and
    the role was Agentive.'

What is means to be "Agentive" is complicated. Causation or control is typically involved.

Next, we confront the well-known observation that what it means to be an Agentive role depends on how the event is described. If the boy bought the bike from a girl, and if we take the buying of the bike to be the same event as the selling of the bike, then the boy's role is Agentive, when the event is treated as a buying but not as a selling. This leads to our final modification:

(130) $\exists e \, \exists \text{R{\scriptsize OL}} \, (\text{bought(a bike)})' \, (e) \wedge \text{boy}' \, (\text{R{\scriptsize OL}}(e)) \wedge \text{Agentive}$
    $(\text{R{\scriptsize OL}}, \textit{buy})$
    'There is an event which was a bike-buying and there is a role and
    the individual who played that role in the event was a boy and
    the role was Agentive for a buying.'

With the verb *buy*, the individual giving the merchandise is described in a *from* phrase. So this verb gives a perspective where the participant giving the merchandise is a Source. Putting together our previous remarks on the meaning of "Agentive," we now say that according to (130), the boy's role involved causation in a buy-sell event where we view the merchandise giver as just a Source.

We now provide a translation for the phrase *3 ounces of gold* for comparison:

(131) $\exists x \, \exists \text{D{\scriptsize IM}}: \text{gold}(x) \wedge \text{3-ounces}' \, (\text{D{\scriptsize IM}}(x)) \wedge \text{MON}(\text{D{\scriptsize IM}}, \textit{gold}).$
    'There is a portion of stuff which is gold and there is a dimension
    and 3 ounces is the extent to which the portion has that dimension
    and that dimension is monotonic relative to the part whole relation
    of gold.'

By putting (130) and (131) side by side, one can see how Spec,MonP is treated like a subject of the extended nominal projection.

This completes the discussion of the syntax and the semantics of partitives and other MonPs. I have gone into much more detail about these cases than

about the attributives. Nevertheless, the attributives play an important supporting role in the story told here. Their existence shows that the impossibility of certain dimension-interpretations in MonPs cannot be the fault of the measure phrase, the QP, or the substance noun phrase or even of the fact that they are combined together. What matters is the syntactic structure, and the crucial piece is the Mon^0 that intervenes between the scalar predicate, measure phrase or QP, and the substance noun phrase.

At the end of section 5.3, I concluded that an adjective like *heavy* was required to be low in the nominal projection and that that forced it to have nonmonotonic interpretations. I left open what forces Q adjectives to have monotonic interpretations. At this point, we have an answer. Their interpretations as predicates of scale parts makes them unfit to be (intersective?) attributive modifiers. The only way they can enter the nominal projection is by being in Spec,MonP—but that entails a monotonic dimension. The adjective *numerous* makes an interesting case for further study. On the one hand, we know it is not a predicate of scalar parts because it cannot be used in comparatives or excessives (*numerous more boys*, *numerous many applicants*) and it cannot be used in a partitive (*numerous of them*). On the other hand, it seems to make use of cardinality—a monotonic dimension. This suggests a position below MonP but not as low as where adjectives like *heavy* go. The fact that Italian *numerosi* licenses *ne* (Giusti 1997) suggests that this intermediate position is above DP.

7. Some of the Main Points

The discussion centered on examples of the kind in (132)–(133).

(132)   Monotonic constructions
      5 pounds of paper   too much paper
      4 inches of cable   a lot of cable

(133)   Nonmonotonic constructions
      5 pound paper   heavy paper
      1/4 inch cable   thin cable

These examples are organized according to the type of dimension that is described by the expression that occurs prenominally. In the examples in (132), you can have weight and length but not density or diameter; in (133) it is the other way around. APs, QPs, and measure phrases are all expressions that can occur in an extended nominal projection as a description of a dimension. The central claim is that:

(134)   The position of an expression within the nominal projection limits the kinds of dimensions it can describe.

The limitation is given in terms of monotonicity relative to a salient part-whole relation on the extension of the noun. A dimension is monotonic on a part-whole relation, if the extent to which something has the dimension is necessarily greater than the extent to which its proper subparts have it.

Section 6 offers a specific proposal about how the limitation is encoded in the monotonic constructions. A functional head, Mon^0, was proposed and its behavior was compared with that of a θ-role assigner. A thematic relation relates events to participants. Verbal arguments describe the participants, and θ-role assigners place constraints on the relation in terms of causation, affectedness, and so on. A dimension relates objects to extents. A measure phrase or QP describes the extent of an object along some dimension. Mon^0 places a constraint on the choice of that dimension in terms of monotonicity.

On the nonmonotonic side, I argued for a particular view of the meaning of number marking. An occurrence of a singular count noun was argued to carry the presupposition that the elements of its extension do not overlap with each other. This has the effect that any dimension is nonmonotonic to the part-whole relation associated with a singular count noun. This in turn leads to a marked difference between mass and count attributives. Attributive measure phrases and adjectives attach quite freely to singular count nouns but are rather restricted in their combination with mass nouns.

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Roger Schwarzschild
Rutgers University
Department of Linguistics
18 Seminary Place
New Brunswick, NJ 08901
USA

sroger@ruccs.rutgers.edu