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MASS EXPRESSIONS*

INTRODUCTION

Problems associated with mass expressions[1] can be divided into the following general areas:

1. distinguishing a class of mass expressions;
2. describing the syntax of this class;
3. describing the formal semantics of this class;
4. explicating the ontology such a class of expressions presupposes, and
5. accounting for various epistemological issues involving our perception of the ontology.

*In our light revision of the 1989 version of this article we have added short discussions of some work from before 1989 that we had inadvertetly omitted. We have also included short discussions of work done since that time. These new works have greatly expanded the understanding of the semantics of the notion of *mass*; and to adequately capture their contributions would require a much more thorough rewriting of this survey than we are able to undertake. Instead, we have interspersed our comments on these contributions at various places in the text, even when there is a mismatch between our old criticisms of previous theories and the relevance of those criticisms to the new accounts. Additionally, we have included a new section at the end, which gives some directions to literature outside of formal semantics in which the notion of *mass* has been employed. We looked at work on mass expressions in psycholinguistics and computational linguistics here, and we discussed some research in the history of philosophy and in metaphysics that makes use of the notion of *mass*.

[1]There is a terminological problem involved in even discussing the topic in a neutral manner, for most of the natural ways of saying things have been pre-empted by theory. For example, we would like a neutral manner of discussing the question of what is properly called mass. 'Mass word' here is incorrect, for some theories apply 'mass' to longer stretches of discourse. 'Mass term' is likely to engender confusion, since some theories (e.g. those inspired by Montague) reserve 'term' for the sort of phrase which can be the (complete) subject of a sentence. 'Mass noun' or 'mass noun phrase' is incorrect since some theories allow other things to be mass. 'Mass phrase' seems wrong since 'phrase' seems to require a sequence of words and further seems to presuppose that words have been already judged as forming some syntactic group. It is with some hesitation that we have adopted 'mass expression', 'count expression', and 'expression' as theory-independent descriptive phrases. It is intended that an expression can be any word, group of words, or other (perhaps smaller) meaningful unit of any syntactic category. Then we can ask such questions as 'What are mass expressions?' or 'Is it the senses of expression which are mass?', and so on.

D. Gabbay and F. Guenthner (eds.),
Handbook of Philosophical Logic, Volume 10, 1–87.

Permeating all these areas are questions of the role of pragmatics (construed broadly so as to encompass questions of how people typically use mass expressions to describe a state of affairs) in formal semantic descriptions. For example, if people normally use expression x in such-and-such circumstances (or normally take a use of x to imply y), should that have some reflex in the syntax, the semantics, the presupposed ontology, etc.? The 'problems of mass expressions' therefore provides a rich area in which to formulate and test various logico-linguistic theories. In this article we indicate (what we take to be) the more important problems and puzzles, survey some suggested solutions, indicate what we think are outstanding difficulties with those approaches, and make a few not-well-defended suggestions of our own to these problems and puzzles. Pelletier [1979a] is a bibliography of most work published on mass terms prior to 1978. The bibliography at the end of the present article includes work from that earlier bibliography only if it is cited in this article. The present bibliography also includes some works that were inadvertently omitted from that earlier bibliography. The new bibliography can also be compared with the one which appeared in the earlier version of this article (a bibliography from 1988). The present bibliography corrects some typographical errors and misinformation in that bibliography, includes some works that were inadvertently omitted, and adds a substantial number of new entries. The new entries come about for two reasons: mostly they were published after 1988, but in addition the present article expands on some issues that were not included in the earlier version of this article, thereby citing some earlier work on these new topics.

WHAT IS A MASS EXPRESSION?

Most works do not address this basic issue, but rather concentrate attention on certain examples which they take to distinguish mass expressions from count expressions. *Water, dirty water*, and *water used in washing yesterday's dishes* are central examples of mass expressions, it is claimed; while *person, tall person* and *person who washed yesterday's dishes* are central examples of count expressions. On the syntactic side, the usual view claims, mass expressions occur with the quantifiers *much* and *little*, with the unstressed article *some*, are susceptible to measurement phrases like *litres of* and *amount of*, and do not exhibit a singular/plural distinction. On the other hand, count expressions occur with the quantifiers *each, every, many, several, few*, and the stressed *some*, they use the indefinite article $a(n)$, they are susceptible to counting phrases like *five, a score of*, and do exhibit a singular/plural dichotomy manifested in the count noun phrase itself and in agreement with the verb phrase.[2]

[2]The usual view, as expressed in the last paragraph, acknowledges that there are many quantifiers which both mass and count expressions accept: *all, most, a lot of*, and others.

From the semantic point of view, count expressions and mass expressions are supposed to be differentiated by the way in which they refer to something. A count expression is supposed to refer to a discrete, well-delineated group of entities, whereas a mass expression refers without making it explicit how its referent is to be individuated or divided into objects. This feature of mass reference gives rise to the test of 'cumulative reference'—any sum of parts which are M is also M [Quine, 1960, p. 91], and to 'distributed (or divided or divisive or homogeneous) reference'—any part of something with is M is also M [Cheng, 1973, pp. 286– 287].

Correlated with the semantic and syntactic conditions is a set of pragmatic features. (Perhaps the syntactic and semantic features follow from the pragmatic ones, or perhaps vice versa). These pragmatic features have to do with the way we differentially *use* various expressions of the language. Most relevant to the present discussion are the concepts of 'individuating' and 'identifying'.

Traditional philosophic wisdom has it that some subset of the count expressions 'individuate' the world in the sense that, given a space appropriate to such an expression C, there is an answer to the question 'How many Cs are in that space?'[3] Such count expressions are traditionally called 'sortal expressions'. Thus, given a building room, it makes sense to ask how many people are in that room—making *person* a sortal expression; given a solar system, it makes sense to ask how many planets are in that solar system—making *planet* a sortal expression. Mass expressions are supposed to fail this test, as are certain count expressions like *thing, object, entity*, etc. (This last because there is no definite answer to the question 'How many things are in this room?', unless *thing* has antecedently been given

Perhaps it should be mentioned that some theorists, e.g. [McCawley, 1981, p. 435] have contemplated the view that *many* and *few* (the apparent count quantifiers) and *much* and *little* (the corresponding apparent mass quantifiers) are, respectively, really the same quantifiers. Some support for this view comes from the fact that some languages use the same word for *much* as for *many*. (German *viel*, French *beaucoup*, Japanese *takusan*). (This is a peculiar argument. Usually the conclusion follows in the other direction: since language X distinguishes these meanings by different words, the single word is language Y must represent two different meanings. Let us be clear in remarking that McCawley does not endorse this position.)

It is also usually admitted that some apparently pluralised expressions are used in a mass-like manner, e.g. *beans, brains, suds*, and *physics*. These are often viewed as syntactic irregularities: *brains* just is separately lexicalised as a (unpluralisable) mass expression. (As in

Joe doesn't have much brains). In what follows we shall regularly use *sm* for the unstressed *some*, following usage popularised by [Cartwright, 1965]. Contrast the intonations of *Some linguists are smart* and *I want sm water*.

These tests, which we below call 'the standard syntactic tests', are of course geared to test nouns (or noun phrases) and do not directly apply to other syntactic categories. We shall later investigate whether the distinction is to be extended to these other categories. For now we just note that the *central* examples come from nouns and noun phrases.

[3]Often the test is 'Does it make sense to ask how many ...?' or 'Can you count them?', etc.

some contextual understanding.) 'Individuate' is supposed to mark off one instance of a count expression from another—and it is claimed that *thing, water*, etc. do not do this. 'Individuate' should be distinguished from 'identify'. Presumably *water* will identify or characterise a certain portion of the environment and distinguish it from other portions—just as *person* does. However, we presume, *thing* does not identify any more than it individuates. And equally, we suppose, words like *stuff* and *quantity* do not identify anything. (Or rather, *thing, stuff*, etc. require some 'pragmatic' background to do it.)[4]

There is no question that the standard examples of mass expressions are nouns or noun phrases; but various authors have made claims about classifying expressions other than nouns and noun phrases as being count or mass. The three main types of expressions that have been suggested for this extended use are: adjectives (and adjective phrases), verbs (and verb phrases), and adverbs (and adverb phrases). We shall consider these each in turn. Moravcsik [1973], Quine [1960, p. 104], Bunt [1980] and Lønning [1987, p. 13f] suggest that some adjectives such as *spherical* be classified as count because they are only true of objects which can be counted. We note that very few adjectives have this property. Perhaps the numeral adjectives, like *one, two, many, several, ...*, are the best candidates for +count adjectives. (Of course, it is hard to make the argument for the plural ones, since one could simply say that, e.g. **two furniture* violates a number agreement—but even ?*one furniture* seems odd). Moravcsik also suggests that adjectives which are divisive should be considered as +mass. For example, *light*, but not *heavy*, *short*, but not *tall*. Of course, if one used the cumulativity test (as Quine does) for determining 'massness', one would get *heavy* but not *light*, *short* but not *tall*. Which test shall we take? Bunt offers us this: only adjectives which are homogeneous (both divisive and cumulative) in their reference can combine with mass nouns ([Bunt, 1981, p. 229]; see also his [1980]). This becomes revised to exclude non-restrictive and generic and collective modification of mass nouns. In the course of this revision, we learn (for a variety of reasons, mostly having to do with polar opposite adjectives where one is divisive but not cumulative and the other is cumulative but not divisive—as in the above examples) that adjectives of size or amount, or of shape or other aspects of outward appearance, are *not* mass adjectives. It seems to us that this at least partially contradicts our intuitive starting point: for very few adjectives will be +mass.[5]

[4] The issues of the last number of paragraphs are more fully discussed in [Pelletier, 1975] and [Bunt, 1981, Chapter 2].

[5] This is somewhat unfair to Bunt's theoretical exposition in [1981, Chapter II]. There the idea was *semantic*: when a +count adjective modifies a noun, a certain interpretation is forced upon the resulting noun phrase, and similarly for when a +mass adjective modifies a noun. The discussion in the text here is really an argument against taking count/mass to be a *syntactic* well-formedness constraint on adjective-noun combinations.

It is perhaps true that such expressions ought to be somehow differentially marked—so that *spherical* can only modify a noun which is judged count, or so that only nouns which are judged mass an be modified by *rancid*. But three things should be noted. First, this need to be a syntactic classification. If one takes the view that count/mass is a semantic well-formedness constraint, then *no* expressions will receive a syntactic marking for mass or count. It will rather be a feature of the semantic representation of *spherical*, say, that it can only combine with semantic representations that are true of individual objects, but it will not be a syntactic classification. If it is a semantic point being made, as it seems to be since the initial test was one of looking for 'cumulativity' and divisiveness', then the combination of *spherical* with, say *water* will be well-formed (syntactically) but simply will not be given a coherent semantic representation. Second, even if it were called syntactic, one should note that the notions of mass and count are here being used in an extended way: it is not really that *spherical* is +count, but rather that *spherical* has a co-occurrence restriction to the effect that it can only combine with expressions judged to be 'really' count—that is, with certain nouns. Third, the co-occurrence restrictions that have been offered seem suspect. Are

> Bring me the spherical ice and leave the irregularly-shaped ice there.
> Look at the fist-sized, perfectly spherical hail.
> Mary has box-shaped furniture.

really ungrammatical?[6]

Some people have been briefly tempted (e.g. [Moravcsik, 1973]) to classify verbs as mass or count, depending on what sort of subject they can take. For example, *flow* might be +mass (taking +mass subjects) while *think* might be +count (taking +count subjects). But they are quickly disabused upon considering that not only does water flow, but so do rivers; and even thinking is not beyond question—not only do people think, but possibly so does computer software (and *computer software* is normally assigned +mass status). More careful theorists have focused on the semantic criterion of 'divisiveness' in giving an intuitive account of why certain verb phrases should or should not be considered mass/count. Leech [1969, p. 134ff], Verkuyl [1972, pp. 54–61], Mourelatos [1978]; Carlson [1977]; Åqvist and Guenthner [1978]; Gabbay and Moravcsik [1979]; Taylor [1977] and Hoepelman

[6] Appendix A of [Bunt, 1981] reports an experiment claiming that ordinary speakers of English (and Dutch) do react oddly to some adjective/noun combinations. One might ask, however, whether these reactions have to do with the assumed features +mass and +count, or perhaps just to other oddities of the situation described by the experimental questions—such as the (assumed) mass noun being liquid at normal temperatures while the (assumed) count adjective presupposing a shape. (Thus *round water* would be judged peculiar because water has no independent shape, not because *water* is a mass expression and *round* a count-adjective).

[1976], all following Vendler [1967] suggest that verbs denoting processes be marked +mass while those denoting achievements be marked +count. The idea is that an event is the primitive verb-phrase denotation, and events can be part of larger events or contain subevents themselves. Some of these events, the ones which are processes like *to eat* and *to run*, have parts that are events denoted by the same verb. Others, the ones which are achievements like *to prove* and *to prepare*, are naturally bounded in the sense that they describe actions that involve change toward a final goal. So they do not have parts that are events denoted by the same verb. This is, of course to apply the 'divisiveness' criterion to verb phrases. Implicit in these discussions is also the possibility of carrying the 'cumulativity' criterion to verb phrases.

An informative discussion of verbs (and adverbs) as mass expressions is in [ter Meulen, 1980, Ch. 4]. She points out that either type of verb phrase can take either mass or count subjects. More interesting, she finds that the (direct) objects of the verb can be of either type, but which one it is determines whether the entire verb phrase is count or mass. Thus *eating cake* is +mass, *eating a cake* is +count; *preparing dinner* is +mass, *preparing a dinner* is +count. And thus the object dominates the simple verb (*eating* was +mass, *preparing* was +count).[7] Following Hoepelman [1976; 1978], who in turn is following Verkuyl [1972], ter Meulen considers certain adverb phrases to be either mass/count. Generally this means that the spatial or temporal extension or duration of the adverb is unbounded (or bounded). For instance, the adverb phrase *for hours* is temporally unbounded; the phrase *along the road* is spatially unbounded; the phrase *in an hour* is temporally bounded the phrase *to the city* is spatially bounded. Generally, ter Meulen suggests, one should look for a final state that will be reached through the action described by the verb phrase in question; if so, then the adverb is +count. ter Meulen notes that any verb (count/mass) can take either type of adverb phrase (count/mass); but it appears that the feature of the adverb phrase dominates the one of the verb. The next question is whether the feature of the entire verb phrase generated by using some count/mass direct object will combine correctly with either type of adverb. The results are a bit complicated and the judgements involved seem to us to be somewhat unreliable, but he answers seem to be this: the entire verb phrase is dominated by the adverb phrase; regardless of whether the verb and direct object are mass or count. Two possible exceptions to this are: (a) when the verb and the direct object are −count and the adverb phrase is +count, we get some sort of anomaly: *John ate cake in an hour*—one needs some special understanding to interpret it, and (b) when the verb

[7] J. D. McCawley (personal communication) points out that the mass:count distinction for verb phrases also depends on the verb: *It takes two hours to bake/*eat bread*; he suggests that the difference lies in whether the verb denotes a process that consumes the object a bit-at-a-time or affects the object all at once.

and adverb are +count but the object is −count, one gets what ter Meulen calls an iterative reading which is +count. Her example here is not well conceived: *Henry solved puzzles in an hour* has perhaps a +count verb and adverb, but it is unclear that *puzzles* is −count. What she says [ter Meulen, 1980, p. 129] is: 'it is interpreted as saying that Henry could provide solutions to puzzles in an hour, which is obviously [an achievement] rather than [a process]'. A better example of this phenomenon might be *Henry repaired furniture in an hour*.

We should note that, whatever else is true of this claim about the count/mass distinction amongst verbs and adverbs, it is founded on a semantic understanding of the distinction. We are told to look for the denotation of the terms and see whether they are divisive (or cumulative). So all the evidence gathered here might find its proper home in an account of the semantic plausibility of certain kinds of combinations, rather than as a syntactic point. With regard to the claim that verbs denoting processes are mass while those denoting achievements are count we might remark that according to the sense which is being used, it is rather the noun phrase *Sandy's eating cake* which is +mass and *Kim's winning a race* which is +count, and not the mere verb phrase, *eat cake* or *win a race*.

As the preceding discussion suggests, there are two senses in which the count/mass distinction might carry over to categories other than nominals. (1) if the count/mass distinction for nominals is a syntactic distinction, then it might carry over to other phrase types as an agreement feature, just as the singular/plural distinction carries over to verb phrases, even though the distinction might be said to derive from a distinction inherent in noun phrases (or their denotations). Carry over of gender to adjectives (from nouns) in many languages is another example of this phenomenon. Or, (2) it might be that there are distinctions among verb phrases (and perhaps other non-nominal categories) which are in some sense *analogous* to the count/mass distinction for nominals, and raise similar problems as to whether the distinctions are syntactic, semantic, or pragmatic. for instance, we have seen the claim that certain verb phrases semantically are true of any part of what they are true of. This would be to claim that the mass/count distinction amongst nouns is a semantic distinction, and that verb phrases have analogous character. We have given reasons to believe that there are no syntactic agreement features which would justify holding (1). As far as position (2) goes, we have seen that the only reasons for holding it are semantic, having to do with the denotation of the verb phrases in question. However true the analogy might be, we think the intuitions behind it are more clear in the nominal case and it ought to be studied there before being generalised to other categories. We therefore think it better to restrict the mass/count classification to nouns and noun phrases, regardless of whether in the latter case it be a syntactic or a semantic classification. We think that the intuitions being appealed to by those who wish to extend the classification

beyond nouns and noun phrases simply do not apply except in a stretched sense. It is really always by considering the *objects* which are characterised by the adjectives that gives us any reason to call the adjectives mass or count—so it is not syntactic, and in fact even the semantic characterisation only applies to the *things*. But *things* are what are designated by nouns and noun phrases. (Cf. [Pelletier, 1975, pp. 9–10] on calling *red* a sortal term.) Again with the verbs, verb phrases and adverb phrases, it is a matter of looking to the *events* denoted by the nominalised verb phrases, or to the kinds of events that can be modified by certain adverb phrases, which makes one want to call verbs, etc. mass or count. But then, just as with the adjectives, we should not call them count/mass, but rather call the noun phrases generated from them by nominalisation either count or mass. For these reasons we shall restrict our further discussion to nouns and noun phrases.

Two of the issues that must be addressed at the outset are, first, the question of whether one is going to posit a mass/count distinction for *expressions*, for *senses of expressions*, or for *occurrences of expressions* and second, one must address the question of how to classify expressions (or their senses or their occurrences) which do not immediately satisfy the syntactic/semantic/pragmatic conditions cited above. We mention these issues together because how one answers one might influence how one answers the other.

Consider sentence like

1. Kim put an apple into the salad.

2. Kim put apple into the salad.

Most theorists would claim that *apple* in (1) is count, whereas in (2) it is mass. If it is the expressions themselves one is going to call or mass, one is faced with a slight, but not insuperable, difficulty, since the expression cannot be both. However, one could claim that there are two separate words here, spelled and pronounced the same, one of which is mass and the other of which is count.[8] (This would be akin to our normal procedure of counting *bank* as at least three separate words.[9]) Another way out for the 'expression approach' would be to claim that *apple* is always count and that sentence (2)

[8] One might even back up a bit and point out that it is not entirely plain that *apple* in (2) need be classified as mass, since none of the standard syntactic criteria listed above directly apply to it.

[9] The issue of when a word is to be entered into the lexicon with multiple senses and when it is to be considered separate homographs is too deep to go into here. Such matters as etymology are involved, as is the more 'practical' matter of 'large' meaning differences giving homographs and 'smaller' meaning differences giving sense distinctions. We take it to be a sufficient condition of homographs that the different words belong to different syntactic categories. Thus, for us *fast* (ADJ) is a different word from *fast* (ADV). So if +count and +mass are syntactic features or classifications, then *apple* (+count) and *apple* (+mass) would be different words. (We realise that there are borderline problems

has a deleted *bits of an* left out. Alternatively one might claim that *apple* is always mass and that (1) uses *an* to construct this mass into a well-defined object. So, with respect to the 'dual life' words like *apple*, one might say (a) that *all* such expressions were 'really' count, or (b) that *all* such expressions were 'really' mass, or (c) that some were 'really' count and others were 'really' mass. One might go even further and say (d) that *every* expression, not just the dual life ones, is 'really' mass, or (e) that *every* expression is 'really' count. (Presumably (d) and (e) would be to adopt (a) or (b) but to claim that all expressions led a 'dual life'). So according to (a), there are some apparently 'dual life' expressions, but they should all be represented as count, and a rule of 'massification' sometimes occurs. According to (b), some expressions lead a 'dual life', but they are all to be represented as mass, and a process of 'countification' sometimes occurs. According to (c), some 'dual life' expressions are represented as count while others are represented as mass, and there are two processes at work. According to (d), every expression is to be represented as mass, and the process of countification has rather a lot of work to do. And according to (e), every expression is to be represented as count, and the process of massification has rather a lot of work to do. We shall consider these approaches shortly.

The difference between these 'expression approaches' and a 'sense approach' is difficult to explicate in the absence of a general theory of the syntax (and semantics) of the language which would show the relationship between the lexical representation of individual words (or senses) and the syntactico-semantic representation of a sentence in which it occurs. As an overview, however, let us just indicate that we have in mind a lexicon which for each word contains some base form of that word, a statement of its membership in a syntactic class (potentially construed as a bundle of features), perhaps some idiosyncratic information about it (e.g. irregular plural), and finally a semantic representation of that word. We furthermore view the syntactic theory as providing some method of analysing the structure of a series of words in such a way as to show how the semantic representations of the words are combined to form a semantic representation of the whole series.[10]

On this account of an overall theory, the 'expression approach' to the mass/count distinction would associate with each entry of the lexicon membership in a syntactic class. Presumably being a mass expression or a count

for this sufficient condition: are *threaten* (__+NP) and *threaten* (_+[VP INF]) separate words? Further, the test says nothing about how many homograhs *bank* represents.)

[10]This viewpoint—one associated with Montague Grammar and related approaches—is not the only one possible, and not even the only one which will be discussed in this article. Perhaps in philosophical logic it is even more common to forego an explicit syntactic theory and to give intuitive 'translations' into first-order predicate logic. While we are ourselves committed to the approach outlined in the text, it is no doubt unfair in a survey to insist that all other accounts follow this methodology. In any case, much of what we intend to discuss is independent of the particular format chosen.

expression are two such classes. The syntactic rules, in analysing a longer sequence of words, might assign such a feature to these longer sequences, and presumably the syntactic rules will be sensitive to its presence in a subphrase when they analyse a longer sequence. For words like *apple* (as above), there might be two separate entries—one marked +count and the other +mass. Call this the 'dual expression approach'. Or there might be just one (marked either as +mass or +count in accordance with the discussion of (a)–(e) above) and some syntactic rule might assign the phrase *an apple* to the category +count. Call these approaches 'unitarian expression approaches'. The 'senses approach', on the other hand, will have only one lexical entry but will have alternate 'senses', some being senses appropriate to count uses.

It seems to us that there is more to the difference between a 'dual expression approach' and a 'senses approach' then merely the cosmetic issue of having one entry in the lexicon with many different semantic representations or having many entries in the lexicon each with one semantic representation. The crucial difference has to do with whether +count and +mass are perceived as *syntactic* features (or classifications), or whether whatever differences there may be between them are to be accounted for entirely within the semantic representations. *Any* 'expression approach' explicitly assigns the features or categories +count and +mass to some elements of the lexicon. We take this to be syntactic information about the expression in question. Therefore, unless it is a completely superfluous classification, some syntactic rules must make explicit reference to these features. Now, if the 'senses approach' were to assign to the different senses of a lexical entry the *syntactic* features +count and +mass, then it *would* just be an alternative notation for the 'dual expression approach', and there would be nothing (other, perhaps, than computational ease) to choose between them. But we take it that central to a 'sense approach' is the claim that +count and +mass are *not* syntactic features or categories, but rather are a description of the semantic representation of the expression. That is, whether a *sense* is a mass or count is something to be discovered after examining the semantic representation of the expression in question.[11] In this approach, *no* syntactic rules refer to +count or +mass (since these are not syntactic objects). Rather, sentences like (1) and (2) each have (at least) two semantic representations—one using a mass representation of *apple* and one using a count representation of *apple*. Presumably, the semantic representation of (1) using the mass sense and the semantic representation of (2) using the count sense are both (semantically) incoherent—they violate some (semantic) type constraint, or violate some other semantic well-formedness rule—but they are (syntactically) well-formed.

[11] And perhaps even later, after examining meaning postulates associated with the representation or its elements; or even, only after examining 'factual axioms' (contingent properties) of the representation or its elements.

Let's now briefly distinguish an 'occurrence approach' from the 'expression approach' and the 'senses approach'. An 'occurrence approach' might take +count and +mass either to be syntactic features (or classifications) or to be a semantic characterisation. (Call these 'syntactic occurrence approach' and 'semantic occurrence approach' respectively). Underlying the 'occurrence approaches' is the conviction that the lexical items are *not* characterised in any way as being count or mass—they have neither a syntactic feature nor independent semantic representations which can be classified as being count or mass. Indeed, the 'occurrence approach' says, it is only in the context of a longer sequence of words that such a classification can be determined. In the lexicon a 'neutral' semantic representation for, say *apple*, is given. As the expression is seen to occur in longer phrases, its representation is then transformed so as to fall into one or the other of count or mass.[12] If the transition to a larger phrase, e.g. from *apple* to *an apple*, is taken to assign to *an apple* the syntactic category or feature +count, then this is presumably because some syntactic rule refers to '+count': this is the 'syntactic occurrence approach'. On the other hand, the theory might hold that the transition does not assign any such syntactic category or feature to our longer phrases, but rather adopts the sort of semantic view espoused by the 'senses approach'—one tells that it is a count occurrence by looking at the semantic representation of this longer phrase. This is the 'semantic occurrence approach'.

As representatives of these various approaches, we might point to [Quirk *et al.*, 1972, p. 128] and [Quine, 1960, p. 91] as proponents of the 'dual expression approach' to such words as *apple*. Such theories recommend that these dual life words be given separate lexical entries, one with the syntactic feature +mass and the other with the syntactic feature +count.

There seem to be no representatives of the view that some ordinary expressions are +count and others are +mass, but that the dual life ones are always +mass. However, [Sharvy, 1978] is a proponent of the 'unitarian expression approach' which takes *all* expressions to be underlyingly +mass in the lexicon, using a 'deletion of nominal measure word' rule to account for apparent count expressions. In brief his argument runs thus: sentences like

3. Give me three beers

do *not* use *beers* as a count expression. Rather there is some (unrecoverable) nominal measure—such as *glasses of, kinds of, litres of*, etc.—which has

[12] Rather, it *sometimes* is seen to fall into one or the other. The 'occurrence approach' can admit that with some sentences one just cannot tell whether the occurrence is mass or count. The other approaches would have to count such sentences as ambiguous: syntactically ambiguous according to the 'expression approach', semantically ambiguous according to the 'senses approach'. The 'occurrence approach' can claim that such a sentence is *un*ambiguous, but has a broad range of interpretations.

been deleted from (3). At least, he claims, a language just like English in all other respects except for this would at least be 'Quine-indiscernible' from our English. But Sharvy applies this to more than just the examples which, like *apple*, appear to exhibit both a count and a mass use. His remarks can be generalised, he claims, to show that all apparent count nouns can be analysed as a deleted nominal measure and the resulting language would be 'Quine-indiscernible' from English. So a sentence like

4. There are three horses in the yard

does *not* have a +count term *horse* in it nor a +count expression like *three horses* or *three horses in the yard* in it. Rather there is a deleted nominal measure phrase, such as *head of*. As an example of a natural language which does not even *appear* to contain any count expressions (unlike English), Sharvy cites Mandarin Chinese.

On the other side of the 'expression approach' are those who take our apparently dual life words such as *apple* to be underlyingly +count. (Although they have in addition some expressions being simply +mass). Here we might point to [Bunt, 1981, Ch. 18] where such words are 'included in the lexicon as singular count nouns', and there is a 'syntactic rule transforming them into ground nouns' [1981, p. 248]. This is done 'to do justice to the observation that many nouns, like *apple, onion, cake* and *rope* occur both as singular count nouns and as mass nouns ('ground nouns')' (*ibid.*). Some of these unitarian expression theories even go to the opposite extreme from Sharvy and say that *all* nouns are underlying +count. Perhaps in this category is Allen [1980] with his 'degrees of countability', but even clearer are textbook accounts of translation from English to predicate logic. Such texts will translate (5) as (5′)

5. Beavers are mammals

5′. $(\forall x)[\text{Beaver}(x) \rightarrow \text{Mammal}(x)]$

and by analogy will translate (6) to (6′)

6. Snow is white

6′. $(\forall x)[\text{Snow}(x) \rightarrow \text{White}(x)]$

Now, the move from (5) to (5′) requires understanding *beavers* as being true of a set of individuals (i.e. as a count expression), so that the quantifier makes sense ('For each thing, if it is a beaver then it is a mammal'). Similarly the move from (6) to (6′) requires understanding *snow* as being true of a set of individuals (like count nominals), so that the quantifier makes sense ('For each thing, if it is (a? sm?) snow, then it is white'). This difficulty has been mentioned by many people, and it forms the locus of study for many of the recent works on the topic, e.g. [Higginbotham, 1994;

Koslicki, 1999], as well as in some of the more metaphysically-oriented authors [Burke, 1994; Zimmerman, 1995]. Cartwright [1965] was one of the earliest to draw attention to it, but see also Pelletier [1974] and Mellema [1981], who more directly fault logic textbooks. Textbook accounts do not discuss the conceptual and linguistic difficulties here, but it is significant to note that people who have seriously advocated a predicate logic account have shied away from the representation of (6) as (6′).[13] As an example of a natural language which does not even *appear* to have mass expressions (unlike English), Whorf [1939, pp. 140–143] cites Hopi. (Although the work of [Malotki, 1983] casts considerable doubt on Whorf's claim.)

As representatives of the 'senses approach' we might point to dictionaries that have entries like

> **lamb** (n.) 1a. A young sheep. 3a. The flesh of a lamb used as food.

(But dictionaries are just as likely to have

> **lamb** (n.) 1. A young sheep or its flesh used as food.)

Pelletier [1975, p. 2] says that 'we need to distinguish not between mass and count *nouns* but between mass and count *senses* of nouns.' He goes on to say that the fact that speakers can isolate the cause of the ambiguity in a sentence like (3)—three bottles of beer, three kinds of beer, three servings of beer—as being due to *beers*, shows that the ambiguity is lexical, and not a matter of the operation of a syntactic deletion rule. For if it were due to the operation of such a rule, then we should be willing to give different syntactic analyses of the sentence, which we do not. With some justification one might accuse Pelletier [1975] of confusion on two distinctions: that between a 'senses approach' and an 'occurrences approach' on the one side, and that between the role of +count and +mass as syntactic features or as a description of semantic representations on the other side. McCawley [1975] is apparently also a representative of this 'approach', although he sometimes can be seen to suggest a 'unitarian sense approach' which uses 'lexical redundancy rules' to generate the other sense. And such an approach would be difficult to distinguish from a 'unitarian expression approach'.

Gillon [1992; 1999] is explicitly an advocate of a senses approach, although since he believes that the different senses need each to be separately entered it is difficult to distinguish his view from one where there are instead a number of distinct words that are homographs. (Intuitively, *light* (being bright) and *light* (having little weight) are separate, identically-spelled words. It is less clear that *light* (being faint) and *light* (being low-fat) are separate words. But Gillon's scheme would represent the two cases in the

[13] [Quine, 1960, p. 91ff], [Davidson, 1967, fn. 9], [Parsons, 1970].

same manner.) His idea is that there are 'standard meanings' for nouns, and these meanings will be marked with the syntactic feature +mass or +count. There is usually more than one sense to a lexical item, and sometimes the different senses will have differing +mass/+count markers—but not as often as our examples might have suggested. For, Gillon would have separate senses only in those cases where the different senses have approximately equal prominence in usage, and even then only when there is no general rule by which one can be converted into the other. The major issue becomes, then, one of giving a semantic interpretation of these syntactic markers. It is not correct, he says, to say that +mass always is interpreted as 'the undifferentiated stuff', because of the minimal parts problem. And while one might wish to say that our language treats *water* as not having minimal parts, it does not treat the mass noun *furniture* this way. Gillon takes this as evidence that we should not treat *water* as being without minimal parts, either. The idea is that grammar simply makes no claims one way or the other about whether +mass entails homogeneity, and thus requires a semantic interpretation of 'don't know'—which in turn calls for a consultation of world knowledge (done by means of a 'pragmatics component'). According to Gillon, there is also a partially productive process of 'coercion' back and forth from +count to +mass at the semantic level. It is this process that makes it not be necessary to have entries for both +count and +mass senses of nouns. Most times the basic one can be turned into the other by means of these processes. However, to interpret the resulting values of the derived mass/count markers will in turn call for more pragmatics-guided interpretation.

Huddleston and Pullum's [2002, 334ff] discussion of count vs. noncount (as they prefer, claiming 'mass' is not suitable for the full range of noncount nouns, p. 340fn4) starts with the claim that 'the count vs. noncount distinction applies to senses or uses of nouns', and argues that these do not characterize homographs but are merely different senses of the same word. They provide a number of relations that reliably give rise to paired count and noncount senses, such as 'servings of drink/food', 'varieties', 'food made from', 'event instantitation', etc. Their idea is that sometimes the count is the 'primary' sense, and sometimes the noncount is 'primary', and there are general principles in operation to generate the secondary from the primary meanings (and sometimes, to generate yet a tertiary sense from the secondary). Their picture seems to be that these are *syntactic* features which adhere to one or another of the senses of lexical items. Correlated with these senses are also some semantic properties concerning countability: count senses allow for individuation and counting; noncount terms are uncountable, but there are various reasons for this uncountability. It may be that they are homogeneous (like *water*), or it may be that they denote a heterogeneous aggregate of parts (like *underwear*) and the 'inherent unboundedness' comes from designating such an aggregate. (The reader will

find a very interesting selection of examples and observations in this work, which will repay careful attention.)

Koslicki [1999] also holds that nouns are semantically interpreted as predicates. She would not have lexical entries entered more than once, but her idea is that since each noun (pretty much) can find itself in a mass or a count occurrence, and since it is idiosyncratic, she says, as to what sort of relation there is between the mass and count sense of any noun, therefore each noun should have *both* its mass meaning and its count meaning entered as parts of the lexical item. The syntactic configuration of the containing sentence that a given noun finds itself occupying will determine which of the senses, mass or count, the noun has in that sentence; and the rules she offers are of the sort that Gillon would be happy to use. However, unlike Huddleston and Pullum, and unlike Gillon, Koslicki does not think that there are any truly general productive relations between the two realms, so that these relations cannot be captured by the sort of *lexical* rules that they have in mind. Koslicki also thinks that predicates from the mass, the count, and the plural realm all are true of the same bit of reality, and that 'the difference lies purely in our concepts, not in the actual objects referred to.' [1999, p. 85, fn. 45].

In Verkuyl [1972], Ware [1975], Bunt [1981, Ch. 2] and sometimes in Pelletier [1974, fn. 1], it is claimed that the notions count and mass are to be applied to *occurrences* of expressions in a sentence. As mentioned above, this entails that the individual lexical entries do not have any such feature in their lexical representation, but rather than such classifications arise as the expressions are seen to occur in longer sequences of words. (For this reason it is probably better to say that it is the entire phrase *an apple*, rather than the individual word *apple*, which occurs here as count.) Verkuyl's train of argumentation started with considerations of verbal aspect, arguing that there was no systematic account of (say) a DURATIVE aspect that attaches to the lexical item *play* that would be able to account for these judgments:

The orchestra played from Schumann's cello concerto for hours.
* The orchestra played Schumann's cello concerto for hours.
The orchestra played in the music center for hours,

Instead, he claimed, the assignment of (NON) DURATIVE has to be made to the entire VP, and is a result of the interaction of the (meaning of the) verb, the preposition, and the NP-complement. The argumentation was carried out in a generative semantics framework, which had the effect of making the features (COUNT, MASS, DURATIVE, etc.) be nodes on a syntactico-semantic tree (on a par with nodes like NP, Determiner, VP, etc.). And the reasons he wishes to ascribe COUNT or MASS to an NP seem a mixture of semantic properties of the referent and syntactic properties like co-occurrence restrictions. Still, his reasoning could be re-applied with more modern assumptions to yield justification for an occurrence approach.

Bunt [1981], in the localised discussion of his Chapter 2,[14] wishes to assign such phrases the *syntactic* marker +count or +mass. His procedure here seems suspicious. He delineates a class of (syntactic) contexts like our standard syntactic tests in which an occurrence is definitely said to be one of either mass or count. For occurrences which do not get classified by these criteria (e.g. sentence (2) above), he applies this test: 'if "E" can be paraphrased by an expression "E_1" in which [the expression in question] occurs in such a syntactic configuration that it can be classified as a mass (count) noun [occurrence], then [the expression] occurs as a mass (count) noun [occurrence] in "E" on the reading "E_1" ' [Bunt, 1981, p. 15]. And in his [1979, p. 250] he says of such occurrences: 'construct an expression ... which does contain such a criterion [as listed above] and in which the noun is used in the same sense as in [the original]. The classification obtained from [this new construction] is also the classification of the noun as it occurs in [the original].' This seems questionable along three dimensions. First, (as Bunt notes) it may not be possible to find any such construction. Second (and more importantly) is there any reason to believe that a mass use can never be paraphrased as a count use? If this can sometimes happen, then perhaps there are some so far unclassified (but 'really' mass) uses which would be paraphrased (and hence classified) as count. Third (and we think most importantly), if it is an *occurrence* which is to be classified, the move to evaluating some *other* occurrence as mass or count would seem to have little if any relevance to the enterprise. (Along these same lines, compare the criticism in Pelletier [1975, pp. 9–10] of calling *red* a sortal expression.) Finally, we might note that this method is unmechanisable. How would a parsing procedure ever *discover* the classification of an occurrence as mass or count? Certainly it is hard to imagine a mechanical procedure which generates the required paraphrase and checks if it means the same as the original!!

As the quotes from Bunt in the previous paragraph make clear, he would want to assign a *syntactic* feature of +count or +mass to the individual expression when it occurs in the appropriate type of context. It is not exactly clear why he would want to do this since there are no syntactic rules which can make use of such a feature.[15] Since the syntactic clues which can be used to classify the expression are exactly the ones for which the information (+count or +mass) might be syntactically useful, it is not obvious what is the reason for wanting to classify the noun at all. There

[14] But his final implementation in Chapter 18 is, as observed earlier, an 'expression approach'.

[15] In the actual implementation of his Chapter 18 there is a point to having the features +count and +mass; namely, certain syntactic rules recognise various combinations of expressions on this basis. Thus if *apple* is +count, then there will be a rule so that the syntactic parser can recognise *six apples* as well-formed. But as we indicated earlier, *apple* is marked +count already in the lexicon—this is an 'expression approach' rather than the 'occurrence approach' being advocated in his Chapter 2.

may be a reason to classify the entire phrase, if there were some rules which were sensitive to a phrase's being +count or +mass, but not the expression itself.[16] One might wonder whether there could be any syntactic reason for classifying an entire phrase +count or +mass; that is, could there by any syntactic rules which make use of an entire phrase's being so classified, but not on whether an individual expression is so classified? Possibly rules like plural agreement with a verb phrase, but Bunt's grammar does not make use of features such as +mass/+count when applied to entire phrases. Instead the rules are entirely semantic in their effect, forcing a certain (semantic) interpretation on certain combinations.

Ware [1975] proposes an 'occurrence approach' according to which one can sometimes (semantically) determine that a phrase is either a mass or count. His tests have to do with 'what sort of evidence we recognise as being relevant to the truth of falsity of the sentence'. Thus our sentence (1) would be counted false if less than one apple were added to the salad or possibly if three-quarters each of two apples were added.[17] Such a test should make the occurrence of *an apple* in (1) be semantically count. Ware is very wary of this test however. He thinks that (almost?) every occurrence can be taken to be mass or to be count, because there are (normal!) circumstances which classify it each way. And indeed, he claims, for a vast number of circumstances the speakers simply do not have any intentions one way or the other. The main point of his paper is to show that no 'pragmatic approach'—one based on speaker's intentions, beliefs, and desires—will suffice to characterise the distinction. Nonetheless, he believes that there is really a distinction there.

Let us return now to an evaluation of which of the various 'approaches' outlined above seems best to account for the mass/count phenomena. At the outset we should say that we think that a completely-worked-out grammar and semantics (perhaps even a computer program) which used the mass/count dichotomy in any one of the above-mentioned ways would convince us that that was the preferred way to view the dichotomy, so long as it was 'sufficiently elegant' and provided 'insight' into the observed syntactic, semantic, and (perhaps) pragmatic phenomena. However, we are not in that position; rather, we have some grammars and semantics which are incompletely worked out (e.g. [Montague, 1973; Bennett, 1977; ter Meulen, 1980; Chierchia, 1982a; Lønning, 1987; Higginbotham, 1994]) and some proposals which are little more than hints toward a semantic theory (e.g. [Quine, 1960;

[16] Except for semantic reasons having to do with how to translate the sentence in question: but then +count and +mass would not be *syntactic* features. Such features ought to be marked as being part of the semantics of the expression; a syntactic feature is one which determines the syntactic properties of an expression—and that means that they should be used in some syntactic rules.

[17] Ware is quick to point out however that this test is highly context-dependent. In certain contexts, putting in half each from two apples might count as putting in an apple, but putting in half each from three apples would not.

Cartwright, 1965; Cartwright, 1970; Parsons, 1970; Burge, 1972; Moravcsik, 1973; Pelletier, 1974; Laycock, 1975; Link, 1981; Roeper, 1983; Moltmann, 1998; Koslicki, 1999]). The only implemented grammar we know if is [Bunt, 1981], and we do not feel that it satisfies the 'elegance' and 'insight' criteria adequately (see also Lønning [1989]). Thus we hope to be excused for an *a priori* statement of what appears to be the most intuitively satisfying account of the dichotomy.

Short of writing a complete grammar and semantics for all the mass/count phenomena, what evidence can be brought to bear on which of the above 'approaches' we should take? It seems to us that the following evidence is relevant. Later, in discussing various of the specific proposals, we shall marshal further evidence in the form of various classes of sentences; here we merely list and discuss overall features of the language.

1. The various criteria proffered for distinguishing count and mass expressions or occurrences (syntactic criteria, semantic criteria, pragmatic criteria) differ in how they classify.

2. Within the same language, one and the same object can be referred to by means of an (apparent) count expressions or an (apparent) mass expression.

3. (Almost?) every expression which can be used in one of the mass or count ways can be used in the other way.

4. For a great number of occurrences, one cannot tell whether it is being used in a count manner or in a mass manner.

5. Languages differ in what entities are referred to by their (alleged) mass expressions.

6. The role of +count and +mass as syntactic features or classifications is either non-existent or at least very slight.

With respect to (1), that our different criteria classify differently, we might note that syntactic criteria (occurrence with numerals, etc.) make *thing* and *object* be count whereas the semantic criteria (cumulativity and divisiveness) make them be mass. And this is only the tip of the iceberg, for different versions of the semantic criteria will make one and the same expression or occurrence be mass or count. Under some versions of divisiveness, for example, *unicorn* in mass (since every 'part' of a unicorn is a unicorn—there are no parts) whereas under other versions it is count. Similarly, some tables are made of smaller tables; a tree branch can consist of smaller tree branches; some animals live symbiotically; and lumps of coal can be counted but also divided into smaller lumps of coal. Although he was talking about the notion of a sortal expression, [Feldman, 1973] is an excellent source

of counterexamples to the claim that the different criteria amount to the same classification. This seems to indicate that we should choose *one* of the criteria as our touchstone and not try to use a variety in concert. Thus Bunt's [1981, Ch. 2] method of setting up syntactic criteria to separate some mass from some count occurrences and then using a semantic paraphrase relation to find others, would be ruled out.[18] Such a method would be bound to cross-classify expressions.

A part of the problem is that the paraphrase test cannot work if point (2) is correct in holding that the same entity can be referred to in a count or in a mass manner. For, if (2) were true then a paraphrase could go in either direction. But point (2) is true. Consider whether there is really any paraphrase difference between *much more data* and *many more data*, between *much more justification* and *many more justifications*, between *much more groceries* and *many more groceries*, between *too much blues* and *too many blues*, between *lots of kindness* and *many kindnesses*, or between *a lot of difference* and *many differences*. Many times we have different words which refer to the same thing where one is mass and the other count. It seems to us that there is simply no semantic or pragmatic fact which could be used to account for the belief that, in the following list, the former are mass and the latter count. There just is no difference [and no differences] between *change* and *coins*, between *clothing* and *clothes*, between *shit* and *turds*, between *footwear* and *shoes*, between *furniture* and *furnishings*, between *fuzz* and *cops*, or between *gin and orange juice* and *orange blossoms* which could be used.[19] And as further evidence that no account which appeals to 'what the expression is about' can be correct, we might point to the fact that even when two expressions refer to the same material in what (naively) seems the same way, one might be count and the other mass. *Knowledge* is mass, *belief* count; *success* is mass, *failure* count; *fruit* is mass, *vegetable* count; *garlic* is mass, *onion* count; *baklava* is mass, *brownie* count; *spaghetti* is mass, *noodle* count; *flu* is mass, *cold* count; *rice* is mass, *bean* count.

But the cross-pervasiveness of mass and of count goes even further. In [Pelletier, 1975] a 'universal grinder' was proposed: into one end is inserted

[18] Not that he really used it anyway. As we have seen, he takes an 'expression approach' in his actual grammar of Chapter 18. And even in the theoretical discussion of Chapter 2, he is willing to allow the semantic criteria to override his syntactic criteria. For example, he claims that being preceded by "an expression like 'a dozen', 'a gross"' [1981, p. 14] establishes a count occurrence. So in *a dozen eggs* or *a gross of wieners, eggs* and *wieners* are +count. Yet in *a ream of paper, paper* is supposed to be + mass. Similarly, when faced with *I have a great admiration for Bette*, he retracts the natural attribution of +count status to *admiration* on the grounds that is is paraphrasable as *I have much admiration for Bette*, in which he thinks—for whatever reason—*admiration* occurs in a +mass manner.

[19] Differences there are, for instance change seems to be money in coin form (compare *ancient Roman coins* with *?ancient Roman change*); but none seem to be relevant to the count/mass distinction. These examples, and the ones following, are culled from [Ware, 1975] and [McCawley, 1975].

an object of which some count expression is true, and from the other end spews forth the finely-ground matter of which it is composed. So a hat is entered into the grinder and after a few minutes there is hat all over the floor. This is so in spite of the fact that we could have also said that there is felt all over the floor, using an 'ordinary' mass expression. Examples like this show that many count expressions can be seen to already have within them a mass sense or a mass use.[20] Universal objectifiers also come to mind, converting sm finely silted mud into a fine mud (cf. [Pelletier, 1975, p. 6] following Richard Grandy; and [Bunt, 1981, p. 11]). Any stuff for which there are standard portions used for whatever purposes will immediately become countified: *three beers, an ice cream, an entertainment*, etc. To top this off, there seems to always be a count sense (or use) for every (alleged) mass expression M which means *kind of* M.

We now turn our attention to those cases wherein it seems unlikely that either mass or count is even intended by a speaker. Consider the italicised nouns in their uses here[21]

> I want more *eggs*
> Some people like *data* better than *theory*
> While in *prison*, Lee felt at *home* only when he was in (the) *hospital*
> The *water meter* reader hit the *snow* man which held the *tape* recorder
> Lee ran into the *brick* wall while she was sniffing *nose* drops
> Sandy worried about the *justification* for the *difficulty*
> I like *smelt* (*Beethoven*/*candy*/etc.)

We think that one would be hard pressed to find criteria according to which one would want to call any of these italicised expressions either count or mass in these uses. Perhaps the best one can do is look to the communicative intensions of the speaker; perhaps the speaker wants whole, entire eggs, and perhaps that makes *eggs* count. Perhaps the speaker believes that there is some one, particular justification—making *justification* count. Perhaps generally, speakers distinguish individualising (counting) and amassing (measuring). When they individualise, the expression being used is count (regardless of how it may appear to an outsider) and when they amass, the expression used is mass (regardless of how it might otherwise appear). But even this concession to pragmatics seems insufficient, for it is just not true

[20] Similar remarks have been made by [Gleason, 1965, pp. 136–137] and [Sampson, 1975, pp. 546–547]. Various people have also pointed out that certain expressions, such as *hole, number, pore, dilemma, sky, noun*, etc. do not seem susceptible to the grinder. See the discussion in [Pelletier, 1975, pp. 6–7] and [Ware, 1975, p. 19].

[21] These examples are from [Ware, 1975] who gives many other reasons to believe that there may just be nothing, whether in the utterance or in the speaker's mind, to determine whether an occurrence is mass or count.

that we use so-called count expressions when individualising and so-called mass terms when we are not. As Ware [1975, pp. 26–27] puts the point

> ... we can use a count noun for beans without individualising and a mass noun for toast while individualising. When we use 'consideration' and 'difference' as count nouns or as mass nouns there is no reason to believe that we are either counting or measuring. In some contexts it is not appropriate to ask whether we are talking about it as stuff or as things ...
>
> When I ask what the justification was for something, I can be totally devoid of intentions that involve individualising or amassing, and there is no need to answer either in terms of a justification or in terms of justification ... If one Beethoven sonata was played and I say that I liked the Beethoven I don't have to be either using a count noun or a mass noun, or individualising or amassing. That is something that may not be determined by my communication intentions, thus leaving a communicative gap. There can be a communicative gap with respect to mass and count occurrences when I say that I like smelt. I don't have to determine whether it is the stuff or the things.

Along these same lines, both the National Broadcasting Corporation (USA) and the Canadian Broadcasting Corporation news, in reporting [July 11, 1984] on the devastation caused by a tornado in Ohio, used the phrases *count the damage* and *count up the damage* more than once. It seems clear that there are no intentions on the part of the newscasters to be amassing damage and then counting it (them?), nor individuating the damage(s?) and then amassing the sum.

Obviously, if in the same language the same physical reality can be referred to by means of an (alleged) mass and an (alleged) count noun, then one should expect that different languages will use the distinction differently. One expects that some languages will describe some stuff by means of a mass noun whereas another language will do it by means of a count noun.[22] Sharvy has already been seen to state that Chinese has only mass nouns (whereas, ordinarily, we see English as having both); and Whorf claims that Hopi only has count nouns. Even within the same language family, we see that English *dandruff* is normally taken as +mass while French *les pelliules* is +count; English *furniture* is +mass while French *les meubles* is +count; English *dish(es)* is +count while French *la vaisselle* is +mass. We doubt that the French do anything different with their dishes or furniture

[22] Of course, we have also offered evidence that everything can be referred to by either a mass or a count noun even in the same language. But this sometimes calls for non-ordinary measures, such as a universal grinder. Here we just point to ordinary circumstances.

than do the English, nor do we think that they conceive of them differently. Other examples from many different languages and language groups come to mind, but we take the point as having been clearly made by just these few examples.

We wish now to consider whether a grammar for English should have +mass and +count as syntactic categories or syntactic features. This means that we shall look to whether there is any syntactic construction which makes use of such information in combining simpler expressions together to form larger ones. Corresponding to our 'expression approaches' is the view that lexical items are in some way marked +mass or +count, and this information is used to rule in or rule out (as syntactically well formed) some longer expressions.[23] Corresponding to our '(syntactic) occurrence approach' is the view that longer stretches of text, for instance complete noun phrases, can be seen as +count or +mass (but this information is not due to the embedded noun's being count or mass). Here, certain properties of the embedded parts (e.g. a determiner *each*) might force the entire noun phrase to be marked +count, but have no effect on the head noun itself. But, of course, to be a *syntactic* occurrence approach, this information +count must be used in describing syntactic well-formedness of some still larger part—e.g. a sentence.

For these two types of approaches, different evidence is relevant. The expression approach will try to use such evidence as: *man* is +count and therefore *a man, each man, few men* [+plural], etc. are well formed; furthermore $*$*sm man*, $*$*much man*, $*$*an amount of man* are not well formed. The occurrence approach will instead wish to focus on evidence relating an entire noun phrase to the rest of the sentence. They will say that, since *a man* and *the man in the room* are +count, they can be pluralised and this allows for plural agreement with the verb phrase. Since *much water* and *little wine*, etc. are +mass they cannot be pluralised.

Part of the reason for constructing universal grinders and objectifiers, for considering 'kind of' meanings for mass terms, and generally for inspecting a wide range of sentences of the sort that we have considered, is to convince one that there is no point to an expression approach. *Every* noun—even *hole* and *pore*—sometimes occurs in noun phrases which we would intuitively call +mass. And every noun sometimes occurs in noun phrases we would intuitively call +count.[24] It simply seems that there is no construction to be

[23] We do *not* consider those cases where this +mass or +count information is used to choose one or another 'interpretations' of the longer expression. That use of +mass/+count is *semantic*, and then these features would not be syntactic. We are here interested in their usefulness as *syntactic* features, determining whether the longer expression is *syntactically* well-formed.

[24] Try it once again: *He has more book than bookshelf, This site has more hole than building, She's all woman, What a hunk of man, "Donald Macdonald, six feet five inches' worth of Toronto lawyer, ...*" [*MacLean's*, 24 Jan. 1983], *A fine wine is a joy to drink, Prairie artists like to put lots of sky in their pictures, He claims to be caught on the*

ruled out by treating mass/count as features of lexical entries. Doesn't this provide a strong reason for discounting the (syntactic) expression approach, of any variety? Well, perhaps one could argue as follows in its favour. The normal usage of *book, bookshelf, hold, building, woman, man, lawyer, sky, dilemma*, and the like (cf. the last note), have been 'stretched'. This kind of stretched or extended use ought to be distinguished from ordinary use. If we do not make a distinction generally, we will in other cases be forced to deny, say, a noun/verb distinction due to such examples as *The weasel treed the squirrel for the kill, Leslie tricycled down the driveway*, or *Kim doorknobbed Sandy* (Kim is a practical joker who rigs doorknobs to deliver electrical shocks).[25] Rather than concluding that *tricycle* and *doorknob* double as verbs, or even that there *is* no noun/verb distinction but rather only a 'predicate' category, we perhaps ought to say that strictly, or conventionally, *tricycle* and *doorknob* are nouns, not verbs, and that there are rules for 'stretching the lexicon'—lexical extension rules—which enable us to use nouns as verbs unconventionally. In such a view of the lexicon, the lexical extension rules would tell us something bout how to use (and how not to use) the semantic translation (and meaning postulates, and contingent properties) associated with the lexical entry. For example, knowing that *Sandy doorknobbed Kim* and *Leslie tricycled* involve a verb obtained by extension from a noun, tells us that we cannot just translate these as $\mathbf{Doorknob}'(s, k)$ or as $\mathbf{Tricycle}'(l)$, but rather that the 'derived verb' translates as something like 'x does something to y involving a doorknob', etc. Note that this requires that we specify the conventional classification of the term in the lexicon. So, if one wishes to hold on to the syntactic expression approach, the onus is put on the theory to come up with the lexical extension rules which convert mass nouns (in the lexicon) to 'derived' count nouns, and rules which convert lexical count nouns to 'derived' mass nouns. We think that there is some promise in such a view and will investigate it further at the end of this paper. Some of the remarks of Huddleston and Pullum [2002] and Gillon [1992] that we surveyed above also seem to point in this direction. For now we shall continue with the other approaches to mass/count nouns.

Regardless of what one thinks about the dispute over the syntactic expression approach states in the last paragraph, the arguments against it do not tell against the (syntactic) occurrence approach. In the examples the last footnote, such an approach says, we wish to call *more book, bookshelf, hole, building*—taken as entire noun phrases, not just the lexical entries—+mass; and we wish to call *a fine wine* and *a joy to drink* +count. This

horns of a dilemma but I see no horns nor much dilemma in his situation. Given the all-pervasiveness of such constructions, why would one wish to posit that *book, bookshelf, hole, building, woman, man, lawyer, sky, dilemma* are +count; or posit that *wine* and *joy* are +mass?

[25] Cf. [Clark and Clark, 1979].

judgement is not due to the lexical nouns' being so marked, but rather is a function of such subparts as *more, a*, etc.

There is something right and something wrong with this suggestion. What is right is that the interpretation of the entire constructions *more book* and *a book*, or *white wine* and *a fine wine* will be different in 'massisness'. There really is a difference in interpretation—which difference is perhaps called a mass/count difference. What we deny is that it ever plays a role in well-formedness. In the occurrence approach, what restriction does the alleged +mass or +count feature of the noun phrase supply in determining whether any longer stretch of language is well-formed? Two possibilities have been suggested. One is pluralisation and the related claim of verb agreement. The other is as direct object of a verb phrase. But these are spurious. A grammar already has a [NUMBER] feature, necessary for distinguishing singular from plural within so-called +count noun phrases. If the so-called +mass noun phrases are marked as singular, the pluralisation and verb agreement automatically works without recourse to any extra +mass feature. Above we discussed Verkuyl, Hoepelman and ter Meulen, about the interaction of certain verbs and their direct objects. It will be recalled that their claim was that any verb can take a direct object of either +mass or +count, but that the interpretations will be different (yielding a process or an achievement as an interpretation). Thus the feature is *not* necessary as a syntactic marker—it would rule out nothing. Rather it is a *semantic* feature instructing us on how to interpret the result of an interpretation of certain constructions.

We conclude, then, that there is no rule of syntax which can be seen as necessitating features or classifications like +count or +mass. The best that can be said is that one way of looking at such matters as language change by lexical extension might be easier to express with a mass/count expression approach. And the view which is suggested by this would have us assign 'usual' mass/count to the lexical items and attempt to state a variety of lexical extension rules. Any of the syntactic approaches—the various expression approaches and the syntactic occurrence approach—have this difficulty, though: since no syntactic construction is ruled out by their presence or absence, it seems incorrect to call them syntactic. (However, the 'extension' approach suggested above can claim to rule out mass uses of count nouns, such as *There was hat all over the floor*, and count uses of mass terms such as *A fluffy snow fell*, re-admitting them only at a 'semi-grammatical' level though the lexical extension rules).

In this section we have canvassed a number of ways that the mass/count distinction might be drawn, and (some of) the consequences each way has in trying to construct an overall grammar-semantics for a natural language. There are a number of ways we might tabulate the various moves that can be made, some more illuminating than others. Here is one way of tabulating our discussion.

The mass/count distinction might be drawn as a distinction of

1. syntax
   (a) all nouns[26] have the same lexical marking [unitarian expression approaches]
      i. all nouns are +count (first-order logic, Whorf's Hopi)
      ii. all nouns are +mass (Sharvy, Chinese)
   (b) some nouns are +count and others +mass
      i. the 'dual life' nouns are always +count (Bunt, Ch. 18) [unitarian expression approach]
      ii. the 'dual life' ones are always +mass [unitarian expression approach]
      iii. some 'dual life' ones are +count, others are +mass, but each has exactly one representation (Gillon, Huddleston and Pullum) [unitarian expression approach]
      iv. the 'dual life' ones are to be represented twice in the lexicon (Quirk, Quine) [dual expression approach]
   (c) no (lexical nouns are +count or +mass, but only longer noun phrases (Bunt, Ch. 2)[(syntactic) occurrence approach][27]
2. semantics[28]
   (a) +mass and +count distinguish between different senses of a lexical entry (Pelletier [1975], McCawley, Koslicki) [senses approach]
   (b) +mass and +count are not semantic properties of lexical items, but of longer phrases [(semantic) occurrence approach] (Verkuyl, Ware, Pelletier [1974])

[26] We restrict our discussion here to nouns, but this general classification of approaches is wider than that. One could put in here the names of all categories for which one thinks a mass/count distinction appropriate.

[27] We note that under certain theories of grammar, e.g. generalised phrase structure grammar of Gazdar *et al.* [1985], this is not possible. Any head feature (other than 'bar level') of a node is inherited downward by the daughter node which is the 'head'. In the present example, a Noun Phrase marked +mass would have the feature +mass transmitted to the daughter Noun node (by their 'head feature convention'). Perhaps this is just a counter-example to the head feature convention.

[28] Although many of the Group 1 theorists also attribute mass/count to senses of expressions, because they employ these features as well-formedness constraints, we classify them as syntactic expression approaches. For, the entry in the lexicon would be the expression with the count/mass marking of its 'primary sense', and there would be further lexical processes that operate on this expression to give rise to differing count/mass markings.

3. pragmatics—the mass/count distinction is neither a matter of syntactic well-formedness nor a description of the semantic representations (or what they are true of), but rather to be accounted for by the intentions, etc. of the speaker. (What Ware argues against.)

Conclusion to this section: if there were any syntactic rules which used +mass or +count, then this would call either for some expression approach or for a syntactic occurrence approach, and what is (and isn't) mass or count would be dictated by these rules. In this case it seems unlikely that any 'across-the-board unitarian' approach will work, since there are just too many different ways expressions will be converted in syntactically different circumstances; there seems to be no general procedure underlying the conversions. Rather, what's called for is some 'unitarian' approach which appeals to 'normal' usage, and has lexical extension rules of various sorts, as in (1.b.iii). It still might seem unlikely that such an approach will work but it might be given a chance, as we shall do later in this paper. If no unitarian approach works, perhaps we should favour a 'dual expression' approach? No, this would be a pointless proliferation of lexical entries; and if we can avoid it, so much the better. There seems to be little motivation for any of the rules one can think of that might use +mass or +count, except possibly for the formation of noun phrases (or maybe other nouns) from nouns. But even these putative rules do not seem to do any work; nor do the rules which would motivate a syntactic occurrence approach. So we would be left with either a 'senses approach', a 'semantic occurrences approach', or a 'pragmatic approach'. There seems to be no point in having different senses of lexical entries—it leads only to a proliferation of items in the lexicon. And in any case what we are interested in is the *overall* interpretation of the sentences, not in the interpretation of individual words of the sentence (except insofar as they aid in the overall interpretation). But there just is no semantic rule which requires information about the mass or count status of a constituent to compute that information about the entire noun phrase of which it is a part. We take Ware's critique of 'pragmatic approaches' to be decisive—most times there is nothing that the speaker has in mind which would allow us to classify the use of a noun phrase as either +count or +mass. Hence we are left with an occurrence approach which takes entire noun phrases as being the bearers of the properties mass and count, and treats them as semantic properties of that noun phrase without comment on whether they have any semantic correlate in the individual lexical items involved. At the end of this paper we shall consider two theories for mass nouns: a syntactic expression approach which appeals to lexical extension rules and a semantic occurrence approach. These two theories seem to us to be the only viable alternatives to the puzzles about mass terms.

A HISTORY OF PROPOSALS FOR MASS TERMS[29]

Different theorists, focusing on different types of examples, have come to different conclusions as to what the 'semantics' of mass expressions is and what the 'logical form' of sentences containing mass expressions is. In the earliest of these, Quine [1960, pp. 97–98], when considering sentences like

> This puddle is water

says

> We can view the mass term in these contexts as general terms, reading 'is water' ... as 'is a bit of water' ... In general a mass term in predicative position may be viewed as a general term which is true of each portion of the stuff in question, excluding only the parts too small to count.

The reason for the restriction on size is the view that for every mass term (e.g. *water*) there are parts of it (in the ordinary sense of 'part') of which the mass term is not true (e.g. the individual molecules of water). However, when focusing on examples like

> Water is liquid

Quine says (p. 98)

> ... the mass term is much on a par with the singular term of 'Mama is big' ... A mass term used in subject position differs none from such singular terms as 'mama' ..., unless the scattered stuff that it names be denied the status of a single sprawling object.

This proposal has been criticised in a number of writings. Burge [1972] remarks that the proposal is incomplete in that it does not assign a role to *snow* in

> Sandy threw snow on Kim

Burge thinks it natural to assign *snow* here the status of a singular term, but then points out that it would give the wrong truth conditions under the assumption that Sandy did not throw the totality of snow on Kim. Bunt [1981, p. 27] recommends instead that this be treated as a position calling for the predicative interpretation of *snow*.

Pelletier [1974] pointed out that various logical properties of the regimented versions do not correspond to the natural language from which they were derived. For example, letting W be the predicate *is water*, w be the singular term *water*, and p name this puddle, the argument

[29] The discussion of this section generally follows the more detailed critiques of [Pelletier, 1974] and [Bunt, 1981, Chapter 3].

This puddle is water, water is wet, therefore this puddle is wet

would be regimented as

$W(p)$, WET(w), therefore WET(p)

which is invalid. Furthermore, sentences like 'Water is water' and 'Dirty water is water' cannot be shown to be analytic without further specification of a relation between the predicate and the constant. (Roeper [1983] remarks that the simple examples under consideration could have been handled by merely defining syllogistic-like rules of evaluation, since nothing seems to turn on the use of predication. To guarantee that we need something essentially stronger than syllogistic rules, we need to consider multiple quantifiers and relations, as in *Some water is denser than all alcohol*.)

The reason for the difficulties is that 'one must treat mass terms as being either predicates or individual constants but not both, on pain of failing to account for the logical relations binding different sentential occurrences together' [Burge, 1972, p. 267]. (Some difficulties for this claim are raised by [Factor, 1975], who alleges that there are some sentences whose logical form requires both). Of course these difficulties could be gotten around if one added a 'meaning postulate' of the following sort for each mass term (where '$<$' is the mereological 'part of' relation, M is the mass predicate, and m is the corresponding mass singular term).

For all $x, M(x)$ iff $x < m$

but the 'minimal parts' view of mass terms prevents this from being acceptable, for it does not hold from right-to-left. And the other direction is insufficient, by itself, for avoidance of the logical difficulties.

Moravcsik [1973] gives two mereological approaches which attempt to treat all syntactic positions as referring to mereological wholes. The idea behind one of these approaches is (p. 283)

> For any mass term 'F', to say 'x is F' is to say that 'x' is a part of that part of F that has the structural properties SP.

So, F-*sp* is that part of the mereological whole F which happens to have the appropriate structural properties (perhaps having to do with size) relevant to being F. It too is a mereological entity: Water-*sp* would be the restricted mereological whole made up by all water-parts of at least the size of a molecule. To say that something is water would be to say that it is a part of Water-*sp*. The 'puddle puzzle' is then analysed as (*water*, in subject position, retains its role as denoting the entire water totality):

$p <$ Water-*sp*
Water-*sp* $<$ Water
Water $<$ Wet-*sp*
therefore, $p <$ Wet-*sp*

Given the transitivity of '$<$', the argument is valid. However, the proposal does not account for the analyticity of 'Water is water', which would come out

Water $<$ Water-*sp*

which is false under the proposal. Perhaps the thing to do here is eliminate the proposal that subject terms get the unrestricted Water, but rather assign them Water-*sp*.

But this proposal is not well conceived in any case. Suppose we are given that $a <$ water-*sp*, for example that a is a certain mereological entity like a single water molecule. Since it is such an entity, it has parts—atoms, perhaps. Maybe b is one such atom, so $b < a$. but now given the transitivity of '$<$', it follows that $b <$ Water-*sp*, contrary to the intended interpretation. As Bunt [1981, p. 30], from whom this criticism is taken, puts it

> Generally speaking, the notion of a mereological object having as parts *only* those entities that have certain properties *SP* is not a well-defined notion.

Moravcsik's second version of mereology consists in leaving the mass expression denotations untouched—the remain the entire mereological entity—but in putting the *SP*-restrictions into the part-whole relation. For every mass term M, with structural properties $SP(m)$, a part-whole relation $<_{sp(m)}$ is introduced. So sentences like 'a is M' get represented as '$a <_{sp(m)} M$'. Such a proposal perhaps accounts for the analyticity of 'Water is water'

$$W <_{sp(w)} W$$

and perhaps also for the analyticity of 'Dirty water is water' (although this last is far from certain)

$$D \cdot W <_{sp(w)} W$$

where $D \cdot W$ is the 'overlap' of the mereological wholes Dirty and Water. (It is unclear because we do not know whether an overlap will retain the *SP*'s of the wholes.) However, it fails as an attempt to solve the 'puddle puzzle'

$p <_{sp(w)} W$
$W <_{sp(\text{wet})}$ WET
therefore, $p <_{sp(\text{wet})}$ WET

is not a valid argument because there is no uniform '$<$' relation to attribute transitivity to.

Bunt [1979; 1981] endorses a fully mereological account called 'Ensemble Theory' for the interpretation of mass expressions. There are a number of nice details of the overall theory having to do with its integration of mereological entities and set theoretic constructs, but these are perhaps

not germane to the present discussion.[30] Instead we concentrate on the proposals specific to the interpretation of mass expressions.

We have seen that adopting the Quinean 'minimal parts view' (which says that for each mass expression M there is a lower size limit less than which M does not apply, even though there may be *parts* of M-things which are smaller) has led the Moravcsik position to impossibility. How then, one might ask, does Bunt's Ensemble Theory avoid these problems? Quite simply, he denies the minimal parts view. Of course, he does not deny that it is a *scientific* truth that, e.g. water has such a minimal size. But, he says, this is not reflected in our linguistic usage.

> ... mass nouns provide the possibility of talking about things as *if they do not consist of discrete parts*... Since we are dealing with the construction of a linguistic semantic theory, which should only account for *linguistic* facts, ... we take the viewpoint that a linguistic semantic theory should take into account that the use of a mass noun is a way of talking about things as if they were homogeneous masses, i.e. as having some part-whole structure but without singling out any particular parts and without any commitments concerning the existence of minimal parts ... We believe that ... mass nouns are semantically different from count nouns. The difference is not in the structure of the entities that mass nouns and count nouns refer to, but in the way in which they refer to them. (pp. 47–48)

Similar views can be found in various authors, e.g. [ter Meulen, 1980, pp. 67– 68], [Cartwright, 1970], [Cook, 1975], [Lønning, 1987], [Ojeda, 1993], and Higginbotham [1994]. Roeper [1983], Moltmann [1998], and Koslicki [1999] also seem at least sympathetic to the view. but we should ask, is this really true? Is the homogeneous reference principle plausible? Bunt mentions apparent counterexamples

> ... like 'furniture', 'footwear', and 'computing equipment', [about which] it is unlikely that any speaker would really believe that the mass noun refers to something non-discrete.

So it is not true that speakers have no beliefs in the matter. One *might* say that the discovery of water molecules is a 'late development' in language, and so should not be counted as within the domain of semantics. But it seems clear that even in Urlanguage 'furniture' was a mass term of which all users knew there were minimal parts. Mellema [1981, p. 170] insists that these

[30] However, on issues having to do with the completeness of theories which merge set theoretic constructs (that is, sets [or predicates] which contain [or are true of] discrete individuals, or mereological entities with 'atoms') with pure mereology, see [Hendry, 1982]. Some comments are also in [Roeper, 1983].

cases are very rare. It is not clear whether this is true... such a claim surely would call for a large-scale study across languages... and even if it is true, it is not at all clear why it should be relevant. As noted above, Huddleston and Pullum [2002] distinguished two types of 'unbounded reference': one that is truly divisive and for which the homogeneous reference principle holds (words like *water* and *gold*) and another that is aggregate-like (words like *crockery* and *furniture*). So how is this to be accommodated here? The answer is that Bunt constructs a 'multi level semantics' according to which the distinction between the two types of mass expressions is reflected *after* the 'purely' semantic interpretation. In the 'purely' semantic interpretation of sentences, there is no difference—other than which constants to use—between sentences containing *water* and those containing *furniture*; they are both interpreted as having nominal entities. Indeed, the whole issue of what ensemble theory constants have minimal parts and which do not is viewed as not being an issue for 'pure' semantics, but rather for some later stage of interpretation. Apparently this is because such a distinction is viewed as generally being a matter which calls for 'information about the world', and hence is not 'purely' semantic. We have a certain sympathy for this view of 'multi stage' interpretation of sentences—although we would not like to call it all 'semantics'.[31] But we think that this general view of semantics should not interpret mass terms as mereological wholes but rather as predicates (at the level of nouns) and as abstract kinds (at the level of bare noun phrases). We shall later outline such a position.

Other theorists to make use of a mereological theory are [Burge, 1972], Cartwright (at least once, in [1975]), [Cocchiarella, 1976], [Roeper, 1983], [Lønning, 1987] and [Higginbotham, 1994]. Burge takes the denotation of a mass expression, e.g. *gold*, to be the fusion (in the sense of the calculus of individuals) of the set of elements which are gold. A fusion of a set of elements is itself an individual of the same ontological type as the elements themselves were. This is obviously the same as the mereological wholes used in other theories, and gives us another way of defining them in terms of the entities which satisfy some predicate like 'is gold'. In his [1975], Burge argues against a form of a predicative approach to mass terms, which he calls the relational account. Most of his arguments have to do with the fact that on the relational account of mass terms, the basic individuals are stages of objects. In this account, sentences like

This ring is now gold

are represented as

Gold (r, now)

[31] See [Schubert and Pelletier, 1982].

Below we shall discuss [Chierchia, 1982a], which in this respect anyway is a relational account of mass terms; Grandy's [1975] theory is also along these lines. Burge's own theory he calls the C-account because the relationship between the basic objects and mass terms is one of *Constitution*. ([Higginbotham, 1994] follows this also.) The above sentence would be represented as

$$(\exists x)(\text{Gold}(x)\&C(x, r,\ \text{now}).$$

In this paper the favoured account is given as predicational (mass terms are predicates true of certain bits of stuffs), but we presume that it would be merged with the [1972] account of the denotation of mass substance names as fusions. (An approach also followed in [Higginbotham, 1994].) One immediate difficulty with this C-account is in the representation of sentences which are not asserting a relation of constitution, such as

Rice is food.

In [Cartwright, 1975] it is suggested that mass terms like *water* by themselves denote the natural kind or substance water. All other occurrences of mass terms in sentences are to be reduced to this kind by means of a translation using an amount function on the quantities of the substance. So predicative mass term occurrences use an amount function which takes sets of quantities into a set of linearly ordered 'applied amounts'. As in Moravcsik, the basic unit of the measurement of the amount is dependent on the structural properties of the substance in question. This account of the denotation of mass expressions is criticised by ter Meulen [1980, pp. 52–53] on the grounds that it confuses 'which item is constituted by what' and 'what item has an amount'. But many of the details of Cartwright's account are adopted by ter Meulen (in [1980, Ch. 3]).

Cocchiarella [1976, p. 212] analyses mass terms in their occurrences that designate natural kinds of stuff as mereological sums, which, as in [Burge, 1972] are 'derived' from predicative mass expressions. A similar approach is taken in [Higginbotham, 1994], for which see below. These nominalised predicates (except when occurring in identity statements) refer to some object or thing correlated with the concept of properties designated by these same predicates in a predicative position. So Cocchiarella distinguishes individuals that are 'concept-correlates' from individuals that are ordinary objects. In his [1978] he gives a formal account of how the logical syntax of such a second-order system goes. Cocchiarella allows nominalised mass terms to denote individuals that can be values of free variables, but they cannot be values of bound variables, and hence cannot be quantities of the same substance they designate. So although the substance *water* is an individual just as quantities of water are, only the quantities can have *is water* predicated of them; the concept-correlate—that which is designated by the nominalised predicate *water*—cannot. So we have here another version

of Quine's 'dual approach', only now we can explicitly define the singular term occurrences by means of the predicative occurrences. ter Meulen [1980, p. 55] mentions that the mereological interpretation of the nominalised predicates is not essential to the proposal, and for her own part has it denote something quite different. Both of these authors, Cocchiarella and ter Meulen, believe that far from being analytic, such sentences as

Water is water

are not even well formed, since a concept-correlate (the denotation of a nominalised predicate) cannot be in the extension of itself taken as a predicate.[32] We disagree with this judgement, and our own theory will count it as analytic. (See below.)

Parsons [1970] offers a view according to which every occurrence of a mass noun is taken as a name. But it is different from the mereological approaches in that it does not make use of any of the apparatus from the calculus of individuals. Rather these are taken as names within an (almost) ordinary first order logic. Thus, for example, g names 'the substance Gold, which is to be taken in the chemist's sense, to stand for the *material*'. In addition to the ontological realm of substances, there are two other realms: physical objects and bits of matter. Objects are related to substances by being *constituted* by the substance; so

My ring is gold

becomes

$$rCg$$

where C is that relation between objects and substances which is true just in case the matter of the object is a *quantity* of the substance. The relation Q, being a quantity of, holds between bits of matter and the substance that they are a quantity of. By analogy to the well-known lambda-abstraction and set-abstraction operators, Parsons introduces a substance abstraction operator μ, which is designed to obtain the substance by abstraction over the quantities of the substance. The formula $\mu x[xQg]$ denotes the substance whose quantities are all quantities of g (Gold); alternatively one could have denoted this substance merely by g. So the above example could have been expressed

$$rC\mu x[xQg].$$

[32] Of course in such a sentence it is open to them to claim that we have an identity. This would then seem to leave them open to the charge that they cannot account for the (alleged) analyticity of *Dirty water is water*. But the charge is not necessarily well taken, for first *dirty water* may not be a nominalised predicate of the right sort, and second they may claim that in such a sentence we are *not* asserting a nominalised predicate to be in its own extension (*dirty water* and *water* are, after all, different expressions). It is only if these do not hold in their systems that they would have to fall back on denying that it is well formed. (We presume that ter Meulen would take the first way: *dirty*, when applied to *water*, does not yield a nominalised predicate.)

In fact, Parsons allows for substance-abstraction over any complex predicate, so that complex mass terms like *dirty water* are represented as $\mu x[xQw\&Dx]$. So Parsons' language contains a primitive name for the substance, a primitive relation of being a quantity of a substance, a primitive substance abstraction operator which forms individuals from sets of quantities of stuff, and a primitive relation of being constituted holding between physical objects and substances. Some theorists have objected to this ontological wealth (e.g. [Burge, 1972; Moravcsik, 1973; Pelletier, 1974; ter Meulen, 1980; Bunt, 1981], and Parsons has provided a defence in [1975]. Other objections that have been made to Parsons' theory include the objection that not all relations of physical objects to substances can be analysed as 'being constituted of', e.g.

Hamburgers are food
This armchair is the furniture in this room

(From [ter Meulen, 1980, p. 58].) Hamburgers are constituted of all kinds of ingredients, but they are not constituted by food. Various relations hold between objects and sets of quantities (or substances) other than just the C-relation. And various relations can obtain between an object and bits of matter. In a Parsons-style approach we would need a new primitive relation for each one of these relations. ter Meulen [1980, p. 58–60] brings up other considerations against Parsons, such as the fact that the μ operator makes substances out of any sets of quantities of stuff, so that Muddy Water would be a substance, as would Leaded Tin That Has Been Annealed, and so on. But, she says, if substances are abstract individuals they cannot be muddy. (Cf. [Moravcsik, 1973; Pelletier, 1974].) Further, ter Meulen claims that some mass term occurrences are 'rigid designators', but Parsons has no method of distinguishing amongst those that are (such as $\mu x[xQg]$) and those that are not (such as $\mu x[xQw\&Mx]$).

It must be admitted, however, that Parsons' proposal gives satisfying solution to the 'logical form' difficulties we mentioned earlier. The 'puddle puzzle' becomes

$$(\forall x)[xQw \rightarrow \mathrm{WET}(x)]$$
$$pQw$$
$$\text{therefore, } \mathrm{WET}(p)$$

which is valid. And the puzzles about the analyticity of *Water is water* and *Dirty water is water* are eliminated, since they are translated respectively as the analytic

$$(\forall x)[xQw \rightarrow xQw]$$
$$(\forall x)[(xQw\&Dx) \rightarrow xQw]$$

(We shall later mention some other sentences and arguments for which Parsons' method does not work so well.)

One problem with Parsons' approach which deserves to be mentioned here has to do with the interpretation of Q. Parsons claims [1970, p. 366n] 'what "parts" of x are quantities of x depends on x, and not some abstract notion of "part" '. He says this because he is aware of Quine's objections to analysing the copula as *is a part of*—that is, Parsons wishes to uphold the view that there are 'minimal parts' of any substance. The Q relation, therefore, behaves either like Moravcsik's $<_{sp}$ relation or else the substances themselves have to be interpreted like Moravcsik's *SP*-wholes. In either case, as we have seen, the proposal does not seem logically coherent. (Cf. the remarks in [Pelletier, 1974, p. 10] and [Bunt, 1981, p. 36]).[33]

In this article Parsons introduced an argument which has been cited as showing that no mereological approach can be correct (e.g. by Pelletier [1974; 1979a]). Suppose all the furniture in the world is made of wood, and all the wood has been made into furniture. Then, in a mereological theory we would have

$$\text{Wood} = \text{Furniture}$$

and, since identity of wholes is defined as containing all the same parts, we would have

$$(\forall x)(x < \text{ Wood iff } x < \text{ Furniture}).$$

But this is false, even in the imagined circumstances. The leg of this chair is wood but is not furniture. The reason for this is that they have different minimal parts.[34] This argument is closely related to the points made against Moravcsik's conception of mereological wholes as being restricted in some way and against the possibility of having differing part-whole relations relevant to different mass expressions. Of course if one denies that there are minimal parts of any mass noun, this argument will not seem to carry much force (e.g. [Bunt, 1981, pp. 48–50]); but, we feel, it *should* be bothersome. Any proposal which flies in the face of the 'primary semantic data' (here: claiming that the leg of the chair *is* furniture) like this should be adopted only after deep and careful analyses of the alternatives show them to be even more wanting. Indeed, there is another class of problems with the notion that mass noun phrases like *furniture* or *water* denote mereological wholes. If, for instance, one takes a subject occurrence of *water* as denoting all the water in the world, there will be a 'paraphrase' problem, since presumably *all the water in the world* also denotes this entity. But *All the water in the world weighs billions of tons* is intelligible and true, yet $*$*Water weighs billions of tons* seems semantically odd. This example, along with

[33] One might also wonder whether the notion of substance abstraction is coherent: might one not get into Russell-like difficulties of the form 'the substance of all whose quantities are not quantities of themselves'? Or perhaps 'the substance of all whose quantities are substances'?

[34] A similar argument can be found in [Sharvy, 1975] where it is put in terms of predicates with different extensions having identical mereological fusions.

Parsons' furniture–wood case, and sentences like *Element 130 is identical with element 131* and *Atoms of element 130 are identical with atoms of element 131* (said of physically possible but unrealised elements—so *element 130* and *element 131* denote the empty totality, and have the same parts namely the empty part), strongly suggest that the denotations of bare *NP*s are intensional.[35]

Another argument against interpreting mass terms as mereological wholes, at least those wholes that are generated by quantities of the stuff, has been put forward independently by Roeper [1983] and Lønning [1987]. As the point is put in Roeper (p. 254), 'While it is true that all phosphorus is red or black, it is not true of every part of the quantity phosphorus that it is red or black.' Some parts of the mereological whole, Phosphorus, are quantities containing both red and black phosphorus, and so it is not true that they are red phosphorus or black phosphorus. Contrast this with an analogous count case: 'All sheep are white or brown.' Were we to find a sheep that is both white and brown, this would falsify the claim; however, the fact that there is a quantity (indeed, a very large number of them) of phosphorus which is both red and black does *not* falsify the claim about phosphorus. Therefore, the quantification is not over quantities, and therefore the designation of the mass term is not the mereological whole generated by quantities of phosphorus. (Lønning gives similar examples involving negation). Instead of proceeding in this manner, Roeper has "mass quantifier NPs" be interpreted as complete Boolean algebras where the mass terms denote elements of this algebra. Lønning too employs Boolean algebras in the interpretation of quantified mass NPs, while giving an explicit (Montaguesque) grammar and being an early employer of generalized quantifiers. Although there are various differences in scope between Roeper's and Lønning's accounts—for example, Roeper's allows for relations between quantified mass NPs (*All water is denser than some alcohol*) and Lønning's contains the quantifiers *most*, *much*, *little*, and measures like *one kilo of* and *less than two kilos of*, but the reverses are not the case—Lønning [1987, pp. 46–47] shows how their formalisms can be mutually interpreted into the other. (This mutual interpretability is foreshadowed by Roeper's remarks at [1983, p. 257]).

Higginbotham's [1994] view is similar to Lønning's in many ways, starting from the thought that one can cast the semantics of mass predication in terms of the *part-of* relation. Even though mass nouns like *water* and mass VPs like *is wet* 'begin their lives as predicates' (with extensions defined as truth sets in the usual way), one can employ the Boolean algebra over

[35]The objections we have listed to the interpretation of mass noun phrases as mereological wholes do not preclude other possible roles for mereology in a theory of mass expressions; e.g. mereology may still be the right tool to account for cumulativity and divisiveness (to the extent that these hold for the referents of predicative mass expressions), or the right basis for an account of measure phrases (see [Bunt, 1981; Cartwright, 1975; Roeper, 1983; Lønning, 1987; Higginbotham, 1994; Moltmann, 1998]).

the quantities of the stuff to form supremums. Then, as in Lønning, the supremum of all things that are M (for a mass predicate M) is regarded as the 'nominalization' of the predicate. And we can say $P(M)$ is true (for M a mass term and P a mass predicate) just in case the denotation of M is an element of the nominalization of P. (This is an alternative to saying: just in case the denotation of M is an element of the denotation of P). E.g., *Water is wet* is true since the totality of all water is part of the totality of all wet stuff (as well as being in the extension of the predicate *wet*). Two related points at which Higginbotham differs from Lønning, and from the theory we present below, are, first, in his claim that 'measures of amount' are *not* quantities, and second, in his denying that 'This ring is gold' is simply true. In the latter case, he instead wishes to paraphrase such sentences in accordance with the 'constitution' theory as elliptical for 'The stuff constituting this ring is gold' [Higginbotham 1994, p. 452, esp. fn. 2]. We have already mentioned a number of examples where this interpretation does not seem right:

This sofa is furniture
This hamburger is food

and the like are all perfectly fine, and yet

? This sofa is constituted of furniture
? This hamburger is constituted of furniture

are bad. Furthermore, it seems incorrect for the 'minimal parts' of any mass term, to which the mass term applies directly without the paraphrase. While

This snowflake is snow
This crystal is salt
This fork is cutlery
This molecule is water

all seem fine,

? This snowflake is constituted of snow
? This crystal is constituted of salt
? This fork is constituted of cutlery
? This molecule is constituted of water

all are bad.

Another problem with Higginbotham's analysis concerns his interpretation of bare singulars as 'nominalizations'. Our view (as given below) is that they are generic and admit of exceptions. Thus we would view *Water is wet* as admitting of exceptions, while Higginbotham dismisses 'the usual (ill-understood) ... exceptional cases' in a footnote [1994, p. 450, fn. 1].

Although it might be true that it is more difficult to find mass analogues of the striking generic examples such as *Dogs bear live young* and *Italians are good skiers*, surely the following admit exceptions, despite their being true

> Garbage is smelly (not inorganic garbage, not all *parts* of garbage)
> Water is drinkable/nearly tasteless (not seawater)
> Glass is fragile (not unbreakable glass)
> Space-within-150km-of-Earth teems with satellites and debris
> (large portions of it are empty)
> Money is legal tender (not outdated money)
> Coffee is stimulating (not decaffeinated coffee)

Despite these apparent shortcomings we find much to agree with in Higginbotham's analysis, and think that it is not so very different from the account that we will offer below. A nice exercise would be to find the exact points of differentiation.

There have been a number of attempts to invoke sets of one variety or another as the interpretation of mass nouns.[36] In [Strawson, 1959], in Quine's 1964 review of [Geach, 1962], and in Clarke [1970] there are suggestions that uses of mass terms should be understood as elliptical for some more complex phrase in which there is an explicit 'individuating standard' (or count phrase) by means of which we can give sense to there being a certain *number* of things for which the mass term is true. Thus, *is water* might, in certain circumstances, be elliptical for *is a body of water* or, in other circumstances, for *is a kind of water; is gold* might be short for *is a vein of gold* or *is a nugget of gold*. Such a position avoids the Parsons anti-mereological argument by pointing out that there are 'individuating standards' applicable to wood which are not applicable to furniture; e.g. the set of pieces of wood is distinct from the set of pieces of furniture, and so *wood* and *furniture* do not denote the same sets. Such a view has been elucidated an criticised in [Cartwright, 1965].[37] A few of the difficulties are that first, some sentences will not receive a representation; second that the representation of some sentences will not have the right truth value; and third that the appeal to varying 'standards' prevents us having a *uniform* translation procedure. As for the first, consider

[36] This is to be distinguishes from the use of predicates as the interpretation of mass expressions. The latter are to be understood as *properties*, which are the kind of thing that admit of an intensional interpretation (at least in some contexts). However, in extensional contexts, the interpretation of predicates may well be a set. Thus some authors (e.g. [Pelletier, 1974, pp. 106–107], [Bunt, 1981, p. 36]) often treat them together. But it should be noted that various of the logical properties of an intensional interpretation cannot be mirrored in a set-theoretic interpretation—namely, those properties which have to do with intensional contexts, such as 'natural kinds', 'rigid designators', and perhaps even (as we shall investigate) the feature of being alternately viewed as a predicate proper and as a (complex) singular term. For this reason we treat them separately here.

[37] See also [Pelletier, 1974, pp. 92– 94] and [Bunt, 1981, pp. 39–40].

What Kim spilled is the same coffee as Sandy wiped up.

Since this is an identity claim, the same 'individuating standard' must be relevant to both sides. But what could it be? It cannot be 'puddle of coffee' for that cannot be spilled. It cannot be 'cup of coffee' for that is not the kind of thing to wipe up. As for the second, consider sentences like

The sugar here is the same sugar as that which was on the boat

(said after the sugar which was on the boat was melted before it got here). The extension of 'this sugar here' contains no lumps, grains, etc., so there is no longer a set of these things (which there was on the boat). Thus the purported set equality fails, yet the English sentence may very well be true. For the third objection, we merely note that in a given particular case we may have no way to tell which of the various 'individuating standards' that are true is applicable. For instance, sameness of shipment of sugar is often sameness of grains and of lumps of sugar. How do we know which one to use? We finally note that statements of constitution will not receive a representation. For instance, in

This shipment is constituted by the grains of sugar

it does not seem that any 'individuating standard' is applicable. Rather it looks as if we need a use of *is sugar* that does not depend on the individuating standards of 'lump', 'shipment', or 'grain'.

It seems therefore hat we should not call into play context dependent 'individuating standards'. If one wishes to call sets into play at all, what is required is the same set for all occurrences of the mass term. One plan, used by [Laycock, 1972] and [Bacon, 1973], is to let the mass term denote the set which contains all and only the *smallest* (minimal) elements of which the mass term is true.[38] One should note that this proposal also avoids the Parsons argument: the set of minimal wood pieces is distinct from the set of minimal furniture pieces. Nonetheless, the proposal has not seemed very attractive. It first seems to involve various 'empirical' hypotheses into the meaning of mass terms (e.g. that part of the meaning of *water* is that it comes in molecules of H_2O). Secondly, it seems that it is often impossible to actually determine a set of minimal elements, even for 'normal' mass terms, such as *garbage*. And thirdly, if we are to include abstract mass nouns like *speed, information*, and *time*, we shall have to invent a whole host of new 'minimal elements'.[39]

[38] Laycock has changed his mind on this. In his [1975] he outlines a theory wherein the use of a mass noun in applying to [undifferentiated] matter is prior to *any* use of it as being true of objects, whether by a singular or plural count noun (cf. his [1975, p. 118 n. 8]). The attribution of the theory to Bacon is somewhat more shakey.

[39] These criticisms and others can be found in [Pelletier, 1974, pp. 94–95] and [Bunt, 1981, p. 40].

Another proposal which assigns a set uniformly to all occurrences of a mass noun can be found in Cartwright [1965; 1970] and Grandy [1973]. In this account, the mass noun M denotes the set of *all* quantities of M. It is also similar to the proposals of [Montague, 1973; Pelletier, 1974; Bennett, 1977] and [ter Meulen, 1980] wherein a mass term denotes the function from indices (possible worlds) to such sets. Such an approach obviously does not suffer from the defects of the 'varying standards' approach nor, apparently, from the defects of the 'minimal elements' approach. But there do seem to be some problems with it (ignoring those problems having to do with its lack of an intensional component). In [Pelletier, 1974, pp. 96–98] various details of Cartwright's view are criticised. First, we should note that Cartwright distinguishes an *amount* from a *quantity*. We could have the same amount of water but not have the same quantities of water; non-identical quantities may be the same amount, and to bring this out Cartwright adopts the terminology of saying that a quantity *contains* a certain amount of it (rather than it *is* that amount). It is also important to mention that Cartwright's notion of the amount contained in a quantity is *not* dependent upon a choice of measure, nor upon the conditions of measurement. Cartwright then attempts to show that there is a 'strong analogy' between a *set* of ordinary objects and a *quantity* of some stuff. As she puts the analogy [1970, p. 29]

> D1: x is a set of A if and only if, for some y, x and y are comparable with respect to the number of A each contains, and x contains nothing other than A...
>
> D2: x is a quantity of B if and only if, for some y, x and y are comparable with respect to the amount of B each contains, and x contains nothing other than B.

The point of this analogy is to show that, just as we understand quantification in the 'set' case by understanding that 'x is a person' is true if and only if x denotes a member of the set denoted by 'person', so too can we understand quantification in the 'mass case' if we can understand what are the permissible values of x in 'x is *sm* water'. But the analogy goes wrong in its details. In the 'set' case, one assigns something *contained* in the set to x. In her [1965, p. 485] Cartwright claims that the values of x in 'x is *sm* water' are quantities of water. But by the above analogy this would be like claiming hat it is *sets* of men which satisfy 'x is a man'. In her [1970, p. 39] Cartwright claims that it is what is contained in a quantity of water which satisfies 'x is *sm* water'. But by the analogy, what is contained in a quantity of water is an amount of water; and *that* is not what we want to quantify over. (Cartwright had already said this in her [1965]). Further every quantity contains exactly one amount, yet sets contain many elements. So one is not quantifying over the quantities, for that corresponds to the

set and one is not quantifying over the amounts, for that corresponds to the number (measure) of the set. What is it that corresponds to elements of a set?

Roeper [1983] and Lønning [1987] argue that no account that tries to use some "surrogate count term" (such as *quantity of*) will work with complex mass terms nor with quantifiers other than *all* and *some*. The sentence 'All phosphorus is red or black' is true yet would be false if it were understood as 'All quantities of phosphorus are red or black' because some quantities will contain quantities of red and of black phosphorus. 'Most water is not potable' falters when it is understood as 'Most quantities of water are not potable' because the notion of 'most' is not well-defined. Koslicki [1999] too objects to such "reference dividing relations" as *is a quantity of* on the grounds that the notion is question-begging.

Laycock [1972; 1975] offers more 'philosophical' arguments against the utility and coherence of the notions of quantity and amount as employed by Cartwright. In turn, the notions are defended against Laycock's attack by Cook [1975]. Bunt [1980, pp. 41–43] offers this attack against Cartwright, which he apparently also thinks applies to all the authors mentioned in this part.[40] Consider, says Bunt, a noun phrase like

> The gold on the table.

There are two ways of understanding the present proposal concerning amounts and quantities, corresponding to

> The thing which is gold and is on the table
> $(\imath x)[x \in G \& \mathrm{On}(x, t)]$

or as

> The things which are gold and are on the table
> $\{x : x \in G \& \mathrm{On}(x, t)\}$

The first alternative is incorrect since if there is *sm* gold on the table, it is generally wrong that there is exactly one quantity of gold on the table. Furthermore, since one can quantify this noun phrase, it seems incorrect to treat it as if it were a definite description

> All the gold on the table.

But if the noun phrase is taken in the second way, then there are difficulties with measurement because we shall be 'counting the same quantity may times'. Consider sentences like

[40] It is most unclear that it really applies against any of the intensional accounts, although it seems to work against Grandy's [1973] account. It is for this reason (amongst others) that [Grandy, 1975] rejects the [1973] account as inadequate.

The gold on the table weighs 2 grams.

Under this proposal we are to sum the weights of the quantities of gold on the table and have it result in 2 grams. Bunt gives this formula as a possible representation

$$\begin{aligned}&\mathrm{Sum}(\{y|(\exists z)(z \in \{x : x \in G \& \mathrm{On}(x,t)\} \&\\ &\quad \& \; y = \mathrm{Weight}(z)\} = 2\mathrm{g}.\end{aligned}$$

Certainly this representation is incorrect since the set $\{x : x \in G \& \mathrm{On}(x,t)\}$ contains may overlapping elements whose weight will be counted many times. Obviously we wish to first sum the elements and then take their (its) weight. These considerations once again appear to lead to mereology as opposed to a set-theoretic approach; for, on the one hand we must be able to refer to the many quantities that go into one physical object, but on the other hand we must be able to refer to them as a group in a way that does not involve the same quantity being in two distinct quantities (or else we shall not be able to discuss such properties as the weight of a quantity).

The final proposal we shall consider is that mass nouns should be analysed as predicates. Recall that we have distinguished this proposal from the one where mass terms are taken to denote sets; in this latter proposal a mass expression is interpreted extensionally, whereas in the former proposal a mass expression is interpreted as denoting a function from points of reference (perhaps to sets). The difference between the two is not merely a matter of what happens in intensional contexts,[41] but also involves the possibility of stating an intuitively plausible relationship between occurrences of mass expressions that appear to characterise things ('predicative mass expressions', as in *This ring is gold*) and those occurrences which seem to name something ('nominal mass terms', as in *Water is wet*). As representatives of this group we might consider [Cocchiarella, 1976; Montague, 1973; Pelletier, 1974; Bennett, 1977; ter Meulen, 1980; Carlson, 1977; Chierchia, 1982a; Lønning, 1987; Higginbotham, 1994; Moltmann, 1998; Koslicki, 1999].

We have already had occasion to mention Cocchiarella and his view that the nominal mass expressions name a mereological entity. One can explain his overall theory as follows:[42] A predicative mass expression denotes a function on possible worlds which picks out a set in each possible world. Nominal mass expressions are systematically related to these predicative mass expressions in that they denote a function on possible worlds which in each possible world picks out the mereological fusion of the set picked out in that world by the predicative mass expression. (Such a view is

[41] Nor in related areas such as the representation of natural kind expressions, counterfactuals, and natural kinds as rigid designators.

[42] Actually his theory is stated in a rather idiosyncratic formalism. We here 'translate' it into the intensional logic idiom.

obviously closely related to that of Burge [1972; 1975]—with the exception of the intensional aspect of it). Since we have already argued against the mereological-sum (-fusion, -whole) interpretation of nominal mass expressions, we shall not discuss Cocchiarella further.

Montague [1973] presented an outline of a theory of mass nouns in the general framework of Montague Grammar which, however, (as he puts it, p. 173) 'is not within the elaborately inflated framework of [Montague, 1973a]'. In this account 'a mass term will denote that function on possible worlds which takes as its value for a given world the set of all samples (or, to give synonyms, portions or quantities (in the sense ascribed to Parsons) or "parts with the correct structural properties") of the substance in question in that world'. So goes Montague's account for occurrences 'standing alone in normal substantive positions', that is, in such positions as *portion of* α and α *is a liquid*. To account for other contexts, Montague remarks that standing alone in predicative position it should be synonymous with *portion of* α; that with a quantifier, a demonstrative, or an adjective phrase the mass noun should there denote the extension of the property usually denoted; and that as an adjective (e.g. *iron bed*) it denotes the extension of the property usually denoted by the mass term. Montague (pp. 174–175) also proposes to treat phrases as *the gold in my ring* as being synonymous with *the gold constituting my ring*. Here *constituting* is taken to denote the set of maximal portions of gold in the ring, and hence the *the* is proper: it denotes a unit set. In this account, *Water is liquid* would be elliptical for *all water is liquid* and hence quite different from *Water is a liquid*. In Montague's account, as opposed to Parsons', quantities or portions of water (say), are taken to be ordinary individuals but the mass noun *water* denotes (at a given possible world) the set of these individuals. In Parsons' account the mass noun also denotes an individual, a *substance*, and there is a primitive (intensional) relation of *being a quantity of*. Montague took a virtue of his analysis to be that he had given an analysis of substances in terms of their (possible) quantities, and thereby had given analysis of *being a quantity of*.

Bennett [1977] develops an account also within the 'Montague Grammar' framework, but his account diverges from Montague's in that, for him, mass terms are not regarded as denoting properties of individuals. In fact he regards mass terms as Parsons does—as denoting individuals, by making *substances* be 'ordinary individuals'. He then follows Parsons in introducing an intensional relation *being a quantity of*, that tells us the quantities of any substance at a point of reference. The difference here between Bennett and Parsons is that, unlike Parsons, who uses his substance abstraction operator to yield substance names from any open formula. Bennett allows only simple mass nouns to denote substances.

A little terminology here will help, not only to understand Bennett's proposal, but also below in the discussion of ter Meulen. Bennett uses the terminology 'count noun (phrase)', CN, as a syntactic classification of

such phrases as *man, tall man, man who is a spy*; and by analogy uses 'mass noun (phrase)', MN, as syntactic classification of such phrases as *water, blue water, water that is pure*. These are to be distinguished from (the syntactic category) 'terms'. Terms also come in two types: 'count terms', CT, are such phrases as *John, a man, every man*; 'mass terms', MT, are such phrases as *water, little water, all water*. CNs and MNs semantically denote sets of individuals. Montague (whom Bennett follows here) gives all CTs the same sort of denotation, so that *John* and *every man* could be regarded as being in the same semantic category. Bennett would do the same with all the MTs although in his [1977] he wants to 'forget Montague's complications'. MNs are the sort of expression that can be modified by adjectives and relative clauses, while MTs are the sort of expression that, when combined with a verb phrase can form a sentence. In Bennett's account, the basic MTs (such as *water* and *gold*) denote substances. From these basic MTs, one can form a sentence when they are combined with a verb phrase of the right sort. Thus, for example, we can form

Water is a liquid.

But there is also a syntactic rule which converts the MT *water* into a count noun phrase (CN) by combining it with *quantity of*. After having formed the count expression *quantity of water*, one can perform ordinary quantification over it to form a term. For example, *All water flows* gets translated as

$$(\forall x)[(\mathbf{quantity\text{-}of}'(\lambda \mathbf{P}\mathbf{P}(\mathbf{water}')))(x) \rightarrow \mathbf{flow}'(x)].$$

This view is obviously very close to Parsons', the only difference having to do with the absence of the substance abstraction operator (and the consequent inability to have complex substance names.) *Blue water is a liquid* would be ill-formed, since *blue*, when it combines with *water*, forms a MN rather than a MT and so cannot be the subject of this sentence; *is a liquid* is taken here as a property of substances, *is liquid* is a property of quantities, so *Blue water is liquid* is well-formed in this grammar. What, then about such sentences as *Water is liquid*? In brief, Bennett's answer is that these are elliptical for *All water is liquid*, where as usual *all water* is analysed as above in terms of quantities.

In spite of this slight difference between Bennett and Parsons, it seems that there are enough similarities that various of the objections to Parsons' account will also apply to Bennett's, in particular those objections having to do with the understanding of basic mass terms as denoting abstract substances. ter Meulen [1980, pp. 61–63] mentions three further objections to Bennett's account. We ourselves are less than taken by these arguments, but mention them here to lead us into ter Meulen's account.[43] First, the

[43] Later we will exhibit various classes of sentences that Bennett's (and ter Meulen's) accounts do not handle.

relation of being a quantity of does not always correspond to an element in a syntactic derivation of the sentence. Thus, *This ring is gold* does not contain *quantity of*, although in Bennett's translation the relation does occur. This, says ter Meulen, goes against a fundamental tenet of Montague Grammar. She herself claims that the sentence should be translated in such a way that it is logically equivalent (given a meaning postulate which says that every entity in the denotation of a predicative mass term necessarily has the property of being a quantity of some substance) to *This ring is a quantity of gold*, but not identical. According to ter Meulen, a consequence of taking the substance to be a first-order individual is that there is no way to distinguish between substances and their quantities—they all can have the same properties. Especially, she says, the substance m and the quantities of m can all have the property of *being* m—a feature which ter Meulen finds 'contradictory and hence undesirable'. Finally, ter Meulen criticises the 'nominalistic outlook' of Bennett's theory (presumably the fact that a substance is a first-order object) as being 'absolutely alien to the ontological wealth of Montague Grammar'.

ter Meulen's theory ([1980], see also her [1981]), is actually quite similar to Bennett's, the major differences being the ones just noted. A crucial feature of her account is the existence of two distinct syntactic categories of basic terms: nominal mass nouns and predicative mass nouns. These basic expressions are such as *gold, water, gas, furniture* and *food*. All these basic lexical entries are given twice: once as nominal (NMNs) and once as predicative (PMNs). The idea is that any of these simple mass nouns might be used to indicate a substance (by using it as a nominal mass noun and converting it to a nominal mass term—recall Bennett's use of 'term'). In this use it can be the subject of a sentence where one predicates a rather special property of it—the type of property which holds of substances, such as *is a liquid, is an element, has atomic number n*. On the other hand these simple mass nouns might be used to say something about the quantities of the substance, as in *Water is wet*. In this case the PMN *water* is converted to a predicative mass terms, which is translated as $\lambda P[\mathbf{water}'(\hat{}P)]$ which is supposed to reduce, by a meaning postulate to $\lambda P(Ax)[\mathbf{water}'(x) \rightarrow P(x)]$.[44] So, in ter Meulen's account, nominal mass terms and predicative mass terms form distinct syntactic categories and cannot be viewed as deriving one from the other. This is, she says (e.g. [1980, pp. 6, 193]; [1981, p. 105]), the most fundamental innovation in her system. A number of important observa-

[44] In fact we think ter Meulen's rules do not generate either of these sentences. As for the first, which she uses as an example [1980, pp. 183–184], her rule S10 will not operate on the top level unless the 'second order terms' are a subset of the terms (which is not stated). Presumably she wishes to use S11 here, but this requires *is an element* to be a second order intrasitive verb phrase. There are no basic such phrases and none of her rules generates one. As for the second sentence, similar remarks hold: unless predicative mass terms are terms S10 does not apply. Finally, as she points out, the closest sentence to the second sentence that her rules analyse is *water is a* [are?] *wet entity*[ies].

tions have been made by her in support of this distinction. Four of these observations are: (a) terms constructed from nominal mass nouns exhibit backwards pronominalisation behaviour similar to that of proper names, (b) nominal mass terms bind only pronouns that are interpreted as denoting the substance, whereas predicative mass terms bind only pronouns that are interpreted as denoting a set of quantities, (c) nominal mass terms semantically behave like rigid designators, unlike predicative mass terms, and (d) nominal mass terms take wide scope over other terms and intensional operators whereas predicative mass terms take narrow scope over quantifiers and intentional operators. As for the first: in the sentence

The man she loves betrays Sarah

it is possible to interpret *she* as anaphoric to *Sarah*. However, when a general term, e.g. *some women*, is substituted for *Sarah*, the resulting sentence is impossible to read with an anaphoric *they*:

The men they love betray some women.

This behaviour is mirrored by mass terms:

Its chemical formula defines water

allows for an anaphoric relation between *its* and *water*, but

The person who finds it sells some gold

does not allow for *it* to be anaphoric with *some gold*. As for (b): consider sentences like *Water is* H_2O and *Water is muddy*. Intuitively in the former reference is made to a kind, whereas in the latter reference is made to quantities of water. To prove that such an interpretation is correct, ter Meulen considers sentences like

Water is H_2O and it is muddy
Water is muddy and it is H_2O.

Both of these sentences are deviant, she says, because the anaphoric bindings in the sentences are deviant. In the first, substances (being abstract entities) cannot be made muddy; and in the second, quantities cannot have properties of substances, such as being defined by their atomic structure. As for (c), ter Meulen claims that once the reference of a nominal mass term is fixed in an interpretation, it remains the same at all reference points. 'What water is in the sense of what the substance water is, is once and for all established in an interpretation of the language. But what is water, in the sense of what quantities of water there are, is a contingent matter... Substances determine what their quantities are, but the quantities do not make up the substance'. [1981, p. 108] And as for (d), most sentences

with double quantifiers are considered ambiguous. E.g. *Every man loves some woman* is usually thought to be ambiguous between every man having some women or other whom he loves, and there being some specific woman (Aphrodite, perhaps) whom every man loves. This ambiguity is described by saying that in the first interpretation, *every man* has wide scope over *some woman*, whereas in the second interpretation *some woman* has wide scope over *every man*. If, in these sentences, *some woman* were replaced by a proper name, e.g. *Aphrodite*, then only the second sort of interpretation is possible—*Aphrodite* is given wide scope over *every man*. ter Meulen thinks that predicative mass terms 'preferably have narrow scope' and that nominal mass terms 'usually take wide scope', over other terms. E.g.

Every child drinks some milk
Mary found little gold but Jane found it in abundance

illustrate the view. It is very difficult to give *some milk* a wide scope over *every child*, even in the passive version (*some milk is drunk by every child*). In the second sentence, it is very difficult to give *little gold* a wide scope over *Mary* and *Jane* (for then they would have found the same gold). Yet the nominal mass terms, as with proper names, the wide scope is usual.

Every child drinks milk
Mary found gold and Jane found it too

These sentences show *milk* and *gold* having wide scope over *every child* and *Mary, Jane* respectively. Similar remarks could be made for the relative scope of terms and intensional operators. In

John believes that gold has atomic number 79

we have wide scope for the nominal mass term *gold* over *believes*, as evidenced by its equivalence to *Gold is such that John believes that it has atomic number 79*. But with predicative mass terms, such as *some gold* in

John believes that some gold is in the box

we do not have the paraphrase *Some gold is such that John believes that it is in the box*.

How convincing are these data? We think that they do not demonstrate the thesis ter Meulen wishes them to. There are two ways one might attack her data: first, show that it is simply incorrect or that it is correct but for some reason other than what she claims; or second, one might concede the data but give some other account of them than that nominal mass terms are names of some entity (a substance) which cannot be defined in terms of anything else (such as the quantities). We will not attempt the former way, although it does seem to us that the data are not so rigid as

ter Meulen makes out.[45] Instead we shall take issue with the interpretation ter Meulen places on this data. Her picture of the situation is this: a predicate like *water* denotes a function on possible worlds which has as its value in a possible world the set of quantities of water in that world. So far we have two types of objects; a semantic one (the function) and a metaphysically real one (the set of quantities). In addition to this, ter Meulen thinks, there is another metaphysically real object, the substance water. This object bears a certain relation to the other real objects, namely the relation of being exemplified by (the converse of being a quantity of). Since the substance is a metaphysically real object, we must have some way to name it—hence the nominal mass terms. The nominal mass term has as its value the object water, which is unchanged when considered from any possible world. Why not, one might ask, just identify this substance with the intension of the predicative mass term? After all that object, the function on possible worlds to sets, does not change from possible world to possible world. Isn't the introduction of a substance just a needless proliferation of entities? Doesn't this function do all the necessary work of picking out what is and what isn't water in each possible world? Aren't we just duplicating this relationship when we add an 'exemplification' relation? ter Meulen's answer would presumably be that the function is a semantic object, and not a metaphysically real one. Any attempt to pretend that they were the same would be a cross-matching of types from different categories. Semantic objects are conveniences in describing the world; metaphysical objects really exist. Underneath it all, it seems to come to ter Meulen's realist feeling that substances exist and are not in any way a construct from more basic entities (such as the quantities). We think (and perhaps ter Meulen does too) that all her data could be accounted for by identifying her substances with the intensions of predicative mass terms. But she would nonetheless object that we have ignored a certain piece of reality: the substance. It would be, to her, rather like denying that people were primitive existents and instead 'constructing' or 'defining' them in terms of person-stages. Maybe it can be

[45] For instance some sentences using a predicative mass term do allow for backward pronominalisation. *Whoever finds it can keep the gold* (cf. [ter Meulen, 1981, n. 2]). As for the 'type restricted binding', consider *Snow is always piling up in his driveway and that's why John hates it.* One reading of this sentence (indeed the preferred one) has it that John hates snow, the stuff, and not just that he hates the quantities which pile up in his driveway. Further counterexamples due to J. D. McCawley (personal communication) are: *Water is H_2O. It is often muddy*, and *Water, which is H_2O, is often muddy.* And finally, is it so clear that it is due to the predicative mass term *some milk* that, in a sentence like *every child drinks some milk, some milk* is given narrow scope? Cannot it be due to idiosyncrasies of the verb *drink*? After all, it is very difficult for more than one child to drink the same quantity of milk. Compare *Every third world country wants some new military hardware which France is exporting—namely the Exocet II*, in which the opposite phenomenon is observed even though *new military hardware...* is a predicative mass term. J. D. McCawley suggests *Every philosopher believes some nonsense* as having a clear scope ambiguity.

done formally and account for all the syntactic and semantic data, but it would just be incorrect as an account of reality.[46] The one argument we find in ter Meulen against this identification is the following. *Any* predicative mass term, even a complex one, has an intension. But only *simple* mass terms can function as a nominal mass term, so in any case we have to distinguish between intentions of predicative mass terms and nominal mass terms. Her evidence here comes from counterfactuals. For example, the sentence *This muddy water might not be muddy* is true; but *This water might not be water* is false.[47] According to her then, complex mass terms cannot be rigid designators, but simple mass terms can be; and so, she concludes, it is not possible to define substances as the intensions of predicative mass terms. In fact though, this does not follow: the simple syntactic manoeuvre of having a category of simple mass nouns to which various syntactic rules apply will do the trick. One rule is to directly convert it into a nominal mass term (and the corresponding semantic rule then would have it denote the intension). Another rule allows it to form predicative mass nouns either by modification (for *muddy water*) or simply by an identity mapping (for use in sentences like *water is wet*). In this kind of case the predicative mass term will designate the family of sets containing all quantities of [say] water.[48] Once a simple mass noun has been converted to a predicative mass noun, it can no longer be converted to a nominal mass term.

In short, while we find ter Meulen's data interesting and parts of her solution intriguing, we do not find the fundamental starting point—a syntactic distinction between nominal and predicative mass nouns—to be well motivated. We think we can account for the data (what hard data there is, anyway) differently, and will try to do so later.

Carlson [1977] is concerned to present a unified account of mass expressions and 'bare plurals'. It had been noted before that bare plurals (e.g. *dogs* in *Dogs are barking outside* and *Dogs are mammals*) resemble mass nouns in a variety of ways, both syntactic and semantic. Carlson's central idea is that both the formation of bare plurals and of nominal mass terms are best regarded as the transformation of an expression that semantically designates a property into something like a proper name. So all unquantified noun-phrases are to be analysed as names of first-order individuals.

[46] The doctrine we here attribute to ter Meulen has been stated in various places, but put like this it most closely resembles the remarks made by Kaplan [1973, p. 518, n. 31].

[47] Or at least so ter Meulen thinks. For us, we find this evidence which relies on intuitions about possible worlds less than convincing. Just as there is a possible world in which this muddy water is not muddy, isn't there a possible world in which this water (i.e. the entity designated by the noun phrase *this water*) is not water but rather, say aqua regia? (Because in that world the fiendish waiter whom I asked for some water poured acid instead).

[48] We note here that ter Meulen's meaning postulate (6i) [1980, p. 180] makes all bare predicative mass terms in subject position be given a universal interpretation. This seems incorrect as sentences like *Muddy water is found on Mars* illustrates.

Carlson gives a wide variety of data, some of which overlaps that mentioned above as coming from ter Meulen, for this conclusion. He argues that we can make sense of all these data by assuming that bare plurals act as names of kinds of things, and that the different readings (sometimes entailing 'all' as in *dogs are mammals*, sometimes entailing 'some' as in *dogs are barking outside*, sometimes having neither sort of entailment as in *dogs are numerous*) that arise in different contexts depend upon the properties of classes of predicates used in the rest of the sentence and upon the aspect of the verb phrase. One class of verb phrases is said to denote properties of *stages* of (ordinary) individuals, e.g. *be drunk, be on the roof, be eating a cake.* Other verb phrases, such as *be intelligent, be a person, know Greek*, denote properties of (whole, ordinary) objects. The 'stage level' verb phrases select 'existential' readings of bare plurals, while object level verb phrases select the 'universal' reading. Carlson also introduces two relations, R and R', which connect individuals to their stages and kinds to their instances. These are introduced by meaning postulates. The result is that sentences like *This ring is gold, Dogs are intelligent*, and *Dogs are barking* will be translated as

$$(\exists x)[R(x, g)\ \mathbf{\&}\ \mathbf{ring}'(x)]$$
$$(\forall x)[\mathbf{Dog}'(x) \rightarrow\ \mathbf{intelligent}'(x)]$$
$$(\exists x)[R(x, d)\ \mathbf{\&}\ \mathbf{barking}'(x)]$$

(The second sentence is the result of applying a meaning postulate to the initial translation according to which the property of being intelligent was attributed to the kind, Dog.) Chierchia [1982a] and ter Meulen [1980, pp. 63–64, 99–100] criticise this account. ter Meulen's criticism is mainly that 'properties of kinds and of their members cannot be distinguished, so kinds can realise themselves'. It is not clear that this is an undesirable consequence; Carlson himself thinks it is true and opposes ter Meulen's evidence about 'type restricted binding' with such sentences as

Gold is an expensive metal, but John buys it regularly

ter Meulen's response to this is merely the question-begging 'apparent counterexamples to the type restricted binding of mass terms can usually be shown to hinge on a failure to recognise that substance-properties can only be inherited by quantities of the substance' [1980, p. 100]. Apparently, what she means is that the present sentence is to be interpreted as meaning 'All quantities of gold are quantities of a metal and are expensive, and John buys them regularly'.[49]

Chierchia [1982a] gives a more thorough development of Carlson's ideas, especially as to how they account for mass nouns. The main points of divergence are: a kind is identified as the intension of a common noun

[49] This is question begging since no one would ever try to paraphrase the sentence unless convinced of ter Meulen's 'type binding restriction' in the first place.

(contra Carlson and ter Meulen), and the notion of a 'stage' is replaced by 'quantities of matter' (the latter interpreted broadly so as to include 'stages' of ordinary objects—for details see [Chierchia, 1982a]). Common nouns, and in general characterising properties, are treated as sets of individual concepts (in the Montague sense). Episodic properties denoted by verb phrases like *run* and *hit* are analysed as sets of portions of stuff. So it is suggested that the difference between states (expressed by certain stative verb phrases) on the one hand, and processes and events (expressed by non-stative verb phrases) on the other, is merely a difference concerning the kinds of entities involved. A kind is the intension of a property, and for an ordinary thing to instantiate a kind is simply for it to have the corresponding property. Moreover, ordinary objects are individual concepts that have stages as their values; so for a stage to realise an object will simply be for it to be the object's value at a given possible world. And the definition of what it is for a stage to realise a kind is that the stage is the (mereological) fusion of stages of one or more objects belonging to that kind. Chierchia [1982a; 1982b] gives an explicit model theoretic account of all this employing Cocchiarella's [1978] theory, which has no semantic types. The meaning postulates that are relevant to the interpretation have the following consequences:

1. if Σ is a count noun or a stative verb phrase, and Σ is true of x, then x is an object;

2. if Σ is a non-stative verb phrase and Σ is true of x, then x is a quantity of matter ('stage');

3. if Σ is a stative transitive verb (e.g. *love*) and Σ is true of the pair $\langle x, y\rangle$, then x is not a quantity of matter;

4. if Σ is a non-stative verb phrase (e.g. *hit*) true of the ordered pair $\langle x, y\rangle$ then x is not a quantity of matter if and only if there is some realisation of x which stands in the Σ relation to y.

Much of the work is to be done by the aspectual system. We will be given (at least) three classes of verb phrases: stative verb phrases that select for kinds, ordinary stative verb phrases, and non-stative verb phrases. The translations of an example of each are (after the application of meaning postulates):

1. (a) Gold is an element.
   (b) $\mathbf{element}'(\hat{}\mathbf{gold}')$

2. (a) Gold is yellow.
   (b) $(\forall x)[R(x, \hat{}\mathbf{gold}') \rightarrow \mathbf{yellow}'(x)]$

3. (a) Water is flooding the city.

   (b) $(\exists y)[R(y, {}^{\wedge}\mathbf{water}') \;\&\; \mathbf{flood\text{-}the\text{-}city}'(y)]$

The idea here is that in the syntactic analysis of the sentence we will notice whether a verb phrase is stative or non-stative. In the latter case the translation will proceed as in 3. In the former case, the translation will proceed as in 1. After this initial translation is complete, the application of certain meaning postulates is considered. Those verb phrases which do directly attribute qualities to the 'kind'—as for example, *is an element, are numerous, is getting expensive*, and the like—do not have a meaning postulate which allows the property to be 'inherited downward' to all the quantities ('stages') of the kind. Thus, 1 remains as initially translated; but 2 allows the application of such a meaning postulate, and the property of being yellow is inherited by all the realisations of gold.

Chierchia concludes that there is a 'true generalisation' here which his theory is able to capture. The name-like properties of bare plurals and of mass nouns follow simply from their being nominalisation of common nouns. Exactly the same explanations given for the behaviour of bare plurals goes through for mass terms without additional stipulations.

The range of evidence given especially in [Chierchia, 1982b] is quite impressive. Nonetheless, we think that there are a variety of problems not handled in this approach. Below we shall list some of these data and indicate our own solutions to them.

AN UNDERLYING MISTAKE

It seems to us that an underlying flaw in all the proposals thus far canvassed—both those accounts of what a mass expression is and those accounts of what the 'logical form' of sentences containing mass expressions is—stems from a failure to adequately distinguish among the semantics associated with a different levels of syntactic description.[50] For example, consider a sentence like

> The dirty water used in washing yesterday's dishes is still in the sink.

When one asks: what is the semantic value of *water*, the question is ambiguous at least between the following. What is the semantic value of *water*, considered merely as an entry in the lexicon? vs. What is the semantic value of *water*, as it occurs in this sentence? And we should like to add further that even in this sentence *water, water used in washing yesterday's*

[50] Exception here should be made for those explicit theories of Bennett, ter Meulen, Chierchia, Lønning and Higginbotham. For them we acknowledge that they have recognised the general point, but we disagree with their specific accounts.

dishes, dirty water used in washing yesterday's dishes, and *the dirty water used in washing yesterday's dishes* will all be given distinct semantic values. Furthermore, these values might be so different that (for example) *water* could be a predicate while *the dirty water used in washing yesterday's dishes* could be a name. There are a variety of possible syntactic analyses of this sentence, dependent on various grammatical theories. For definiteness we mention an X-bar theory along the lines of Gazdar and associates (cf. [Gazdar *et al.*, 1985]). In this theory there are, as it were, different 'levels' of being a noun phrase or a verb phrase. We indicate these levels by superscript. (So N^2 is the third level of noun phrase.) An analysis of the sentence in this theory might be as depicted in Figure 1.[51]

Here we see that there are many different nodes of the syntactic analysis tree, and that each one might be associated with radically different semantic values. Following the methodology of the Gazdar (ultimately Montague) approach, the only restrictions here are (1) for each node other than the terminals, its semantic value is some function of the semantic values of the immediately dominated nodes, and (2) the semantic value of the topmost node is a truth value. Perhaps our point, that the semantic values corresponding to our N^2, N^1, N^0 nodes in this tree are distinct, seems obvious for this example, but now consider such examples as

Gold is expensive

Water is widespread.

Again the question 'What is the semantic value of *water*?' is ambiguous at least between the questions 'What is the semantic value of *water*, considered as an element in the lexicon?' and 'What is the semantic value of *water* in this sentence?' And again, there is no reason for them to be the same. There might be various answers to the second question even in this example. Perhaps a sentence is formed by the combination of an N^2 and a V^1; but since the lexical item *water* is simply an N^0, it cannot be combined with

[51] We do not wish these analyses to be taken as if they were fixed in stone, immune from revision, and clear on all details. The point rather is that any serious linguistic theory will make certain kinds of distinctions amongst 'levels' of analysis of (say) being a noun phrase. Here these distinctions are put: an N^2 is the kind of syntactic entity which can be the subject of a sentence (for example), and N^1 is that N^2 considered without its determiner (e.g. *the tall man* considered without the *the*), and possibly without certain of its modifiers (e.g. *fast flight to London that we took* considered without *fast* and without *that we took*), and an N^0 is the noun as it occurs in the lexicon (here, it is that part of the N^1 *flight to London* without the prepositional phrase *to London*—i.e. the N^0 is merely *flight*). We take it that the addition to premodifying adjectives and optional postmodifying prepositional phrases, relative clauses, etc. leave the semantic category of the nominal unaltered, e.g. *flight* and *fast flight that we took* map into the same semantic category. We therefore do not distinguish them here (unlike some theories). Different linguistic theories might make somewhat different claims about these categories, but they all have to make some such distinctions, and that is the point being made here.

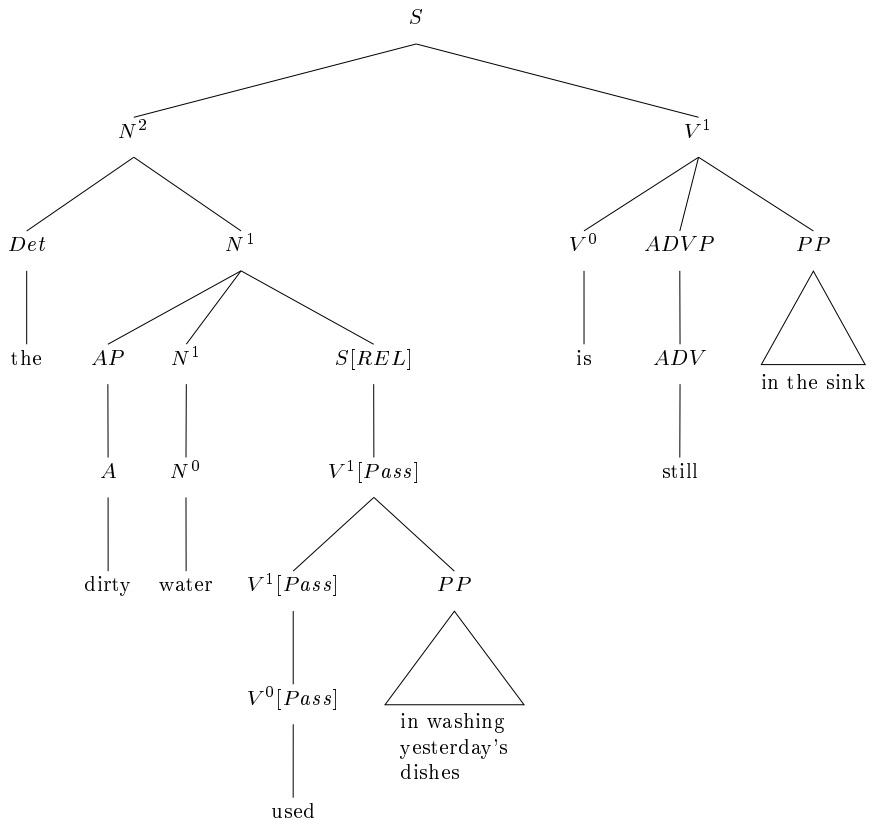
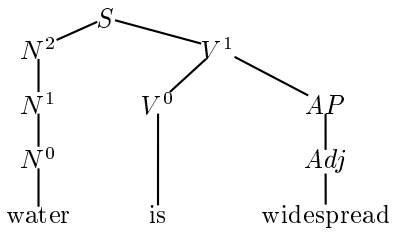


Figure 1.

the V^1 to form a sentence. Perhaps one expansion of N^2 is as N^1 and one expansion of N^1 is N^0. Then the structure of the sentence would be



In such a case, the question 'What is the semantic value of *water* in this sentence?' is itself ambiguous amongst asking it of *water* considered as N^0 (its value in the lexicon), of *water* considered as an N^1, and of *water* considered as an N^2.

We think that much of the disagreement and confusion in the whole area is due to inattention to this fact. The proper investigation of mass expressions will proceed by first finding a suitable type of value for the lexical entries so that, when combined to form 'higher' node-values, these too will have the correct sort of values. A condition of adequacy then is that all values corresponding to a particular syntactic category will have the same semantic type. If, for example, N^2's are sometimes names, then all N^2's are names. If some combination function sometimes combines (say) two predicates to form another predicate, then that function cannot be used to combine (say) a predicate and a name to form a predicate. And so on.

We suggested that there may be several 'levels' of being a noun phrase or a verb phrase. The theory that we cited employs two levels of each, in addition to the basic N^0 and V^0 level. (The V^2 level is the entire sentence.) Semantically speaking, one needn't distinguish all three 'levels', and for the simple grammar we shall present later we will distinguish only two 'levels'. We shall call these two levels CN and NP, identifying NP with our earlier N^2, and CN ambiguously with N^0 and N^1. The (semantic) justification for this simplification is that we can safely ignore mass nouns with subcategorised complements (*cream of wheat, salt of epson*), so that for the rest N^0 reduces to N^1 without semantic change. So we shall make a distinction between a lexical noun (and other CN's), e.g. *water*, and its noun phrase occurrence in a sentence, especially as a 'bare noun phrase'—as in *water is wet*. From now on, we shall mark this difference as *water: CN* and *water: NP*. Similarly, we distinguish *water: CN* from the predicate *is water: VP*—an entire verb phrase. This makes the basic problem that of providing an analysis of the semantics of mass (and plural) CN's. The semantics of bare NP's, quantified NP's (e.g. *this wine, some dogs*) and predicates (e.g. *is water, are dogs*) must build on this basis. For example, if *water: CN* is claimed to express a predicate over quantities of matter while *water: NP* expresses the name of a substance, we would like to know how the former is transformed (syntactically and semantically) into the latter. Similarly, we would like to know how the meaning of the sentential predicate *is water: VP*, in such contexts as *the stuff in this bottle is water*, and *mineral water is water*, is derived from the meaning of *water: CN*.

We mention there three desiderata: (1) A syntactic-semantic homomorphism. Since we are looking at semantics within a Montague-style framework, we cannot be satisfied with just any 'philosophically satisfying explication' of mass term and bare plural semantics. (In particular we want to avoid *ad hoc* 'reconstruals' of sentences containing bare noun phrases.) Instead, we enquire in addition that there be semantic rules paired with syntactic rules of formation, delivering the logical translations of the syntactic constituents. In the current context, this entails at least that phrases of the same syntactic category should be of the same semantic category. This makes it desirable, for example, that *water: NP* should denote the same

thing in the sentences

> Water covers most of the globe.
> Water is a liquid.
> Water is dripping from the faucet.

(2) Uniform treatment of bare mass noun phrases and bare plural noun phrases. There is plenty of linguistic evidence (cf. [Carlson, 1977; Chierchia, 1982a]) for taking these two types of noun phrases as being of the same semantic category, despite the fact that they carry the SING and PLUR feature respectively.[52] Any semantic analysis should explain the systematic connection between the two types of bare noun phrases. (3) Substitutivity of alleged paraphrases. Often, semantic analyses of mass and plural CN's (and the corresponding NP's and VP's) are accompanied by informal (i.e. English) paraphrases or elucidations that indicate how these constituents are to be understood intuitively. For example, *water: CN* might be said to denote '(is a) quantity of water'; similarly *water: NP* might be said to denote 'All the water in the world', or perhaps 'The substance, water'. We should take such paraphrases seriously, and hence require that (a) substitution of alleged paraphrases for the original phrases should map an originally intelligible sentence into another intelligible sentence synonymous with the original—apart, perhaps, from pragmatic defects such as unwanted implicatures. (b) It should be possible to analyse the paraphrase formally, showing that it leads to a translation logically equivalent to the translation of the original CN, NP or VP. In other words, it should be possible to formalise (a).

There seem to be at least five intuitively distinct roles that mass terms can assume, and the problem then is to try to determine which of them is semantically primitive, i.e. which corresponds to the meaning category of lexical mass nouns such as *water: CN*.

1. As names: this seems to be motivated by examples like *Water covers most of the globe, Water is oxidised hydrogen, Methane is abundant on Titan*, together with the tacit assumption that the denotations of CN's and the corresponding bare NP's are the same.

2. As predicates over quantities/portions of matter: this is apparently motivated by such sentences as *The contents of this bottle is (are) water, John drank (sm) water*. It is also motivated by quantified phrases such as *sm water* and *the gold on the table*, which can plausibly be read as *some quantity of water* and *the (largest) quantity of gold on the table*.

[52] We think that the differences in 'discreteness' (atomicity) should probably be handled via meaning postulates, rather than differences in translation.

3. As predicates true of objects: this is motivated by such examples as *This ring is gold, This sandwich is food*, and *This boy is skin and bones.*

4. As predicates over kinds/substances: this is motivated by such examples as *Claret is wine, Rice is food.*

5. As predicate modifiers: this is motivated by such examples as *She wore a gold anklet.* It would be akin to treating mass nouns as adjectives.

6. As predicates which combine the kinds of predicates mentioned in(2), (3) and (4). So there are four such possible combinations (2)–(3), (2)–(4), (3)–(4), (2)–(3)–(4).

We now give some general problems for (some of) these approaches. With respect to (1), that mass (and plural (CN's) are names, we might consider such sentences as *Pure lemonade is lemonade* and *Fake fur is not fur.* It seems pretty clear in general that adjectives map predicates into predicates. For example, *red* and *fake* map *flower* (whose extension is the set of flowers) into *red flower* and *fake flower* respectively (whose extensions are the set of red flowers and the set of fake flowers respectively). But if *lemonade: CN* and *fur: CN* are names, then we require that adjectives also map names into names, yielding such new names as *pure lemonade: CN* and *fake fur: CN* (the extensions of names being individuals rather than sets of individuals). Attributing two sorts of functions to adjectives seems inelegant at best, and it is hard to see how to axiomatise the latter function. Both Bunt and Parsons try to get around the problem by analysing [ADJ CN]: NP, where CN is a mass noun,[53] as *the substance whose quantities are quantities of CN and are ADJ* (where for Bunt 'the substance ...' corresponds to mereological supremum while for Parsons it remains his unanalysed substance-abstraction operator). Thus *pure lemonade* comes out as *the substance whose quantities are of lemonade and are pure.* But his is wrong, for whether a quantity of lemonade is 'pure' depends on whether it is viewed as lemonade (lemon juice plus water plus sugar) or as something else, such as water (with lemon and sugar impurities), or lemon juice (diluted with sugar water). In other words, *pure* is *essentially* a predicate operator, which cannot be construed conjunctively.[54] Finally, it is well known that

[53]The [ADJ CN]:NP means an NP formed by premodifying a CN by an adjectives. We intend this discussion also to include the postmodification of a CN by a relative clause.

[54]Theoretically it is open to Bunt and Parsons to read [ADJ CN]:NP as *The substance whose quantities are ADJ quantities of CN.* Thus *pure lemonade* is the substance whose quantities are pure quantities of lemonade. But this is not very plausible. It seems to us that 'quantity of ADJ CN' in general differs in meaning from 'ADJ quantity of CN'. For example, a 'fake quantity of fur' may be a bag of cocaine topped off with (real) fur, rather than being a quantity of fake fur. Similarly, quantities of coarse sand, cube sugar, and small furniture are not the same as coarse quantities of sand, cube (cubical?) quantities of sugar, and small quantities of furniture, respectively.

mass CNs, like count CNs, are premodifiable by nouns (*rabbit fur*), attributive adjectives (*white fur*), quantifying adjectives (*much fur*), ordinals and determiners (*the first snow*), and can occur as predicate in sentences like *White wine is wine* where the *is* is not the '*is* of identity'. These NP roles indicate that mass CNs are to be treated on a par with count CNs. We conclude that position (1), that the mass CNs should be assigned the status of names, is highly implausible, and appears to be the product of precisely the kind of confusion between the levels of noun phrase structure that we have drawn attention to.

Are mass (and plural) CNs then to be predicates over quantities of matter, as in ter Meulen [1980], Chierchia [1982a], Montague [1973]? A problem with this approach is finding a way to translate *quantity of fur: NP* so that its intension will differ from the intension of *fur: CN*, and hence, that *quantity of fake fur, quantity of small furniture*, etc. will have intensions different from *fake quantity of fur, small quantity of furniture*, etc.[55] Another problem is to show how this choice of primitive role for mass expressions can account for the role of mass NPs as predicates over (ordinary) objects and predicates true of kinds/substances. It should be noted that, even if one chooses this role of mass NPs to be primitive and assigns it to the CNs, one can still translate the NP as something other than a predicate. For example, Chierchia's [1982a] translation of *dew worms* would be the 'name' $^{\wedge}\mathbf{dew\text{-}worm}'$, and Link's [1981] translation would be $(\exists x)$ $(\oplus\mathbf{dew\text{-}worm}'(x)\& \ldots x \ldots)$. (For Link $\oplus\mathbf{dew\text{-}worm}'$ is true of $\oplus$-sums of individual dew worms (at least two).)

There seem to be no theorists who allow role 3, that mass terms are predicates true of ordinary objects, to be their primitive role assigned to mass CNs. However some theorists (e.g. Pelletier [1974], Chierchia [1982a; 1982b] whose formal semantics does not distinguish quantities of matter (in the informal sense) from 'things', and Link [1981] (see especially his Example 45) combine roles 2 and 3, allowing that mass nouns are at root predicates over quantities of matter, lumps, nuggets, slices, helpings, etc. of stuff, as well as over ordinary things. The main problem with such an approach is its apparent inability handle mass NPs which exemplify role 4. There is also a paraphrase problem here analogous to that which we cited for position 2: intuitively, a sample of M, where M is a mass NP, is true of both quantities of M and things exemplifying M (e.g. a given quantity of furniture is a sample of furniture, as is any piece of furniture). Yet a small sample of furniture is not the same as a sample of small furniture.

[55] Or show how to treat *fake, small*, etc. as operating on the two-place relation *quantity of*, without positing new logical forms and meanings for them, distinct from those in contexts such as *fake flower, small chair*.

Role 4 is that mass nouns are true of substances, or kinds, or varieties.[56] Examples of this role are such sentences as *Claret is wine* where *wine* appears to classify or describe or be true of kinds/species/varieties. Such uses are often paraphrasable as *wine of a certain kind/variety* or *variety/kind of wine* or *a wine*. In other words, this use of mass NPs in forming VPs comes close to, or coincides with, the use of the putative mass noun as a count noun. It is tempting to try to paraphrase these uses of mass NPs as a quantification of some sort. E.g. ter Meulen [1980] and Pelletier [1974] would paraphrase this (after the application of meaning postulates) as *All (the quantities of) Claret are (quantities of) a wine*; and possibly some theories would paraphrase it as *Some (quantities of) claret are (quantities of) wine*. But sentences like *Claret is wine and is currently out of stock* (in response to a liquor store request. 'I need some claret, whatever that is') thwarts this move. Obviously this conjunctive sentence has the same term *claret* as subject of both conjuncts, and yet no quantificational reading can work for both conjuncts. Other examples of this role are *Muddy water is water but is not potable, Fake fur is not fur yet sells well.*

If this is chosen as the meaning of mass CNs, it would entail that all mass terms derive from count nouns (expressing predicates over substances/kinds). Corresponding to roles 1, 2 and 3 above we would have to introduce into our semantics certain operators that work on these basic meanings to form names of the substance, to form predicates over quantities of matter, and to form predicates over ordinary objects. For example, we might have (for one of these mass CNs M)

$$\mu M \quad qM \quad cM$$

where μ is a name-forming operator, giving the top (most general kind) of a 'is a kind of' semilattice of M-kinds, q maps substance-predicates to quantity-of-matter predicates, and c maps substance-predicates to thing-predicates (things, unlike substances, being concrete). If we wish to conflate the q and c operators along the lines suggested earlier, we might introduce

$$\mathfrak{p}M$$

which forms a predicate that is true of quantities of matter and ordinary objects, given a substance predicate. An objection to this approach is that there is *already* a category of nouns generally regarded as denoting substance-predicates, and these are intuitively quite unlike mass nouns. Examples of this category are *element, substance, metal, liquid, stuff, gas, material*, etc. Why are these not transformable to mass terms by applying μ, q, c, and $\mathfrak{p}$? The answer, possibly, is that these terms *are* transformable in this way—consider *traces of yellow gas, lots of material, molten metal in*

[56] We shall ignore here certain implicatures about such uses of mass NPs to the effect that it be a *natural* or a *conventionally recognised* or a proper *sub*-kind.

large vats, and the like. At least some of these kinds of 'substance predicates' seem to be susceptible to the 'paraphrase problem' as positions 2 and 3 were; e.g. *This hamburger is greasy food* seem roughly paraphrasable as *This hamburger is a greasy kind of food*, and similarly for *This shipment is heavy furniture* to *This shipment is a heavy kind of furniture*.

As far as the 5th role of mass terms goes, the predicate modifier role, the only person we know to have suggested that it is basic was Aristotle. We shall consider it no further as a candidate for primitiveness.

Re position(6)—combinations of (2)–(4). We have already seen that a paraphrase problem arises not only for position(2) (that mass CNs denote quantities of matter) but also for (2) and (3) in combination. There is a similar difficulty for *all* combinations of (2), (3) and (4). For example, if we want to claim that mass CNs are predicates over quantities and varieties of matter, it seems that we should be able to paraphrase *is CN* as *is a CN-quantity of CN-variety*. Yet *is a small furniture quantity or furniture variety* is not synonymous with *is small furniture*, since the former is necessarily true of any small furniture quantity, while the latter is not. Since one of the theories we shall develop later appeals to a combination, we shall let it have its say about this paraphrase argument. Briefly, it denies the inference

1. CN′ denotes quantities and varieties of CN therefore,
2. CN is paraphrasable as *CN-quantity or CN-variety*

Its reason for denying this inference might be that the explicit English *or* in 2 is always read *distributively* in context (e.g. x is *a small P or Q* is always read as *x is a small P or x is a small Q*), whereas in *small CN*, when CN is mass, *small* acts on the entire intension of CN′.

TWO THEORIES FOR MASS NOUNS

In this section we offer two theories to account for the data we have mentioned earlier in this paper. One theory, the *p*-theory, is a semantic occurrence approach. In this theory MASS and COUNT are not syntactic categories or features, but are rather a description of the sort of semantic translations generated by the Gazdar-style syntactic rules. The other theory, the *s*-theory, is a syntactic expression approach. In this theory MASS and COUNT are explicitly syntactic features which attach to lexical nouns. The *s*-theory invokes the lexical extension rules (mentioned above) to describe certain phenomena. These two theories seem to us to be the most plausible candidates for a unified theory of mass nouns. The fragment of English that these two theories are concerned with is roughly those sentences with a copular verb and either a mass, a count, or an adjectival expression as predicate and whose subjects are either bare noun phrases or quantified noun phrases.

The two theories share much—in particular, they are in agreement as to the range of data to be accounted for. They agree, for example, that sentences like the result of the universal grinder are to be given a representation, that sentences using a putative mass term with the indefinite article (e.g. *a wine*) are to be given a representation, and in general they agree on what semantic representation is appropriate to the entire range of example sentences to be considered. The ontological underpinnings of both theories are that 'reality' contains two sorts of times: (1) 'ordinary objects' such as rings, sofas, puddles (and including here what many theorists have called 'quantities/portions of matter').[57] (2) 'kinds of stuff', that is, 'varieties', 'substances', etc. (we have in mind here such items as wine, claret, red wine, and the like) and 'kinds of portions', i.e. kinds of standard or conventionally recognised servings. (*This is a beer* might be true because *this* denotes a quantity of beer or a beery object—type (1) objects; but it might be true because *this* denotes a kind of stuff, say pilsner, or because it denotes a standard kind of serving, e.g. a bottle of beer). We wish to make no special metaphysical claims about the relationships that might hold between 'ordinary objects' and 'kinds' instead we content ourselves with describing how such an ontology leads to a simple and natural description of various of the facts concerning mass (and possibly plural) expressions.

Linguistically, that is semantically, we take there to be two distinct types of predicates: (a) those which apply only to 'kinds', e.g. *is a substance, is a wine, is a kind of wine*,[58] *is scarce, is abundant*, and (b) those which can apply to both 'kinds' and 'objects'. In this last group we have in mind mass predicates such as *is wine, is furniture, is food, is computer software* and the like on the one hand, and count predicates such as *is a dog, is a puddle, is a quantity of gold*, and the like, on the other.[59] We hope that

[57] We take no stand on the issue of whether an object is identical with the bit of matter that constitutes it. We do insist, however, that there are both types of individual; thus our lack of a position here amounts to taking no stand on whether two objects can occupy exactly the same spatial location (e.g. the ring and the bit of gold of which it is made). However, see our remarks below in the section MASS/COUNT IN OTHER FIELDS.

[58] This use of *kind* is to be carefully distinguished from its use as a 'hedge': *This is kind of a wine.* Contrast *A zebra is a kind of horse, A zebra is kind of a horse*, and **A zebra is a kind of a horse.*

[59] We think there are no predicates which apply only to 'objects'. The usual examples one can think of, such as *is a sofa* or *is a dog*, can in reality apply also to kinds, as in *An ottoman is a sofa* and *The Beagle is a dog.* (Which we take to *imply* statements about individual ottomans and dogs, but not to be equivalent to them. They seem to us to rather be equivalent to *The ottoman is a kind of sofa* and *The beagle is a kind of dog*, making *is a sofa* and *is a dog* be used as a kind designator.) Even *is a puddle* and *is a quantity of gold* can be used in this way: consider *This nugget is a quantity of gold*, which uses the predicate to be true of an 'object', and *A nugget is a quantity of gold*, which uses it to be true of the kind. (It may be inaccurate, but it is so used). In the sequel we shall make no assumption that any English predicate is true only of individuals, but will instead introduce into the formal semantics an operator which forces such a reading in certain contexts. We take the view that most English predicates have the mixed,

the discussion of the last section has made it plausible that mass VPs can apply to both 'kinds' and objects' as required by (b). We also take it to have been established in that section that these 'kinds' are abstract rather than 'scattered individuals'.[60]

Both of these theories take it that *is wine* is true of the (abstract) kind claret in addition to an individual quantity such a the contents of this glass. Moreover, they take *is wine* to be true of an object such as a drop or puddle of wine, occupying the same region as some quantity of wine. (*This ring is gold* or *This hamburger is food* are clearer examples of the application of mass predicates to objects.) Generally speaking, the theories view the kinds of M as forming an upper semilattice of kinds with M at the top. This is a 'formal' semilattice in that the union of any two elements of it is a member of the semilattice, and we view *is wine* as being true of any of these formal kinds. So a sentence like *Sauterne mixed with claret is wine* will be true, since their union is an element of the semilattice. Adverbial modifications of elements of this 'formal' semilattice also are members of the semilattice. Thus *Cheap wine is wine* will be true, since *cheap wine* names an element of the semilattice.

Predicates like *is a wine* are true of 'conventional' kinds (*Claret is a wine* is true) but not of every 'formal' kind since, e.g. *Cheap wine is a wine* is not true.[61] (*Sauterne mixed with claret is a wine* is also not true, showing that *is a wine* is not true of unions of elements of the semilattice). These predicates are not only true of the conventional kinds but also of individual servings such as the bottle of wine on the table or the 250ml in this glass and of conventional kinds of servings of wine (such as *Viertel* in a German bar, or 4oz in Alberta bars). When a bare mass noun phrase (or indeed other bare noun phrases, although we shall not dwell on them here) is used as a subject (or object, but again we shall not consider that here), it is taken to name the kinds. So in *Cheap wine is wine*, the subject *cheap wine* names a kind; and since the sentence is true it must name a 'formal kind' so that *is wine* can be predicated of it. But since *Cheap wine is a wine* is not true, the formal kind cannot be a conventionally recognised kind (nor, for that matter, a conventional kind of serving nor an individual quantity).

Both theories hold that mass CNs should be translated into the semantics as predicates. Strictly this is not required: for, all we have given direct evidence for is that mass VPs be translated as predicates with a mixed object/kind extension. It could be the case that mass CNs are quite different, yet in the formation of a mass VP the entire VP gets assigned a mixed, predicate denotation. Still, it would be simple, and in keeping with much

comprehensive extension; and that some few others are true only of kinds.

[60] Established by the *Water weighs billions of tons* examples (in addition to the evidence that the denotation of a mass NP must be intensional).

[61] The appropriate sense of 'conventional' appears to be 'bearing a proper name'. Thus *Sauterne*, being a proper name, designates a conventional kind while *red wine* does not.

philosophical and linguistic analysis, to assume coincidence of CN and 'is CN' denotations (at least when tense is ignored, as here).

With just this much of the theories sketched, we can see that they overcome various of the difficulties that plagued other theories. For example, it is most unclear that any other theory can adequately translate sentences like

Tap water is water
This puddle is water

without doing one of the following implausible things: make *water* in the two sentences designate different predicates (one over kinds, the other over objects); make *tap water* be an implicit universal quantification over quantities of tap water,[62] or make *tap water* be an implicit existential quantification over quantities of tap water.[63] Consider also sentences like

All wine is wine

wherein the subject *all wine* seems to quantify over both kinds of wine and quantities of wine, covering both *White wine is wine* and *The litre of wine in this bottle is wine*, for example. It seems to us that no other theories allow for this comprehensiveness. An even clearer example of such comprehensive denotation is

Everything edible is food

from which both of

Rice is food
This sandwich is food

follow, given that rice is edible and this sandwich is edible. (Note also the comprehensive denotation of *edible*). No other theories we know of can account for the validity of these two arguments, although it is clear that (both of) ours can, at least if we assign correct denotations to the subject NPs.

According to these two theories, and following most work on mass terms, bare NPs in subject position are taken to be names. We use μM to form the name of the kind/substance/etc., $\mathbf{M}$.[64] Thus we have the (a) sentences translated as (b):

[62] Implausible because it incorrectly predicts that *Tap water is water and is in short supply* or *Fake fur is not fur, yet sells well* will get a universally quantified subject. But their meanings are not preserved when *all tap water* or *all fake fur* are substituted for the respective subjects.

[63] More plausible perhaps for sentences like *Water is dripping from the faucet*, but consider *Water, though scarce in this part of the world, is dripping from the faucet*, wherein *water* cannot be replaced by *some water*.

[64] This is reminiscent of Parsons' substance abstraction operator, although it is not defined in terms of quantities as his is. We also do not take a position on the question of whether these are to be distinguished from the intension of M, i.e. from $\hat{}\mathbf{m}$.

a Water is wet

b $\mathbf{Wet}'(\mu\mathbf{Water}')$

a Tap water is water

b $\mathbf{Water}'(\mu(\mathbf{Tap\ Water})')$

Universally quantified mass NPs, as these theories see them, are comprehensive in their extension: sentences like 'All water...' assert that '...' is true of all varieties and of all quantities.

a All water is wet

b $(\forall x)[\mathbf{Water}'(x) \rightarrow \mathbf{Wet}'(x)]$.

Existentially quantified NPs, as these theories see them, using the stressed *some*, are not comprehensive: rather they are true only of 'kinds'. Our two theories distinguish these from occurrences of the unstressed *sm*, which they see as being true of 'quantities'. Yet, given the assumed comprehensive extension of many of our predicates, they can be translated identically. Thus both

Some rice is tasty
Sm rice is tasty

would be translated as

$(\exists x)[\mathbf{Rice}'(x)\ \&\ \mathbf{Tasty}'(x)]$.

Given the comprehensive extension of *Rice* (and of *Tasty*), the first sentence is true because, say, *Rice* is true of the kind 'brown rice' (which is tasty), and the second sentence is true because *Rice* is true of, say, this bowl of brown rice (which is tasty). According to this 'bare bones' version other two theories, the difference between our two sentences is not a matter of semantics, since they have the same representation. However, should we choose to treat this difference as a semantic phenomenon, these theories could be augmented with operators β and $\mathfrak{p}$ which respectively take a mass CN M and form a predicate true only of M-kinds/varieties or a predicate true only of M- objects/quantities. Our two sentences would then be translated respectively as

$(\exists x)[\beta\ \mathbf{Rice}')(x)\ \&\ \mathbf{Good}'(x)]$
$(\exists x)[(\mathfrak{p}\ \mathbf{Rice}')(x)\ \&\ \mathbf{Good}'(x)]$

(Of course these β and $\mathfrak{p}$ operators would be introduce by the syntactic-semantic rules by translations of *some* and *sm*, not by ambiguously translating *rice* sometimes as $(\beta\ \mathbf{Rice}')$ and sometimes as $(\mathfrak{p}\ \mathbf{Rice}')$.) A sentence which is unquestionably ambiguous is

This is a beer

which the p-theory translates as

$(\beta\ \mathbf{Beer'})(t) \vee (\gamma\ \mathbf{Beer'})(t)$

and the s-theory translates as either

$(\beta\ \mathbf{Beer'})(t)$
$(\gamma\ \mathbf{Beer'})(t)$

making it refer ambiguously to a kind of beer or a quantity/portion/etc. of beer. ($(\gamma\ \mathbf{Beer'})$ is true of conventional portions and kinds of portions of beer.)

Our grammars will cover only certain stative sentences. However, in view of the importance of the stative/non-stative distinction in the interpretation of sentences containing mass nominals, we should indicate briefly how we would treat mass nominals in an extended grammar covering non-stative verb phrases. The translations of the following sentences would be as indicated:

a Snow is falling

b $\mathbf{Falling'}(\mu\ \mathbf{Snow'})$

a John threw snow at Mary

b $\mathbf{Threw\text{-}at'}[j, (\mu\ \mathbf{Snow'}), m]$

a Sm snow is falling

b $(\exists x)[(\mathfrak{p}\ \mathbf{Snow'})(x)\ \&\ \mathbf{Falling'}(x)]$

a John threw sm snow at Mary

b $(\exists x)[(\mathfrak{p}\ \mathbf{Snow'})(x)\ \&\ \mathbf{Threw\text{-}at'}(j, x, m)]$

Note that the bare mass terms in the first two sentences have been interpreted as kind-denoting, despite the non-stative context, as in the Carlson–Chierchia approach. The implication of the first sentence, that sm snow is falling, would be obtained by a meaning postulate to the effect that if x is falling and x is a kind, then some 'object' y of kind x is falling. Similarly for the implication of the second sentence that John threw sm snow at Mary. In this way the first two sentences lead to consequences which coincide with

the translations of the third and fourth sentences, without actually being synonymous with those sentences at the level of logical form.[65]

Our examples have invoked the predicate-restricting operators β, γ, and $\mathfrak{p}$, either in the translations of certain English sentences, or in the meaning postulates applicable to the translations. In any case, whether we choose to do it in the direct translations or in the meaning postulates, both of our theories will want to be able, in the semantics, to form predicates which are true of kinds, or of servings, or of individuals, given a predicate which has comprehensive extension. So, for example, from the predicate $\mathbf{water}'$ which is assumed to be true of quantities, servings, and kinds, we shall want to be able to form $(\beta\ \mathbf{water}')$ which is true of conventional kinds of water, to form $(\gamma\ \mathbf{water}')$ which is true of conventional portions (and kinds of portions) of water, and to form $(\mathfrak{p}\ \mathbf{water}')$ which is true of quantities of water and objects which coincide with such quantities. Conversely, if we have a predicate which is true of individuals and kinds, we shall want to form a predicate true of *all* the entities that mass predicates are true of—quantities of stuff, kinds of stuff, conventional kinds of servings, and objects coincident with quantities of stuff. For example, if $\mathbf{man}'$ is a predicate true of objects and kinds, then $(\Sigma\ \mathbf{man}')$ is the comprehensive predicate formed therefrom.

Having seen where they agree, let us look at where they differ. The *p*-theory takes all predicates, *animal* as well as *water*, to have comprehensive extension—to be true of kinds (of stuff or things), true of conventional kinds of servings, true of quantities (of stuff), and true of objects coinciding with quantities of stuff. It makes no use of syntactic features +mass and +count, and instead interprets certain occurrences of entire noun phrases as being (semantically) mass or count—depending upon whether the predicate as used therein is true of stuff or of things and kinds. (This is determined by the syntactic constructions.) On the other hand, while the *s*-theory agrees with the *p*-theory on the basic extension of mass predicates like *water*, assigning them a comprehensive extension, it distinguishes these from the count predicates which it takes to be true only of individual objects and kinds of individual objects. It marks this difference in the lexicon with the syntactic features +mass and +count respectively. In certain sentences a count noun is used as a mass noun; to generate these, the *s*-theory employs a 'lexical extension' rule which (a) changes the mass/count feature, (b) adds a +EXT (for 'extended usage') marker, and (c) suitably alters the semantic representation of the original noun to make it fit the extended

[65] It remains unclear to us whether non-stative verb phrases should be viewed as predicates which apply to stages rather than to things, as Carlson and Chierchia claim. While the claim seems plausible for progressive verb phrases, it seems much less plausible for non-stative verb phrases in the simple past tense, such as *threw snow at Mary* or *melted and then evaporated*; such phrases appear to apply to temporal segments of things which are longer than mere 'instantaneous' stages.

usage. Overall, a sentence in which some term is marked +EXT is judged 'semi-grammatical'.

We shall close by giving an indication of how the two theories handle a variety of constructions involving mass expressions. We do not give a detailed statement of either the syntax or the semantics but rather just state the relevant rules of syntactic combination and the associated semantic representation.[66] The two theories use a Gazdar-style grammatical theory and an associated intensional logic semantics. Here we content ourselves with an informal presentation of the associated notions; in particular it is part of our goal to stay as 'close' to a traditional first-order theory as we can (augmented by certain operators).[67] Finally, here we ignore certain grammatical niceties, such as the feature system which handles number and person agreement. Rules of these theories are stated by two parts: a context-free parse and the associated semantic representation, separated by a comma. We use a prime to indicate the semantic representation of some syntactic item. We allow ourselves complex syntactic nodes, for example [N +ADJP] is a noun which has the feature of being premodified by an adjective phrase, and [ADJP +INT] is an adjective phrase which is intersective.

The rules for the relevant portion of our two theories are (with tacit restriction to the *singular* throughout):

1. S $\rightarrow$ NP VP, $\mathbf{VP'(NP')}$

2. VP $\rightarrow$ [V +be] PRED, $\mathbf{PRED'}$

3p. PRED $\rightarrow$ N, N$'$

3s. PRED $\rightarrow$ [N +MASS], $\mathbf{N'}$

4p. PRED $\rightarrow$ [DET $+a$] N, $(\lambda x[(\beta\ \mathbf{N'})(x) \vee (\gamma\ \mathbf{N'})(x)]$

4s. PRED $\rightarrow$ [DET $+a$] [N +COUNT], $\mathbf{N'}$

5. PRED $\rightarrow$ NP, $(\lambda x)(x = \mathbf{NP'})$

6. PRED $\rightarrow$ ADJP, $\mathbf{ADJP'}$

7p. NP $\rightarrow$ N, $(\mu\ \mathbf{N'})$

7s. NP $\rightarrow$ (N + MASS], $(\mu\mathbf{N'})$

8p. NP $\rightarrow$ DET N, $\langle \mathbf{DET'}\ \mathbf{N'} \rangle$[68]

[66] For example, we follow our practice of earlier and only distinguish CNs from NPs, rather than other intermediate levels of NPs.

[67] For details see [Schubert and Pelletier, 1982].

[68] This can be thought of as a quantifier $\mathbf{DET'}$ which is *restricted* by the predicate $\mathbf{N'}$. This restricted quantifier is assigned a scope in a post-parsing phase. For further details on how these theories handle quantified terms, see [Schubert and Pelletier, 1982]. here

8s. NP →[DET SING] [N SING], $\langle \mathbf{DET}'\ \mathbf{N}' \rangle$ (where SING may particularise to +MASS or +COUNT)[69]

9. [N + ADJP]→[ADJP +INT] N, $(\lambda x)\ (\mathbf{ADJP}'(x) \& \mathbf{N}'(x))$

10. [N + ADJP]→ [ADJP −INT] N, $\mathbf{ADJP}'(\mathbf{N}')$

The *s*-theory distinguished in the lexicon MASS from COUNT nouns. And it has what might be called 'lexical extension' rules to give us the 'stretched' meaning of nouns that we have earlier talked about. For example, it has lexical entries

[N +COUNT]→ *sofa, man, substance, wine,*...
[N +MASS]→ *wine, water,* ...

and extension rules

[N +EXT +COUNT] → [N -EXT +MASS], $(\beta\ \mathbf{N}')$
[N +EXT +COUNT] → [N -EXT +MASS], $(\gamma\ \mathbf{N}')$
[N +EXT +MASS] → [N -EXT +MASS], $(\Sigma\ \mathbf{N}')$

So, for the minimal grammar considered here, a sentence is a noun phrase and a verb phrase. A verb phrase is a copula followed by a PRED, which in turn is either an adjective, or a bare noun (as in *Claret is wine* or *This puddle is man*—the latter said after an application of the universal grinder), or an *a* followed by a noun (as in *John is a man* or Claret is *a wine*), or is an entire noun phrase (as in *John is the man most likely to succeed* or *Claret is my favourite red wine*). A noun phrase is either a bare noun (as in *Claret is a dry red wine* or *Dogs are barking outside*) or else is a quantified term (as in *All men are mortal* or *Sm red wine is tasty*—we include as determiners *this, all, some, sm, much, little, each, every*, and the numeral quantifiers). Nouns may themselves be either an adjective-phrase noun combination, or just a noun.[70] We consider here two cases of adjective modification: intersective and non-intersective. For the former we have in mind such adjectives as *red*, while for the latter we think of such adjectives as *fake*.[71] The rules which give alternatives, such as (3p) vs. (3s) are those rules which are different

we forgo discussion of 'quantifier scoping' and the like, but rather just assert that the stated translations actually come out as given. The quantified terms are those in angle brackets and are treated specially.

[69]The *s*-theory takes SING to be a node of an agreement feature hierarchy, with root NUMB, with disjoint successors SING and PLUR, and with SING in turn subdivided into MASS and COUNT. Thus COUNT applies to singular count nouns and determiners only. A node agrees with any of its descendants, including itself.

[70]This is one of the places where a fuller grammar would distinguish different 'levels' of noun phrases.

[71]We do not wish to enter the dispute as to whether there really are any truly intersective adjectives. Cf. [Kamp, 1975] and [Siegel, 1977] for statements of the views. On the one hand, even the colour terms do not seem to be clear examples; for example, white wine is hardly white! On the other hand, we *can* take many (perhaps most) adjectives as truly intersective, as long as we recognise that their meanings are context-dependent.

from the two theories of mass terms. The *p*-rules are for the semantic occurrence approach while the *s*-rules are for the syntactic expression approach.

Now, both of these theories can give the correct semantic representation to a wide range of sentences involving mass terms, given certain meaning postulates. (The two theories do it slightly differently, as might be expected since they have somewhat different semantic understandings of the lexical nouns. For example, the *s*-theory takes *man* to be true of individual men and of kinds of men, while the *p*-theory takes it to be true also of the stuff of which men are made. In the *p*-theory, when a sentence uses *a*—as in *a man*—then the semantic operators convert this 'basic' meaning into one that is true of individual men and of kinds of men. The *s*-theory instead has a lexical redundancy rule which will convert the lexical count noun *man* into one which is a mass noun and is true of the stuff of which mean are made and quantities thereof. They will also take a different tack on what quantified terms designate, although that has been hidden in Rule 8 above by assigning the same logical form to both theories. Nonetheless, the meaning postulates of the two theories will differ for these.) Let us state, then, the translations for three of our DETs into our 'first order-ish semantics' for the two theories:

11. $\mathbf{sm}' = (\lambda P)\langle\exists(\mathfrak{p}\ P)\rangle$

12p. $\mathbf{some}' = (\lambda P)\langle\exists(\lambda x)[(\gamma\ P)x \vee (\beta\ P)x]\rangle$

12s. $\mathbf{some}' = (\lambda P)\langle\exists\mathbf{P}\rangle$ (where *some* is [DET NUMB])

13. $\mathbf{all}' = (\lambda P)\langle\forall P\rangle$[72]

So, in the *p*-theory, the predicates of the lexicon are comprehensively true of anything that any use might dictate. But in certain contexts, such as being in a quantified noun phrase of a certain sort, the semantic representation of the entire noun phrase is sometimes (e.g. when the quantifier is *some* or *a*) such that we can say that is true of individuals (including kinds) and sometimes (e.g. when the quantifier is *sm*) such that we can say that it is true of stuff. So, by looking at the semantic representation, we can say whether it is a count noun phrase or a mass noun phrase—but this is all in the semantics and holds of entire noun phrases (not individual nouns) as befits a semantic occurrence approach. The *s*-theory will already have COUNT and MASS as features on the nouns and use this information to induce the correct, allowable combinations and meanings of quantified terms.

Thus, white wine is indeed white (note that we do say things like *This wine is white*), but in a sense appropriate to wines. After all, even nouns can show such context dependence. *This hay is food* has a truth value dependent on whether we are talking about food for people or food for cattle, for example. Moreover, the interaction of an attributive adjective with the noun it modifies does not exhaust its context-dependence: the truth of *He is a tall man* still depends on whether we are talking about horse racing or basketball.

[72]Where in the *s*-theory, *all* is [DET +MASS] (when restricted to the singular).

These rules, and the informal remarks preceding them, indicate how the theories would translate the usual run of sentences encountered in discussions of the semantics of mass expressions. For example, using the rules just given

Sm Einsteinium is in the lab

is translated as

$$(\exists x)[(\mathfrak{p}\ \mathbf{Einsteinium}')(x)\&\mathbf{In-Lab}'(x)]$$

making the sentence assert that some quantity (ingot, puddle, etc.) of Einsteinium is in the lab. In contrast, the rules assign to

All Einsteinium is in the lab

the translation

$$(\forall x)[\mathbf{Einsteinium}'(x) \rightarrow \mathbf{In-Lab}'(x)]$$

where the values of x can be both quantities (ingots, puddles) Einsteinium and also the kinds of Einsteinium. And then the sentence asserts that they are all in the lab.[73]

One might further wish to inquire about the relationship between quantities and kinds. for example, if a quantity of Einsteinium is in the lab, is there also a kind of Einsteinium in the lab, and vice versa? If all quantities are in the lab, are all kinds, and vice versa? Our two theories answer these questions negatively, in general. While it may seem plausible in the example just given, the following slightly different examples show that these four propositions are false.

1. If a kind of M has property P, then some quantity of M has property P.

2. If a quantity of M has property P, then some kind of M has property P.

3. If all kinds of M have property P, then all quantities of M have property P.

[73] For the more difficult quantifiers, such as *most*, the formal translation would be much like those in 11–13, viz.

$$\mathbf{most}' = (\lambda P)\langle \mathrm{MOST}\ P\rangle.$$

However, a direct reduction to standard first-order format, as for $\forall$ and $\exists$, is not possible for MOST. (Cf. [Barwise and Cooper, 1981]). Rather, a semantics would have to be supplied for the unreduced, predicate-restricted, scoped quantifier; alternatively, some sort of set theory could be introduced to allow translation of statements involving such quantifiers into first-order statements about set cardinality. For discussion along these lines, see [McCawley, 1981, pp. 425–433].

4. If all quantities of M have property P, then all kinds of M have property P.

Consider, respectively, that while some kinds of wine are scarce, no quantity is; that this quantity of water is a puddle but no kind of water is a puddle; that all kinds of wine are kinds of wine, but no quantity is a kind; and finally, it might be the case that all the quantities of Einsteinium are in the lab, but not all the kinds (maybe there are two kinds, but currently only one of them is instantiated by any quantities—all of which are in the lab).

Of course, *sometimes* the inferences are valid, and for those cases the two theories use meaning postulates. Recall that these theories have two types of predicates: those true only of kinds, and those true of both kinds and objects/quantities. Our theories hold that if the predicate is *not* exclusively a kind predicate, and if it holds of a kind M, then it (1) holds of some (perhaps all) subkinds of M (recall that the theories take kinds of M to form an upper semilattice), and (2) holds of at least some (perhaps all) quantities of any such subkind. For example *is a liquid* is true only of kinds while *is liquid* is true of both.[74] The two theories take the view that in such cases the kind property entails the comprehensive property. Thus (as indicated earlier) the (a) sentences entail the (b) sentences.

(a) Water is a liquid

(b) Water is liquid

(a) Claret is a wine

(b) Claret is wine

(a) Gold is a metal

(b) Gold is metal[lic]

When the predicate in question is a comprehensive one, the theories take the view that if the kind has it, then at least some quantity of the subject has it. Thus the following inference from(a) to (b) (and hence to (c)) is taken to be valid.

(a) Water is dripping from the faucet

[74]The two theories get this result in different ways: *liquid* is an adjective which has comprehensive extension, and is introduced by Rule 10, in both theories. *a liquid* is a PRED and introduced by Rule 4 from the noun *liquid*. In the *p*-theory, the noun *liquid* has comprehensive extension, but *a liquid* gets its meaning restricted to kinds/servings by Rule 4p. In the *s*-theory, *liquid* is marked as MASS, and a lexical extension rule converts this to a COUNT noun with the meaning 'kind of liquid'; and finally Rule 4s says that the PRED has the meaning of this derived COUNT noun.

(b) Sm water is dripping from the faucet

(c) Some quantity of water is dripping from the faucet.

Furthermore, following Chierchia [1982a; 1982b], the theories take the position that stative VPs of the comprehensive sort, such as *is liquid, is wine*, etc. induce a 'universal' reading on the sentence. Non-stative VPs of the comprehensive sort, such as *is dripping from the faucet* or *is lying on my desk*, are assumed to induce an 'existential' reading on the sentence. Thus while *water is liquid* is equivalent to *all water is liquid* and entails *all quantities of water are liquid*, the non-stative sentence *gold is lying on my desk* entails *some quantity of gold is lying on my desk*. These, and similar inferences, can be handled in the theories either by means of meaning postulates or directly in the translations (or by a combination of both, as in Chierchia who handles the universal import in stative sentences via meaning postulates but handles the existential import of non-stative VPs directly though a semantic rule for non-stative VPs).[75]

It will be recalled that both theories take a PRED formed with *a* plus M to denote the subset of conventional kinds of M belonging to the semilattice of kinds of M. (For present purposes, we an ignore the alternative denotation consisting of conventional portions and kinds of portions of M.) So *is an* M is a predicate true of all the subkinds of M (whereas M as a complete noun phrase, as when it is the bare subject of a sentence names the uppermost element of the semilattice). This gives our theories' account of why

Claret is a wine

Sauterne is a wine

Burgundy is a wine

and the like are all true (given that *Claret, Sauterne*, and *Burgundy* are, in fact, conventional kinds of wine). It is also our theories' reason for saying that *All wines are wines* is true. Although we have not discussed our theories' handling of plurals, we will assert that *are wines* is the plural VP corresponding to *is a wine*, and hence the sentence will be true if *all wines* designates a class of conventionally recognised subkinds of wine—which it does according to these theories, namely the class of all conventionally recognised subkinds of wine. This, together with the previously mentioned meaning postulate, is the reason *All wines are wine* is true—*are wine* is the (plural) comprehensive predicate corresponding to the kind predicate *are wines*. Since *All wines are wines* is analytically true, the meaning postulate will have it entail *All wines are wine*. *All wine* (as opposed to *all wines*), it

[75] Perhaps it should be noted that many VPs have both a stative and non-stative reading, for example in *Gold glitters in the mines* or in *Oran-utans inhabit the jungles of Borneo*.

will be recalled, designates not only the subkinds of wine, but all quantities of wine, so a sentence like *All wine is a wine* will be false (or semantically anomalous) because of the mismatch between the subject designator and the predicate. Similarly, *Wine is wine* and *All wines are wine* will be true (and analytic), but *Wine is a wine* will be false.[76]

With these meaning postulates and semantic theory, the two theories can account for a variety of sentences and inferences, by generating them and giving them the correct logical form, which are beyond the scope of other theories.[77] Correct logical form is assigned to these sentences.

Wine is wine (two readings, both analytic)
Wine is a wine (false)
Chilled wine is a wine (false)
All wine is wine (analytic)
*All wine is a wine (semantically anomalous)
Water is dripping from the faucet (entails: sm water is dripping from the faucet)
Water is a liquid (entails: water is liquid).

Consider these inferences:

1. Claret is a wine, wine is a liquid, so claret is a liquid
2. Claret is a wine, wine is a liquid, so claret is liquid
3. Claret is a wine, wine is liquid, so claret is liquid

These three are valid inferences, according to the theories, because: the first premise of each asserts that claret is a kind (of wine), and in (1) and (2) are also told that wine is a kind (of liquid), hence in (1) we get from the semilattice of kinds[78] that claret is a kind (of liquid) and by our meaning postulate we get (2) that claret is liquid. In (3) we are told that wine is liquid, so everything which is wine is liquid and hence claret is liquid.

Now consider

4. Claret is a wine, wine is liquid, so claret is a liquid
5. Claret is wine, wine is a liquid, so claret is a liquid

[76]Since both theories take *is a wine* to be a predicate true only of conventional subkinds of wine, *wine*—as a 'formal' kind but not a conventionally recognised subkind of wine—will not fall in the extension of *is a wine*. For the same reason, *Chilled wine is a wine, Cheap wine is a wine, Claret mixed with Sauterne is a wine*, etc. are false.

[77]Of course we believe to have already shown that our theories can account for the analyticity of certain sentences, the anomaly of certain sentences, the validity of certain inferences, and so on, which no other theory can account for. Here we give further examples.

[78]In particular, the following is a valid inference in the semilattice: $A(B), B(C)$ therefore $A(C)$. Replace A by *liquid*, B by *wine*, and C by *claret* for our inference.

6. Claret is wine, wine is a liquid, so claret is a liquid

7. Claret is wine, wine is a liquid, so claret is a liquid

8. Claret is wine, wine is liquid, so claret is liquid.

(4) is invalid because although claret is conventionally recognised wine-kind, it may not be a conventionally recognised liquid-kind. In (5)–(8) we are not given in the first premise that claret is a kind—for all we were told, it might be a name or description of a quantity or object—and so the Arguments mentioned above no longer work to show any of these to be valid arguments. Of course, with an added premise to the effect that claret *is* a conventional kind (5), (6) and (8) would be valid; but we are currently interested in which of the inferences are valid without this added information. Obviously, if it is not given that claret is a conventional kind, then the conclusions of (5) and (7) might be false, so they cannot be valid arguments. The second premise of (6) entails, by the meaning postulates, the second premise of (8); thus, showing that (8) is valid will imply that (6) is also. And indeed (8) is valid, since *is liquid* and *is wine* are stative VPs and hence induce a universal reading upon the sentences, as in *All claret is wine* and *All wine is liquid*.

We know of no other theories which can do all these things. Yet the two theories are radically different: one has a mass/count distinction in the syntax and the other doesn't, and they have different extensions assigned to the lexical items. So the question naturally arises—which is better? What can be said against the two theories? There is not space in a survey to go into the issues involved here in detail, so we shall content ourselves with just hurling the main charge that each one directs against the other. Briefly, the *p*-theory charges the *s*-theory with pretending to use syntactic features +mass and +count but allowing them to do no syntactic work. For every sentence which has a mass term in a given location, there is another sentence which has a count term in that position. No constructions are ruled out (although some are marked as +EXT, i.e. as involving lexical extension); the only use of the +mass/+count features is in directing the semantic translation process. And that suggests that the features should all along have been semantic. The *s*-theory charges the *p*-theory with being unable to give coherent meaning or factual postulates because of its commitment to a comprehensive extension to the lexical terms. For example, suppose one wanted to give as a factual postulate that *A lamb has fur*. The *s*-theory can do this without difficulty: **lamb′** is true of individual lambs and the postulate says of each of them that they have fur. But the *p*-theory cannot easily do this: **lamb′** is true of stuff, among other things, so the predicate must be converted to one which is true only of individuals. But there is no provision in the *p*-theory for doing this—the closest that it could come is with a predicate that is true of both conventional kinds and 'conventional

portions' (i.e. ordinary lambs or servings of lamb). See [Heintz, 1985] for further comments along these lines.

CONCLUSION

It will be recognised that the two theories draw from many other theories. Many of our remarks about kinds can be found in [ter Meulen, 1980]—although we do not accept her claims that 'only simple lexical expressions can denote kinds' and 'no sentence of the form *M is M* can be well-formed. Some of the remarks about semilattices can be found in [Link, 1981]—although he does not consider a semilattice of kinds as we do. Our use of stative vs. non-stative VPs to induce a universal vs. existential reading on sentences is due to Chierchia [1982a; 1982b], which in turn is due to Carlson [1977; 1982]. Various of the informal understandings of the notion of a quantity can be found in [Cartwright, 1970]. The conflation of 'ordinary' objects and quantities into a single category can be found in [Pelletier, 1974], Chierchia (*op. cit.*), and [Link, 1981]. And the underlying conception of a grammatical theory is due, of course, ultimately to Montague [1973a] as filtered by the works of Gazdar *et al.* [1985]. Many of the details of our view are also to be found in [Lønning, 1987] and [Higginbotham, 1994]. Perhaps what is most novel here is the attention paid to the denotation of mass CNs as opposed to mass NPs, and the view that they are predicates true not only of objects and quantities, but also of kinds.

So, which theory is to be preferred? That is a topic for further research. We hope to have shown where we think the issues lie and where future efforts should (and should not) focus. One thing should be clear from this survey of the work done on the topic of the semantics (and syntax) of mass expressions: the time for studies of mass expressions with only causal reference to the syntax and semantics of language is past. Only systematic attempts to account for large classes of mass expressions within formal syntactic-semantic-pragmatic frameworks can hope to resolve the remaining issues.

MASS/COUNT IN OTHER FIELDS

In this section we briefly mention areas that have either studied the mass-count distinction from a different perspective than we have pursued, or have employed the distinction in the pursuit of other philosophical purposes. In the former group we think primarily of psychological research but also of some computational work, while in the latter group we think of the use of count/mass to explicate the thought of figures in the history of philosophy as well as in the characterization of certain ontological issues. Our exposition here will necessarily be short, but we feel that the preceding discussion of

the syntactic, semantic, and pragmatic topics concerning the distinction can enable others to understand more fully the types of assumptions being made by these researchers and to evaluate their claims in a more successful manner.

There has been some psycholinguistic research on the mass/count distinction, particularly in the context of children's development of a mass-count distinction in their language and in their cognitive differentiation between the two. When it comes to mass vs. count concepts that are of solid substances ('concrete mass terms' such as *wood* or *metal*, as opposed to 'abstract mass terms' like *freedom* and *happiness*), children even up to the age of 4 or 5 years apparently have difficulty understanding novel words as naming the *stuff* (the mass concept of substance) an object is made of, when they are presented with an object made out of that stuff. Instead, they prefer to interpret the term as naming the object or *kind of object* (the count concept of a group) being presented. For example, when shown a new object made out of an unknown material, and told 'This is blicket' or even 'This is made of blicket,' the children only rarely interpreted 'blicket' as the name of a material, and instead thought of the object as one blicket. That is, they interpreted 'blicket' as a count noun rather than a mass noun ([Dickinson, 1988], also [Markman and Wachtel, 1988]). However, when the mass term in question picks out 'non-substantial' features, even 3-year-olds are able to make the intuitively correct distinctions. An example is a bell sound which is presented rapidly enough that it could be construed either as a set of discrete sounds or as undifferentiated noise, and children are told either 'These are feps–there really are a lot of feps here' or 'This is fep–there really is a lot of fep here'. If the children are asked to 'make a fep' or 'make fep' with a stick on a real bell, they make a single sound for 'make a fep' and a lot of sounds when asked to 'make fep' [Bloom, 1994b]. Other aspects of these developmental studies can be found in [Bloom, 1994a; Bloom, 1994c; Gathercole, 1985; Gathercole, 1986; Gordon, 1988; Hall *et al.*, 1993; Macnamara and Reyes, 1994; McPherson, 1991; Nelson *et al.*, 1993; Prasada, 1993; Prasada, 1999; Shipley and Shepperson, 1990; Soja, 1992; Soja, 1994; Soja *et al.*, 1991; Soja *et al.*, 1992]. A survey of the developmental literature can be found in Bloom [2000, pp. 198–211]. Psycholinguistic evidence of a non-developmental nature is put forward by Gillon [1999] and Xu [1997]; physiological evidence for localization of these features is suggested by Semenza [2000].

There has also been work in trying to incorporate mass-count information into computational accounts of natural language. Bond and colleagues [Bond *et al.*, 1994; Bond and Vatikiotis-Bateson, 2002; Baldwin and Bond, 2003] and also O'Hara *et al.* [2003] have investigated how this information might interact with a 'computational ontology', how it might be employed in machine translation, and how a computer system might 'learn' the mass-count distinction from an unannotated corpus of text, such as large datasets

that are unmarked for the count/mass distinction. One interesting result of this last is the discovery of the large number of nouns that have both count and mass uses of approximately equal frequency.

Many researchers have sought to use a mass/count (or sortal) distinction as a way to understand figures in the history of philosophy. Sometimes the researchers have suggested that the historical figures were consciously drawing attention to the distinction and were making philosophical points based on having made such a distinction; other times it is the researchers themselves who employ the distinction in an attempt to explain how the historical figures might have been led to draw some of their other philosophical conclusions by an unconscious appreciation of the distinction. We hope that our survey of positions on the semantic and ontological aspects of mass, count, and sortal predicates will enable others to evaluate accurately the various attempts that have been made to use them when explicating historical figures. Some of the historical figures we have in mind are Parmenides [Pólos, 1987b], Anaxagoras, [Furley, 1976; Furley, 1987; Mann, 1980; Paxson, 1983], Plato [Smith, 1978; Zembaty, 1983], Aristotle [Sellars, 1967a; Sellars, 1967b; Sellars, 1967c; Sharvy, 1983b; Furth, 1988; Cresswell, 1992; Cohen, 1996], Alexander of Aphrodisias [Sharples, 1999], Locke [Pelletier, 1977], Spinoza [Madanes, 1989] and Heidegger [Stewart, 1987].

A very interesting interpretative strand for the "White Horse [is] not Horse" paradox of Kung-sun Lung (b. 380 BCE) was begun by Hanson [1976], who argued that nouns and adjectives were interpreted by speakers of classical Chinese as being mass, and that this could give the required understanding for Kung-sun Lung's paradox. This interpretation has garnered a large number of responses, many of which employ some of the semantic considerations mentioned in our survey of mass terms. The interested reader is referred to Hansen [1976; 1983], Reiman [1981], Cheng [1983], Graham [1986], Harbsmeier [1991], Lai [1995], Thompson [1995], and Mou [1999].

Finally, and as indicated already in the INTRODUCTION of this article, the notions of *mass* vs. *count* (or *sortal* [79]) have also played an important role in metaphysics, both as part of a description of the ultimate nature of the world and as an explanatory device in accounting for change and our perception of reality.[80] Both of these areas of metaphysics embody a huge literature that we cannot even hope to survey. And so we will mention some of those works that more consciously employ the notion of *mass* in their accounts.

One strand of the relevant metaphysics is more descriptive of natural language than others, and has come to be called 'natural language metaphysics' (a term coined in [Bach, 1981]). This version of metaphysics follows some

[79] We will not here say more about the notion of sortal, except to indicate that there is an immense literature that follows up Strawson [1959].

[80] There are also attempts to emply the concept of *mass* in the philosophy of religion: Madanes [1989], Pfeifer [1997].

programmatic statements of Strawson [1959] and sets itself the task of answering the questions "what sorts of things do people talk as if there are?" and "what sorts of things and stuff, and relations among them are needed to exhibit the structure of meanings that various languages seem to have?" This approach has been championed by Bach [1981; 1986a; 1986b; 1994], who pays particular attention to the role of *mass* and *count* in different languages, and the sort of ontology these uses seem to presuppose. One should also consult Chierchia [1998] in this regard. (The history and background of this approach is discussed in [Pelletier and Thomason, 2002]).

In a more speculative vein of metaphysics, a discussion of using *mass* to give an account of the ultimate nature of reality might start with Zemach [1970] and Simons [1994] as overviews of different strategies in reasoning about ontologies. Theorists advocating a fundamentally mass ontology include Laycock [1972; 1975], van Brakel [1986], Elder [1996], Burke [1994; 1997], and Zimmerman [1995; 1996]. Relevant work in the formal semantics literature would seem to be Roeper [1983] and Lønning [1987], who argue that mass predication is more basic than count predication by interpreting both realms as Boolean algebras and then claiming that the count realm is that special case of the mass realm where we add an extra axiom asserting the existence of atoms (but we cannot likewise generate the mass realm by a simple denial of this axiom). Moltmann [1998] argues that all three of mass predication, singular count predication, and plural count predication are equally basic and that they are differentiated by an "intensional notion of integrity" that characterizes some subjects of predication. The difference between a pile and the sand of which it is made is a matter of the intensional "object integrity", and not anything "in reality". With a similar nod to intensional notions, Koslicki [1999] argues that the three different predications (mass, singular count, plural count) are irreducibly distinct, but then denies that there is therefore an ontological difference among the distinct items that are subjects of predication. Instead it is a 'conceptual difference': *is hair, is a hair*, and *are hairs* are each true of the same external phenomenon, but they describe it in different ways. The difference lies purely in our concepts, not in the actual objects referred to.

Of course, any mass/stuff ontology will need to deal with the issue of mixtures—which seem clearly not to be completely homogeneous, despite being *mass* [Sharvy, 1983a]. Furthermore, such theories will also want some account of why it is that we have count terms when masses are basic. Background speculation on this topic can be found in Pelletier [1991]. Burke [1994; 1997] and Zimmerman [1997] argued over the way that such a category might be useful for undermining the puzzle of two-different-but-coincident-objects. Wandinger [1998] argues that Zimmerman's theory can't get causal interactions right.

One particular area of metaphysics, already touched upon in the preceding paragraph, where issues of mass and count arise concerns the fact that

individual *objects* (as characterized by count terms) are constituted by *stuff* (as characterized by mass terms). And therefore there arise many issues concerning the relationship between the two realms. If one 'reduces' the count realm to the mass realm, then one has the ready answer that the relationship is one of identity. But then the problem becomes one of trying to show that despite the identity, it seems that an object can come and go all the while its 'matter' remains, or that its 'matter' can change all the while the object endures. The alternative explanation is that the object is *constituted* by the stuff, but not thereby identical. But this makes it important to understand the constitution relation. We have already had an opportunity to mention some of the intricacies of this relation when we discussed earlier mass-noun-semantics proposals. For instance, Burge (1975) had noted that while we are happy to say that Theseus's ship remains the same ship despite the gradual replacement of all its matter, we would not be willing to claim that the Parthenon remains the same structure if all its material were gradually replaced (even if replaced by exact-duplicate-appearing modern plastic). Considerations such as these argue for a "contextualist" understanding of "what is essential to the object", being dependent on how the object is perceived by members of a society. This and related issues are very widely discussed. Here we point to a few works that bring out issues of mass terms: Cartwright [1984], Rea [1997], Burke [1994; 1997], Zimmerman [1997], Elder [1998], Thomson [1998], Wandinger [1998].

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the help of members of the 'Logical Grammar Study Group' at the University of Alberta, especially Matthew Dryer (Linguistics), David Justice (Linguistics), and Bernard Linsky (Philosophy). Their stimulating discussions each week during 1983 and 1984, and various memos they wrote on particular topics involving mass expressions, allowed us to more carefully formulate and test our ideas. Many of the things they brought up have been incorporated into this work without explicit acknowledgement. Further, we thank Harry Bunt, John Heintz, Henry Laycock, James McCawley and Alice ter Meulen for their numerous astute comments on an earlier draft of this article, and hope that the revisions we have made address, to some extent, the issues they have raised. We are grateful to Ray Elugardo, Alex Mourelatos, and Mark Steen for bibliographic help in preparing the revised version of this survey. And the revised version of this article would never have been possible except for the excellent help of Jane Spurr.

The authors also acknowledge the aid of NSERC Grant A5525 (FJP), NSERC Grant A8818 (LKS), and Grant R0245/12 from the Deutsche Forschungs Gemeinschaft under the auspices of Christian Rohrer in the summer of 1983 (FJP).

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BIBLIOGRAPHY

[Allen, 1977] K. Allen. Classifiers. *Language*, **53**, 285–311, 1977.

[Allen, 1980] K. Allen. Nouns and countability. *Language*, **56**, 451–467, 1980.

[Allen, 1981] K. Allen. Review of U. Weinreich's 'On Semantics'. *Language*, **57**, 941–948 (esp. 947), 1981.

[Åqvist and Guenthner, 1978] L. Åqvist and F. Guenthner. Fundamentals of a theory of verb aspect and events within the setting of an improved tense-logic. In F. Guenthner and C. Rohrer, eds. *Studies in Formal Semantics*, pp. 167–199, North Holland, Amsterdam, 1978.

[Bach, 1981] E. Bach. On time, tense, and aspect: an essay in English metaphysics. In *Radical Pragmatics*, P. Cole, ed., pp. 63–81. New York, Academic Press, 1981.

[Bach, 1986a] E. Bach. The algebra of events. *Linguistics and Philosophy* **9**, 5–16, 1986.

[Bach, 1986b] E. Bach. Natural language metaphysics. In *Logic, Methodology, and Philosophy of Science VII: Proceedings of the Seventh International Congress, Salzburg 1983*. R. Marcus, G. Dorn, and P. Weingartner, eds., pp. 63–81. Amsterdam, North-Holland, 1986.

[Bach, 1994] E. Bach. The semantics of syntactic categories. In *The Logical Foundations of Cognition*, J. Macnamara and G. Reyes, eds. pp. 264–281. Oxford, Oxford UP, 1994.

[Bacon, 1973] J. Bacon. Do generic descriptions denote? *Mind*, **82**, 331–347, 1973.

[Bahm, 1976] A. Bahm. Degrees and Scales. *ITA Humanidades*, **12**, 67–73, 1976.

[Baldwin and Bond, 2003] T. Baldwin and F. Bond. Learning the countability of English nouns from unannotated corpora. *Proceedings of Association for Computational Linguistics*, 2003.

[Barwise and Cooper, 1981] J. Barwise and R. Cooper. Generalised quantifiers and natural language. *Linguistics and Philosophy*, **4**, 159–219, 1981.

[Bennett, 1977] M. Bennett. Mass nouns and mass terms in Montague grammar. In S. Davis and M. Mithun, eds. *Linguistics, Philosophy and Montague Grammar*, pp. 263–285. University of Texas Press, Austin, 1977.

[Bloom, 1994a] P. Bloom. Generativity within language and other cognitive domains. *Cognition*, **51**, 177–189, 1994.

[Bloom, 1994b] P. Bloom. Possible names: The role of syntax-semantics mappings in the acquisition of nominals. *Lingua*, **92**, 297–329, 1994.

[Bloom, 1994c] P. Bloom. Controversies in language acquisition: Word learning and the part of speech. In *Handbook of Perceptual and Cognitive Development*. R. Gelman & T. Au, eds., pp. 151–184. New York: Academic Press, 1994.

[Bloom, 1999] P. Bloom. The role of semantics in solving the bootstrapping problem. In *Language, Logic, and Concepts: Essays in Honor of John Macnamara*. R. Jackendoff, P. Bloom, and K. Wynn, eds. pp. 285–309. Cambridge, MA: MIT Press.

[Bloom, 2000] P. Bloom. *How Children Learn the Meanings of Words*. Cambridge, MA: MIT Press, 2000. (Especially pp. 198-211).

[Bloom and Kelemen, 1995] P. Bloom and D. Keleman. Syntactic cues in the acquisition of collective nouns. *Cognition*, **56**, 1–30, 1995.

[Bond *et al.*, 1994] F. Bond, K. Ogura, and S. Ikehara. Countability and number in Japanese-to-English machine translation. *Fifteenth International Conference on Computational Linguistics (COLING-94)* pp. 32–38, 1994.

[Bond and Vatikiotis-Bateson, 2002] F. Bond and C. Vatikiotis-Bateson. Using an ontology to determine English countability. *Nineteenth International Conference on Computational Linguistics (COLING-2002)*, vol. 1: pp. 99–105, 2002.

[Bricker, 1988] P. Bricker. Review of [Bunt, 1985]. *Journal of Symbolic Logic*, **53**, 653–656, 1988.

[Briscoe *et al.*, 1995] T. Briscoe, A. Copestake, and A. Lascarides. Blocking. In *Computational Lexical Semantics*, P. Saint-Dizier and E. Viegas, eds. pp. 273–312. Cambridge: Cambridge UP, 1995

[Bunt, 1976] H. C. Bunt. The formal semantics of mass terms. *Papers from the 3rd Scandinavian Conference of Linguistics*, Helsinki, 1976.

[Bunt, 1978] H. C. Bunt. A formal semantic analysis of mas terms and amount terms. In J. Groenendijk and M. Stokhof, eds. *Amsterdam Papers in Formal Grammar*, Vol II, 1978.

[Bunt, 1979] H. C. Bunt. Ensembles and the formal semantic properties of mass terms. In [Pelletier, 1979, pp. 249–27].

[Bunt, 1980] H. C. Bunt. On the why, the how, and the whether of a count-mass distinction among adjectives. In J. Groenendijk and M. Stokhof, eds. *Formal Methods in the Study of Language*, pp. 51–77. Mathematical Centre, Amsterdam, 1980.

[Bunt, 1981] H. C. Bunt. *The Formal Semantics of Mass Terms.* Dissertation, University of Amsterdam, 1981.

[Bunt, 1985] H. C. Bunt. *Mass Terms and Model Theoretic Semantics.* Cambridge University Press, Cambridge, 1985.

[Burge, 1972] T. Burge. Truth and mass terms. *Journal of Philosophy*, **69**, 263–282, 1972.

[Burge, 1975] T. Burge. Mass terms, count nouns and change. *Synthese*, **31**, 459–478, 1975. Reprinted in [Pelletier, 1979, pp. 199–218].

[Burke, 1994] M. Burke. Preserving the principle of one object to a place: a novel account of the relations among objects, sorts, sortals, and persistence conditions. *Philosophy and Phenomenological Research* **54**, 591–624, 1994.

[Burke, 1997] M. Burke. Coinciding objects: a reply to Lowe and Denkel. *Analysis*, **57**, 11–18, 1997.

[Carlson, 1977] G. Carlson. A unified analysis of the English bare plural. *Linguistics and Philosophy*, **1**, 413–456, 1977.

[Carlson, 1982] G. Carlson. Generic terms and generic sentences. *Journal of Philosophical Logic*, **11**, 163–182, 1982.

[Cartwright, 1965] H. M. R. Cartwright. Heraclitus and the bath water. *Philosophical Review*, **74**, 466–485, 1965.

[Cartwright, 1970] H. M. R. Cartwright. Quantities. *Philosophical Review*, **79**, 25–42, 1970.

[Cartwright, 1975] H. M. R. Cartwright. Amounts and measures of amounts. *Nous*, **9**, 143–164, 1975. Reprinted in [Pelletier, 1979, pp. 179–198].

[Cartwright, 1984] H. Cartwright. Parts and partitives: notes on what things are made of. *Synthese* **58**, 251–277, 1984.

[Cheng, 1973] C.-Y. Cheng. Response to Moravcsik. In [Hintikka *et al.*, 1973, pp. 286–288].

[Cheng, 1983] C.-Y. Cheng. Kung-sun Lung: white horse and other issues. *Philosophy East and West*, **33**, 341–354, 1983.

[Chierchia, 1982a] G. Chierchia. Bare plurals, mass nouns and nominalisation. In D. Flickinger, M. Macken and N. Wiegand, eds. *Proceedings of the First West Coast Conference on Formal Linguistics*, pp. 243–255, 1973.

[Chierchia, 1982b] G. Chierchia. Nominalisation and Montague grammar. A semantics without types for natural language. *Linguistics and Philosophy*, **5**, 303–354, 1982.

[Chierchia, 1983] G. Chierchia. On plural and mass nominals and the structure of the world. In T. Borowsky and D. Finer, eds. *Univ. of Massachusetts Occasional Papers, VIII*, GLSA, Amherst, 1983.

[Chierchia, 1998] G. Chierchia. Reference to kinds across languages. *Natural Language Semantics*, **6**, 339–405, 1998.

[Clark and Clark, 1979] H. Clark and E. Clark. When nouns surface as verbs. *Language*, **55**, 767–811, 1979.

[Clarke, 1970] D. S. Clarke. Mass terms as subjects. *Philosophical Studies*, **21**, 25–29, 1970.

[Cocchiarella, 1976] N. Cocchiarella. On the logic of natural kinds. *Philosophy of Science*, **43**, 202–222, 1976.

[Cocchiarella, 1977] N. Cocchiarella. Sortals, natural kinds and re-identification. *Logique et analyse*, pp. 439–474, 1977.

[Cocchiarella, 1978] N. Cocchiarella. On the logic of nominalised predicates and its philosophical interpretations. *Erkenninis*, **13**, 339–369, 1978.

[Cohen, 1996] S. M. Cohen. *Aristotle on Nature and Incomplete Substance.* Cambridge: Cambridge University Press, 1996.

[Cook, 1975] K. Cook. On the usefulness of quantities. *Synthese*, **31**, 443–457, 1975. Reprinted in [Pelletier, 1979, pp. 121–135].

[Cresswell, 1992] M. Cresswell. The ontological status of matter in Aristotle. *Theoria*, **58**, 116–130, 1992.

[Davidson, 1967] D. Davidson. Truth and meaning. *Synthese*, **17**, 304–323, 1967.

[Dickinson, 1988] D. K. Dickinson. Learning names for materials: Factors limiting and constraining hypotheses about word meaning. *Cognitive Development*, **3**, 15–35, 1988.

[Elder, 1996] C. Elder. Contrariety and 'carving up reality'. *American Philosophical Quarterly*, **96**, 277–289, 1996.

[Elder, 1998] C. Elder. Essential properties and coinciding objects. *Philosophy and Phenomenological Research*, **58**, 317–331, 1998.

[Factor, 1975] R. L. Factor. A note on the analysis of mass terms. *Southern Journal of Philosophy*, **13**, 247–249, 1975.

[Feldman, 1973] F. Feldman. Sortal predicates. *Nous*, **7**, 268–282, 1973.

[Furley, 1976] D. Furley. Anaxagoras in response to Parmenides. *Canadian Journal of Philosophy*, Sup. Vol. **2**, 61–85, 1976.

[Furley, 1987] D. Furley. *The Greek Cosmologists, Vol. 1: The Formation of the Atomic Theory and its Earliest Critics.* Cambridge: Cambridge UP, 1987.

[Furth, 1988] M. Furth. *Substance, Form, and Psyche: An Aristotelean Metaphysics.* Cambridge: Cambridge UP, 1988.

[Gabbay and Moravcsik, 1979] D. M. Gabbay and J. M. E. Moravcsik. Verbs, events and the flow of time. In C. Rohrer, ed. *Time, Tense and Quantifiers*, pp. 59–84. Niemeyer, Stuttgart, 1979.

[Gathercole, 1985] V. C. Gathercole. 'He has too much hard questions': the acquisition of the linguistic mass-count distinction in 'much' and 'many'. *Journal of Child Language*, **12**, 395–415, 1985.

[Gathercole, 1986] V. C. Gathercole. Evaluating competing linguistic theories with child language data: The case of the mass-count distinction. *Linguistics and Philosophy*, **9**, 151–190, 1986.

[Gazdar *et al.*, 1985] G. Gazdar, E. Klein, G. Pullum and I. Sag. *Generalised Phrase Structure Grammar*, Harvard University Press, Cambridge, MA, 1985.

[Geach, 1962] P. Geach. *Reference and Generality*, Cornell University Press, Ithaca, 1962.

[Gillon, 1992] B. Gillon. Towards a common semantics for English count and mass nouns. *Linguistics and Philosophy*, **15**, 597–640, 1992.

[Gillon, 1999] B. Gillon. The lexical semantics of English count and mass nouns. In *The Breadth and Depth of Semantic Lexicons*, E. Viegas, ed. pp. 19–37. Dordrecht: Kluwer, 1999.

[Gillon *et al.*, 1999] B. Gillon, E. Kehayia, and V. Taler. The mass/count distinction: evidence from on-line psycholinguistic performance. *Brain and Language*, **68**, 205–211, 1999.

[Gleason, 1965] H. A. Gleason. *Linguistics and English Grammar*, Holt, Rinhart and Winston, New York, 1965. (Esp. pp. 134–137.)

[Glouberman, 1975] M. Glouberman. Strawson's hidden realism. *Journal of Critical Analysis* **5**, 135–145, 1975.

[Gordon, 1988] P. Gordon. Count-mass category acquisition: distributional distinctions in children's speech. *Journal of Child Language*, **15**, 109–128, 1988.

[Graff, 2001] D. Graff. Descriptions as predicates. *Philosophical Studies*, **102**, 1–42, 2001.

[Graham, 1986] A. Graham. The disputation of Kung-sun Lung as argument about whole and part. *Philosophy East and West*, **36**, 89–106, 1986.

[Grandy, 1973] R. Grandy. Reply to Moravcsik. In [Hintikka *et al.*, 1973, pp. 295–300].

[Grandy, 1975] R. Grandy. Stuff and things. *Synthese*, **31**, 479–485, 1975. Reprinted in [Pelletier, 1979, pp. 219–225].

[Hall *et al.*, 1993] D. G. Hall, S. R. Waxman, and W. M. Hurwitz. How two- and four-year-old children interpret adjectives and count nouns. *Child Development*, **64**, 1651–1664, 1993.

[Hansen, 1976] C. D. Hansen. Mass nouns and 'A white horse is not a horse'. *Philosophy East and West*, **26**, 189–209, 1976.

[Hansen, 1983] C. D. Hansen. *Language and Logic in Ancient China*. Ann Arbor, MI: Univ. Michigan Press, 1983.

[Harbsmeier, 1991] C. Harbsmeier. The mass noun hypothesis and the part-whole analysis of the white horse dialogue. In *Chinese Texts and Philosophical Contexts*. H. Rosemont. ed. pp. 49–66. LaSalle, IL: Open Court, 1991.

[Heintz, 1985] J. Heintz. Do lambs have fur? Paper read at Canadian Philosophical association meetings, Montreal, 1985.

[Hendry, 1982] H. Hendry. Complete extensions of the calculus of individuals. *Nous*, **16**, 453–460, 1982.

[Hestevold, 1978] H. S. Hestevold. *A Metaphysical Study of Aggregates and Continuous Wholes*, PhD dissertation, Brown University, 1978.

[Higginbotham, 1994] J. Higginbotham. Mass and count quantifiers. *Linguistics and Philosophy*, **17**, 447–480, 1994.

[Hintikka *et al.*, 1973] J. Hintikka, J. M. E. Moravcsik and P. Suppes. *Approaches to Natural Language*, D. Reidel, Dordrecht, 1973.

[Hoeksema, 1983] J. Hoeksema. Plurality and conjunction. In A. ter Meulen, ed. *Studies in Model-theoretic Semantics*, pp. 63–83. Foris, Dordrecht, 1983.

[Hoepelman, 1976] J. Hoepelman. Mass nouns and aspects, or: Why we can't eat gingercake in an hour. In J. Groenendijk and M. Stokhof, eds. *Amsterdam Papers in Formal Grammar, Vol I*, Math. Centrum, Amsterdam, 1976.

[Hoepelman, 1978] J. Hoepelman. The treatment of activity verbs in a Montague-type grammar, a first approximation. In F. Guenthner and C. Rohrer, eds. *Studies in Formal Semantics*, pp. 121–165. North-Holland, Amsterdam, 1978.

[Hoepelman and Rohrer, 1976] J. Hoepelman and C. Rohrer. On the mass-count distinction and the French imparfait and passé simple. In C. Rohrer, ed. *Time, Tense and Quantifiers*, pp. 85–112. Niemeyer, Tübingen, 1976.

[Huddleston and Pullum, 2002] R. Huddleston and G. Pullum. *The Cambridge Grammar of the English Language*. Cambridge: Cambridge UP, 2002. (See esp. pp. 334–340).

[Kamp, 1975] H. Kamp. Two theories about adjectives. In E. Keenen, ed. *Formal Semantics of Natural Language*, pp. 123–155. Cambridge University Press, 1975.

[Kaplan, 1973] D. Kaplan. Bob and Carol and Ted and Alice. In [Hintikka *et al.*, 1973, pp. 490–518].

[Klooster, 1972] W. Klooster. *The Structure Underlying Measure Phrase Sentences*. D. Reidel, Dordrecht, 1972.

[Koslicki, 1999] K. Koslicki. The semantics of mass predicates. *Nous*, **33**, 46–91, 1999.

[Lai, 1995] W. Lai.White Horse not horse: making sense of a negative logic. *Asian Philosophy*, **5**, 59–74, 1995.

[Laycock, 1972] H. Laycock. Some questions of ontology. *Philosophical Review*, **81**, 3–42, 1972.

[Laycock, 1975] H. Laycock. Theories of matter. *Synthese*, **31**, 411–442, 1975. Reprinted in [Pelletier, 1979, pp. 89–120].

[Laycock, 1985] H. Laycock. Mass terms again. Paper read at Canadian Philosophical Association meetings, Montreal, 1985.

[Leech, 1969] G. N. Leech. *Towards a Semantic Description of English*, Longman, London, 1969.

[Link, 1981] G. Link. The logical analysis plurals and mass terms: a lattice-theoretical approach. In R. Bäuerle, C. Schwartz and A. von Stechow, eds. *Meaning, Use and Interpretation of Language*, pp. 302–323, de Gruyter, Berlin, 1981.

[Löbner, 1985] S. Löbner. Definites. *Journal of Semantics*. **4**, 279–326, 1985.

[Lønning, 1987] J. Lønning. Mass terms and quantification. *Linguistics and Philosophy*, **10**, 1–52, 1987.

[Lønning, 1989] J. Lønning. Computational semantics of mass terms. *Proceedings of the Fourth European ACL* Manchester, UK, pp. 205–211, 1989.

[Lowe, 1989] E. Lowe. *Kinds of Being: A Study of Individuation, Identity, and the Logic of Sortal Terms*. Oxford, Blackwells, 1989.

[McCawley, 1975] J. McCawley. Lexicography and the count-mass distinction. *Proceedings of the First Annual Meeting of Berkeley Linguistics Society*, pp. 314–321, 1975.

[McCawley, 1981] J. McCawley. *Everything the Linguists Always Wanted to Know About Logic*. University of Chicago Press, Chicago, 1981.

[Macnamara and Reyes, 1994] J. Macnamara and G. E. Reyes. Foundational issues in the learning of proper names, count nouns and mass nouns. In *The Logical Foundations of cognition*. J. Macnamara & G.E. Reyes, eds. Oxford: Oxford University Press, 1994.

[McPherson, 1991] L. McPherson. 'A little' goes a long way: Evidence for a perceptual basis of learning for the noun categories COUNT and MASS. *Journal of Child Language*, **18**, 315–338, 1991.

[Madanes, 1989] L. Madanes. 'Nature', 'Substance', and 'God' as mass terms in Spinoza's *Theologico-Political Treatise*. *History of Philosophy Quarterly*, **6**, 295–302, 1989.

[Malotki, 1983] E. Malotki. *Hopi Time: A Linguistic Analysis of the Temporal Concepts in the Hopi Language*. Mouton, Berlin, 1983.

[Mann, 1980] W. Mann. Anaxagoras and the Homoiomere" *Phronesis* **25**, 228–249, 1980.

[Markman and Wachtel, 1988] E. M. Markman and G. F. Wachtel. Children's use of mutual exclusivity to constrain the meaning of words. *Cognitive Psychology*, **20**, 121–157, 1988.

[Massey, 1976] G. J. Massey. Tom, Dick and Harry and all the king's men. *American Philosophical Quarterly*, **13**, 89–107, 1976.

[Mellema, 1981] G. Mellema. On quantifiers and mass terms. *American Philosophical Quarterly*, **18**, 165–170, 1981.

[Moltmann, 1997] F. Moltmann. *Parts and Wholes in Semantics*. New York, Oxford UP, 1997.

[Moltmann, 1998] F. Moltmann. Part structures, integrity, and the mass-count distinction. *Synthese*, **116**, 75–111, 1998.

[Montague, 1973] R. Montague. Reply to Moravcisk. In [Hintikka *et al.*, 1973, pp. 289–294]. Reprinted in [Pelletier, 1979, pp. 173–178] as The proper treatment of mass terms in English.

[Montague, 1973a] R. Montague. Reply to Moravcsik. The proper treatment of quantifiers in English. In [Hintikka *et al.*, 1973, pp. 221–242].

[Moravcsik, 1973] J. M. E. Moravcsik. Mass terms in English. In [Hintikka *et al.*, 1973, 263–285].

[Mou, 1999] Bo Mou. The structure of the Chinese language and ontological insights: a collective-noun hypothesis. *Philosophy East and West*, **49**, 45–62, 1999.

[Mourelatos, 1978] A. P. D. Mourelatos. Events, processes and states. *Linguistics and Philosophy*, **2**, pp. 415–434, 1978.

[Mufwene, 1980] S. S. Mufwene. Number, countability and markedness in Lingala LI-/MA- noun class. *Linguistics*, **18**, 1019–1052, 1980.

[Mufwene, 1981] S. S. Mufwene. Non-individuation and the count/mass distinction. *Chicago Linguistic Society Papers*, **20**, 221–238, 1981.

[Mufwene, 1983] S. S. Mufwene. The proper name/common noun distinction. Paper presented at Winter Meeting of Linguistic Society of America, Minneapolis, 1983.

[Mufwene, 1984] S. S. Mufwene. The count mass/distinction and the English lexicon. In D. Testen, V. Mishra and J. Drogo, eds. *Papers from the Parasession on Lexical Semantics*, pp. 200–221. Chicago Linguistic Society, 1984.

[Nelson *et al.*, 1993] K. Nelson, J. Hampson, and L. K. Shaw. Nouns in early lexicons: Evidence, explanations, and implications. *Journal of Child Language*, **20**, 61–84, 1993.

[Nola, 1980] R. Nola. 'Paradigms lost, or, the world regained'—an excursion into realism and idealism in science. *Synthèse*, **45**, 317–350, 1980.

[Noonan, 1978] H. Noonan. Count nouns and mass nouns. *Analysis*, **38**, 167–172, 1978.

[O'Hara *et al.*, 2003] T. O'Hara, N. Salay, M. Witbrock, D. Schneider, B. Aldag, S. Bertolo, K. Panton, F. Lehmann, J. Curtis, M. Smith, D. Baxter, and P. Wagner. Introducing criteria for mass noun lexical mappings using the Cyc KB, and its extension to WordNet. In *Proceedings of the Fifth International Workshop on Computational Semantics* Tilburg, Netherlands, 2003.

[Ojeda, 1993] A. Ojeda. *Linguistic Individuals* Stanford, CSLI Publications, 1993.

[Parsons, 1970] T. Parsons. An analysis of mass and amount terms. *Foundations of Language*, **6**, 363–388. Reprinted in [Pelletier, 1979, pp. 137–166].

[Parsons, 1975] T. Parsons. Afterthoughts on mass terms. *Synthese*, **31**, 517–521, 1975. Reprinted in [Pelletier, 1979, pp. 167–171].

[Paxson, 1983] T. Paxson. The Holism of Anaxagoras. *Apeiron* **17**, 85–91, 1983.

[Pelletier, 1974] F. J. Pelletier. On some proposals for the semantics of mass terms. *Journal of Philosophical Logic*, **3**, 87–108, 1974.

[Pelletier, 1975] F. J. Pelletier. Non-singular reference: some preliminaries. *Philosophia*, **5**, 1975. Reprinted in [Pelletier, 1979, pp. 1–14].

[Pelletier, 1977] F. J. Pelletier. Locke's doctrine of substance. *Canadian Journal of Philosophy*. Sup. Vol. **3**, 121–140, 1977.

[Pelletier, 1979] F. J. Pelletier, ed. *Mass Terms: Some Philosophical Problems*, D. Reidel, Dordrecht, 1979.

[Pelletier, 1979a] F. J. Pelletier. A bibliography of recent work on mass terms. In [Pelletier, 1979, pp. 295–298].

[Pelletier, 1991] F. J. Pelletier. Mass terms. In *Handbook of Metaphysics and Ontology*, B. Smith, ed. pp. 495–499. Philosophia Press: Munich, 1991.

[Pelletier, 1998] F. J. Pelletier. Mass terms. In *The Routledge Encyclopedia of Philosophy*. 1998.

[Pelletier and Thomason, 2002] F. J. Pelletier and R. Thomason. Twenty-five years of linguistics and philosophy. *Linguistics and Philosophy*, **25**, 507–529, 2002.

[Pfeifer, 1997] K. Pfeifer. Pantheism as Panpsychism. *Conceptus*, **30**, 181–190, 1997.

[Pólos, 1985] L. Pólos. Mass nouns: a semantic representation. *Tertium non Datur*, **2**, 1985. In Hungarian.

[Pólos, 1987a] L. Pólos.
Mass nouns, plurals, events. *Tertium non Datur*, **4**, 1987. In Hungarian.

[Pólos, 1987b] L. Pólos. Mass terms: a found key to Parmenides. *Tertium non Datur*, **4**, 1987. In Hungarian.

[Prasada, 1993] S. Prasada. Learning names for solid substances: Quantifying solid entitles in terms of portions. *Cognitive Development*, **8**, 83–104, 1993.

[Prasada, 1999] S. Prasada. Names for things and stuff: An Aristotelian perspective. In *Language, Logic, and Concepts: Essays in Honor of John Macnamara*, R. Jackendoff, P. Bloom, and K. Wynn, eds., pp. 119–146. Cambridge, MA: MIT Press, 1999.

[Prior, 1967] A. Prior. Things and stuff. In *Papers in Logic and Ethics*, A. Prior, ed. pp 181–186. London: Duckworth, 1967.

[Quine, 1960] W. V. Quine. *Word and Object*, MIT Press, Cambridge, MA, 1960.

[Quine, 1964] W. V. Quine. Review of [Geach 1962]. *Philosophical Review*, **73**, 100–105, 1964.

[Quirk *et al.*, 1972] R. Quirk, S. Greenbaum, G. Leech and J. Svartvik. *A Grammar of Contemporary English*, Longman, London, 1972.

[Rea, 1997] M. Rea. Supervenience and co-location. *American Philosophical Quarterly*, **34**, 367–375, 1977.

[Reeve, 1980] C. D. Reeve. *Mass, Quantity and Amount*. PhD dissertation, Cornell University, 1980.

[Reiman, 1981] F. Reiman. Kung-sun, white horses and logic. *Philosophy East and West*, **31**, 417–447, 1981.

[Reyes *et al.*, 1999] M. Reyes, J. Macnamara, G. E. Reyes, and H. Zolfaghari. Count nouns, mass nouns, and their transformations: A unified category-theoretic semantics. In *Language, Logic and Concepts: Essays in Honour of John Macnamara*. R. Jackendoff, P. Bloom and K. Wynn, eds., pp. 427–452. MIT Press, Cambridge, MA, 1999.

[Roeper, 1983] P. Roeper. Semantics for mass terms with quantifiers. *Nous*, **17**, 251–265, 1983.

[Sampson, 1975] G. Sampson. Review of Hintikka *et al.* (1973). *Foundations of Language*, **12**, especially pp. 546–547 (review of Moravcsik 1973), 1975.

[Scha, 1980] R. Scha. Distributive, collective and cumulative quantification. In J. Groenendijk, T. Janssen and M. Stokhof, eds. *Formal Methods in the Study of Language*, Vol. II, pp. 483–512, 1980.

[Schubert and Pelletier, 1982] L. K. Schubert and F. J. Pelletier. From English to logic: context-free computation of 'conventional' logical translation. *American Journal of Computational Linguistics*, **8**, 26–44, 1982.

[Sellars, 1967a] W. Sellars. Aristotle's Metaphysics: an interpretation. In *Philosophical Perspectives: History of Philosophy*, W. Sellars, pp. 73–124. Reseda, CA: Ridgeview Pub. Co., 1967.

[Sellars, 1967b] W. Sellars. Substance and form in Aristotle. In *Philosophical Perspectives: History of Philosophy*. W. Sellars, pp. 125–136. Reseda, CA: Ridgeview Pub. Co. 1967.

[Sellars, 1967c] W. Sellars. Raw materials, subjects, and substrata. In *Philosophical Perspectives: History of Philosophy*. W. Sellars, pp. 137–152. Reseda, CA: Ridgeview Pub. Co. 1967.

[Semenza *et al.*, 2000] C. Semenza, S. Mondini, and K. Marinelli. Count and mass nouns: semantic and syntax in aphasia and Alzheimer's disease. *Brain and Language*, **74**, 428–431, 2000.

[Sharples, 1999] B. Sharples. On being a 'Tode Ti' in Aristotle and Alexander. *Methexis*, **12**, 77–87, 1999.

[Sharvy, 1975] R. Sharvy. The indeterminacy of mass prediction. In [Pelletier, 1979, pp. 47–54].

[Sharvy, 1978] R. Sharvy. Maybe English has no count nouns: notes on Chinese semantics. *Studies in Language*, **2**, 345–365, 1978.

[Sharvy, 1983a] R. Sharvy. Mixtures. *Philosophy and Phenomenological Research*, **44**, 227–240, 1983.

[Sharvy, 1983b] R. Sharvy. Aristotle on mixtures. *Journal of Philosophy*, **80**, 439–457, 1983.

[Sharvy, 1985] R. Sharvy. Compound mass terms: a reply to Pelletier. *Logique et Analyse*, **28**, 105–108, 1985.

[Shipley and Shepperson, 1990] E. F. Shipley and B. Shepperson. Countable entities: developmental changes. *Cognition*, **34**, 109–136, 1990.

[Siegel, 1977] M. Siegel. Measure adjectives in Montague grammar. In S. Davis and M. Mithun, eds. *Linguistics, Philosophy and Montague Grammar*, pp. 223–262. University of Texas Press, Austin, 1977.

[Simons, 1981] P. Simons. Plural reference and set theory. In B. Smith, ed. *Parts and Moments*, pp. 199–260. Philosophia, Munich, 1981.

[Simons, 1994] P. Simons. New categories for formal ontology. *Grazer Philosophische Studien*, **49**, 77–99, 1994.

[Smith *et al.*, 1992] L. B. Smith, S. S. Jones and B. Landau. Count nouns, adjectives, and perceptual properties in children's novel word interpretations. *Developmental Psychology*, **28**, 273–286, 1992.

[Smith, 1978] R. Smith. Mass terms, generic expressions, and Plato's theory of forms. *Journal of the History of Philosophy*, **16**, 141–153, 1978.

[Soja, 1992] N. N.Soja. Inferences about the meanings of nouns: The relationship between perception and syntax. *Cognitive Development*, **7**, 29–45, 1992.

[Soja, 1994] N. N. Soja. Evidence for a distinct kind of noun. *Cognition*, **51**, 267–284, 1994.

[Soja *et al.*, 1991] N. N. Soja, S. Carey and E. S. Spelke. Ontological categories guide young children's inductions of word meaning: Object terms and substance terms. *Cognition*, **38**, 179–211, 1991.

[Soja *et al.*, 1992] N. N. Soja, S. Carey, and E. S. Spelke. Perception, ontology, and word meaning. *Cognition*, **45**, 101–107, 1992.

[Stanley, 2002] J. Stanley. Nominal restriction. In *Logical Form and Language*, G. Preyer, ed. pp. 365–388. Oxford: Clarendon Press, 2002.

[Stewart, 1987] R. Stewart. Intentionality and the semantics of 'Dasein'. *Philosophy and Phenomenological Research*, **58**, 93–106, 1987.

[Strawson, 1959] P. Strawson. *Individuals*, Methuen, London, 1959.

[Taylor, 1977] B. Taylor. Tense and continuity. *Linguistics and Philosophy*, **1**, 199–220, 1977. (A revised version of this paper is in B. Taylor (1985) *Modes of Occurrence: Verbs, Adverbs and Events*. Oxford, Blackwells, Chapter 3: 'Tenses and Verbs', pp. 51–82.)

[ter Meulen, 1980] A. ter Meulen. *Substances, Quantities and Individuals*, PhD Dissertation, Stanford, 1980.

[ter Meulen, 1981] A. ter Meulen. An intensional logic for mass terms. *Philosophical Studies*, **40**, 105–125, 1981.

[Thomson, 1998] J. Thomson. The statue and the clay. *Nous*, **32**, 149–173, 1998.

[Thompson, 1995] K. Thompson. When a white horse is not a horse. *Philosophy East and West*, **45**, 481–499, 1995.

[van Benthem, 1994] J. van Benthem. Determiners and logic. *Linguistics and Philosophy*, **6**, 447–478, 1994.

[van Brakel, 1986] J. van Brakel. The chemistry of substances and the philosophy of mass terms. *Synthese*, **69**, 291–324, 1986.

[Vendler, 1967] Z. Vendler. *Linguistics in Philosophy* (Chapter 4), Cornell University Press, Ithaca, 1967.

[Verkuyl, 1972] H. Verkuyl. *On the compositional nature of the aspects*. Dordrecht: Reidel, 1972. (Especially pp. 54-61).

[Wandinger, 1998] N. Wandinger. Masses of stuff and identity. *Erkenntnis*, **48**, 303–307, 1998.

[Ware, 1975] R. X. Ware. Some bits and pieces. *Synthese*, **31**, 379–393, 1975. Reprinted in [Pelletier, 1979, pp. 15–29].

[Whorf, 1939] B. Whorf. The relation of habitual thought and behaviour to language. In J. Carroll, ed. *Language, Thought and Reality: Selected Writings of Benjamin Lee Whorf*, pp. 134–159. MIT Press, Cambridge, MA, 1956.

[Xu, 1997] F. Xu. From Lot's wife to a pillar of salt: evidence that physical object is a sortal concept. *Mind and Language*, **12**, 365–392, 1997.

[Zemach, 1970] E. Zemach. Four ontologies. *Journal of Philosophy*, **67**, 231–247, 1970.

[Zembaty, 1983] J. Zembaty. Plato's *Timeaus*: mass terms, sortal terms, and identity through time in the phenomenal world. *Canadian Journal of Philosophy*, Sup. Vol. **9**, 101–122, 1983.

[Zimmerman, 1995] D. Zimmerman. Theories of masses and problems of constitution. *Philosophical Review*, **104**, 53–110, 1995.

[Zimmerman, 1996] D. Zimmerman. Could extended objects be made out of simple parts?: an argument for 'Atomless Gunk'. *Philosophy and Phenomenological Research*, **56**, 1–29, 1996.

[Zimmerman, 1997] D. Zimmerman. Coincident objects: could a stuff ontology help? *Analysis*, **57**, 19–27, 1997.

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