

# **Count nouns, mass nouns and their acquisition**

A psychological investigation

David Nicolas

Department of psychology, McGill, Montreal  
Centre de Recherche en Epistémologie Appliquée, Paris

Submitted to the department of psychology  
For the special comprehensive examination at McGill university

Supervisors: Yuriko Oshima-Takane (McGill)  
Daniel Andler (CREA)

December 1996

Do not quote without permission.

'Die Philosophie darf den tatsächlichen Gebrauch der Sprache in keiner Weise antasten, sie kann ihn am Ende also nur beschreiben. Denn sie kann ihn auch nicht begründen. Sie läßt alles wie es ist.'  
'Alle Erklärung muß fort, und nur Beschreibung an ihre Stelle treten.'

'Philosophy may in no way interfere with the actual use of language; it can in the end only describe it.  
For it cannot give it any foundation either.  
It leaves everything as it is.'  
'We must do away with all explanation, and description alone must take its place.'

— Ludwig Wittgenstein

'Infants learn their language by first determining, independent of language, the meaning which a speaker intends to convey to them, and by then working out the relationship between the meaning and the language.'

— John Macnamara

### *Acknowledgments*

I have felt the subtle and gentle presence of John Macnamara accompanying me from Heaven, where no doubt he now is, as I was thinking and writing on the issues dealt with in this paper. I want to warmly thank Yuriko Oshima-Takane, Keith Niall, Leslie McPherson, and Brendan Gillon for discussing several of these issues with me. Yuriko decided me to write this paper; her comments and help throughout this term were invaluable. Over the years, Keith has read everything I have written, pointed the delusions into which the use of language had driven me, and encouraged me to deepen my study. Leslie has shown a high interest in my work on count nouns and mass nouns, and the depth of her thinking on the subject has enlightened me and stimulated me. I was greatly influenced by discussions with Brendan. I would also like to thank Daniel Andler, Sandeep Prasada, and Paul Bloom for some interesting exchanges of ideas.

## Table of contents

<b>Introduction</b> .....	1
<b>I. Do count and mass nominal expressions belong to distinct grammatical categories?</b> .....	2
Parts of speech and grammatical categories .....	2
Usual characterizations of the count-mass distinction in English and in French .....	4
Important linguistic facts about the use of count and mass expressions .....	5
Does the count-mass distinction apply to nominal expressions, to their senses or to their occurrences? .....	7
Evaluating the various approaches .....	8
<b>II. Can the count-mass distinction be semantically characterized?</b> .....	11
Individuation .....	11
Atomicity and minimal parts .....	14
Cumulative reference .....	15
Divisive reference and homogeneous reference .....	17
Mute mass nouns as linguistic wisdom.....	18
Gillon on semantic characterizations of count and mass nominal expressions .....	18
Summary and conclusions .....	19
<b>III. How may we represent the interpretations of mass and count nominal expressions?</b> .....	21
Mass expressions interpreted as predicates .....	21
Mass expressions interpreted as mereological wholes .....	23
Mass expressions interpreted as sets of portions .....	26
Conclusions .....	29
<b>IV. How may children acquire the count-mass distinction?</b> .....	32
What does a child have to learn and what abilities need she have when acquiring the count-mass distinction? .....	32
Distributional accounts .....	34
Innate semantic views .....	35
Gordon's theory .....	37
Is knowledge of the count-mass distinction necessary to learn the sense of count and mass grammatical markers?.....	38
<b>V. Empirical evidence concerning the acquisition of the count-mass distinction</b> .....	40
What empirical evidence would help distinguish between the competing accounts?.....	40
How children older than three use and understand 'much' and 'many'.....	41
Understanding of 'a', 'another', 'some' and bare noun phrases shown by children older than three..	42
Understanding of 'a', 'another', 'some' and bare noun phrases demonstrated by children younger than three .....	43
Children's use and understanding of noun pluralization .....	45
Children's errors with typical and atypical count nouns and mass nouns.....	46
<b>Summary of the paper</b> .....	47
Appendix: Other formalizations of the interpretations of count and mass nominal expressions.....	50
Bibliography.....	57

## **Introduction**

In English, some common nouns, like 'dog', can combine with determiners like 'a' and 'many', but not with 'much', while other nouns, like 'water', can be used together with 'much', but not with 'a' and 'many'. These common nouns have been respectively called count nouns (CNs) and mass nouns (MNs). How do children learn to use CNs and MNs in the appropriate contexts? Gaining a better understanding of this is the goal of this paper. To do so, it is important to first get clear on the nature of the distinction between CNs and MNs. Is it a grammatical distinction? Does the distinction apply to nouns, to their senses, or only to their occurrences within noun phrases (NPs)? Showing that the count-mass distinction really is grammatical and applies to nouns is the matter of my first part. Then the question occurs as to whether the distinction corresponds to a systematic difference in the sense of count and mass expressions. If it does, children's acquisition of the distinction may simply follow from their ability to learn the senses of these expressions and determiners. In a second part, I thus discuss various semantic characterizations that have been proposed, and make explicit the exceptions from which they suffer. Now, understanding the sense of an expression is interpreting it correctly as it occurs in an utterance. Formal characterizations of our interpretations help to clarify what is involved in learning and understanding these expressions. In my third part, I examine several formal characterizations with the purpose to specify what would be an adequate representation of the interpretations of mass and count nominal expressions. The understanding gained in these first three parts is used to identify what abilities are exercised by children when they acquire the count-mass distinction. The picture that emerges differs from earlier views of the acquisition in several respects. I thus describe these views and highlight the differences between them and my own proposal. In a final, fifth part, I critically examine the experimental evidence that proponents of some of the accounts of the acquisition of the count-mass distinction have cited in their favor.

## I. Do count and mass nominal expressions belong to distinct grammatical categories?

I begin this part by clarifying the notion of a part of speech, as it is invoked at several places in my discussion. I then describe how the count-mass distinction is often characterized, both in English and in French. I go on to report several important facts about the use of count and mass nominal expressions so characterized. These facts have led several authors to propose other characterizations of the distinction. These alternative characterizations are considered in detail by Pelletier and Schubert (1989: 332-349) ; I present their discussion in a condensed form, together with some remarks and conclusions of my own.

### *Parts of speech and grammatical categories*

Traditional grammar identified parts of speech like *nouns*, *verbs*, *adjectives* and *prepositions*. Parts of speech were partially *semantically characterized*. They were grouped depending on the way in which they signified things, properties or relations to which elements in the language referred. They often corresponded to extra-linguistic categories that were thought to be universal. Consider for instance the definitions given by Denys of Thrace: 'The noun is a part of speech which can be inflected for case and which signifies a person or a thing'; 'the verb is a part of speech that cannot be inflected for case, which can be inflected for tense, case and number, and which signifies an activity or the fact of being subject to an action'. Noun and verb are defined, not only in semantic terms by what they signify, but also by their inflectional characteristics. Such characterizations have been criticized for their circularity; for the mixing of potentially non-coincident morphological, syntactic and semantic criteria; and for their inapplicability to certain languages (since inflection is not a universal property of all languages).

These problems have led modern linguists to characterize parts of speech in a *formal* way. A part of speech is taken to be a set of linguistic elements that share the same *distribution*. The distribution of a linguistic element is the set of *contexts* in which it can appear, i.e. its potentiality to occur in sentences with respect with the occurrence of other words in the same sentence. The grammar is then nothing else than a description of the acceptable sentences in a language in terms of combinations of words (and phrases, etc.) in virtue of their belonging to distributional classes. Lyons (1970: 104; see also 1968a, reprinted 1991; and 1981 ch.11) stresses that this is not to deny that the grammatical structure of a language and its semantic structure tend to correspond closely to one another: what is denied is that one may be reduced to the other. As an example of distributional approaches, consider Emonds' description of how transformational grammars characterize the class of nouns and that of determiners in respect of each other. 'In the typical cases, a determiner is an element of a class which can or must modify semantically the noun that follows it, in all positions in which nouns

occur, while a noun is an element which, in all positions, may or must be preceded by a determiner that modifies it semantically' (1986: 97).

*Once a grammatical class is established on formal grounds, how should it be called?* The 'notional [i.e. semantic] definitions of the parts of speech may be used to determine the names, though not the membership, of the major syntactic classes of English and other languages. [...] If [a notional class] A is almost included in [a distributional class] X, then X may be given the label suggested by the 'notional' definition of A' (Lyons 1968b: 318). In practice, this is indeed how a distributional class X in a foreign language is identified *as* a class of nouns, or verbs, or adjectives, or prepositions. The class X is taken to be a class of nouns if it includes most words for persons and animals, and a number of concrete objects.

At this point, a brief note on the notions of grammatical category and lexicon is in order. Lyons (1970: 212) says that parts of speech are *primary grammatical categories*, while such notions as tense, mode, case, number, etc. are *secondary grammatical categories*. Syntactic relationships between members of primary categories are accompanied by specific morphological forms in some or all of the variable forms involved. Such syntactic requirements are the basis of the splitting up of the total set of forms of variable words into several different secondary categories. For instance, English nouns exhibit two grammatically different forms (/ / and /-s/), which vary with the verb forms consisting of root and root plus /-s/, /-z/, and /-iz/ (as in 'man eats' and 'men eat') in the basic {noun + verb} sequence. These two forms of nouns and the verb forms required with each are labeled *singular* and *plural*, and together form in English the category of *number*. Lyons distinguishes primary and secondary categories from functional (grammatical) categories; functional categories correspond to the traditional syntactic notions of subject, predicate, object, etc. An essential requirement is that all the grammatical categories of a language must correspond to morpho-syntactical regularities in the language. Which words belong to which grammatical category (or categories) is specified in the *lexicon*, together with a description of the *sense* of words (p. 128).

Let me briefly mention here that I distinguish the sense of a word from what it denotes. For instance, to say what 'eye' denotes is to identify all those things in the world that are correctly called eyes. But the denotation of 'eye' seems at most remotely involved in understanding an utterance like: 'the eye of night, however, was immovable, enormous, [...] no longer beholding, being but the blinding lightning-cleft of nothingness, absorbed all eyes, the eyes of lovers, the eyes of the wakeful, the eyes of the dying, failing for love, failing in death, the human eye failing because it peered into timelessness' (Hermann Broch, *The death of Virgil*). I also distinguish denotation, which is invariant, from reference, which I take to be a property not of lexemes, but of some of the expressions that occur *within utterances*. Reference is thus variable and utterance-dependent. For example, the word 'eye' always denotes the same class of things,

whereas the phrase 'her eyes' in a sentence like 'I like her eyes' will refer to different members of the class on different occasions of utterance.

In this paper, I follow Lyons in his understanding (and classification) of grammatical categories. This means that I consider a set of expressions to be a grammatical category in a particular language *only* if it is associated with morpho-syntactical regularities. This leaves entirely open the *empirical* question of whether a grammatical category in a given language (which therefore has a specific distribution) can be semantically characterized: no logical or "linguistic" necessity prevents it from being so. And there are indeed modern proponents of semantic characterizations. Langacker (1991: 63) states: 'A "noun" designates a "region" in some domain'. He also gives a semantic characterization of verbs (p.78-81) —I do not describe it for it is understandable only in the specific context of 'cognitive grammar'. From an Aristotelian perspective, McPherson (1995) proposes a semantic characterization for a category of predicators, that groups verbs and adjectives. 'Predicators are single words (lexical units) that denote properties (either essential or accidental) of individuals or relations among individuals' (p.43). In my second part, I will precisely be concerned with the possibility of a semantic characterization for a particular grammatical distinction, that between count and mass nominal expressions.

Let me now introduce the count-mass distinction, by describing how it is often characterized in English and in French. This common place characterization will be critically examined and compared to other possible characterizations in later sections.

### *Usual characterizations of the count-mass distinction in English and in French*

In English, CNs are those common nouns that can combine with the determiners 'a(n)', 'each', 'every', 'a few', and 'many', and with numerals ('one', 'two', etc., and also 'a dozen'). MNs are those common nouns that can combine with the determiner 'much', the quantifier 'a little' or 'a little of', amount phrases like 'a cup of', and expressions like 'a large/small/... quantity/amount of'. Singular CNs must be used together with a determiner, quantifier or numeral; MNs can occur without one. CNs admit of the singular/plural contrast, while MNs do not. (Interpretable) NPs that combine a noun with a determiner like 'a' will be claimed to be count; while (interpretable) NPs that combine a noun with a determiner like 'much' will be claimed to be mass .

These criteria are of course specific to English. Are there other languages that (would also seem to) draw the count-mass distinction? The following evidence suggests that French is one such language. French determiners like 'un', quantifiers like 'un peu de' and numerals are readily translated into English determiners like 'a', quantifiers like 'some' and numerals. Doing so, we find that a certain class of French common nouns combines with the determiner equivalent with 'a' and with numerals, while another class does not, and combines with the



quantifier equivalent with 'some'. Similar remarks are also made by several French grammarians (but some grammarians like Martinet (1979: 45) altogether deny the distinction between CNs and MNs). Grevisse (1993: 704) notes that *concrete* nouns can be classified as countable nouns like 'pied' and non countable nouns like 'neige' (the French expression for countable noun is 'nom comptable' or 'nom nombrable'). The indefinite article 'un' is used with a noun designating a being or a thing (p.868). The partitive article, or 'article partitif', 'du' and its other forms 'de la' and 'de l' is an indefinite article that is used before a noun designating a reality that is not countable, in order to indicate that one is talking about an indefinite quantity of that thing (p.869). Gross (1986: 20-21) describes three traditional nominal categories: abstract nouns, countable nouns ('noms nombrables') and mass nouns ('noms de masse'). The latter can be preceded by 'beaucoup de' and 'une quantité de' ('a quantity of'), while singular countable nouns cannot.

What precedes suggests that French, like English, distinguishes between count and mass nouns. Using as a starting point the characterizations just given, a number of significant linguistic facts can be identified about count nouns and mass nouns. They follow.

*Important linguistic facts about the use of count and mass expressions<sup>1</sup>*

- *An entity can be referred to by a mass expression in a given language and by a count expression in another language.*

We have already seen 'meuble(s) and 'furniture'. As other French CNs and English MNs, we find: 'nouvelle(s)/news', 'renseignement(s)/information', 'conseil(s)/advice', 'connaissance(s)/knowledge'.

- *One and the same entity can be referred to by means of a count expression or a mass expression in the same language.*

For instance, we can talk of much or many more data, as well as of much and many more justification(s). Note also that for each of the following pairs of nouns, both nouns seem to have the same extension: 'change/coins', 'clothing/garments', 'machinery/machines', 'cattle/cows', 'kitchenware/kitchen utensils', 'poetry/poems', 'fiction/novels'. Likewise, the respective count and mass status of expressions like 'success(es)/failure', 'belief(s)/knowledge', 'fruit(s)/vegetable', 'bean(s)/rice', 'noodle(s)/spaghetti', 'onion(s)/garlic', 'datum(data)/data', 'article(s) (of commerce)/merchandise' seems arbitrary.

- *Almost every common noun can be used both in a mass way and in a count way.*

<sup>1</sup> Except if otherwise specified, the examples in this section are taken from Mufwene (1984) and Pelletier & Schubert (1989).

Notice that there seems always to be a count sense, or use, for every mass expression M, which means a kind of M (e.g. 'a wine'). The classiest restaurants accept such orders as 'three coffees', even if 'coffee' is usually thought to be a MN. Consider also these verses of Jacques Roubaud, in *Signe d'appartenance*, where 'neige' is used as a CN: 'savions-nous combien peu durerait le manteau de neiges dans les vignes [...] combien peu de neiges nouvelles fondraient à des anneaux de fer ou sur la brique du foyer'. And as Macnamara observed in *Names for things* (1982: 139): 'Take books and shelves; they are clearly CNs. Yet one can imagine a philistine discussing their respecting merit as fuel for fire and saying, 'You should always mix a little shelf with book'. And the same is true of all the CNs in the language.' Pelletier (1974) has imagined a "universal grinder" which takes any entity denoted by a count expression, like a dog, and spews forth the finely-ground matter of which it is composed on the floor. One could then properly say that there is dog all over the floor!

- *Often, one cannot tell whether an expression is being used in a mass or count way.*

Consider 'Some people like *data* better than *theory*', and 'I like *candy*'. Those sentences are understandable without one having to classify the nouns, either as count or mass. And likewise, in French: 'Tout était sous ses pieds *deuil*, *épouvante* et *nuit*' (Hugo, *Les contemplations*). The words in italics do not seem to be intended by Victor Hugo to be specifically understood in a count or a mass way.

These facts have lead some authors to see the count-mass distinction as applying not to nouns themselves but to their *occurrences* within NPs. Others deny that it is a *grammatical* distinction. Let us see what has been proposed.

*Does the count-mass distinction apply to nominal expressions, to their senses or to their occurrences?*

The central issue is whether the count-mass distinction is taken to be a grammatical one. To say that it is is to claim that count nominal expressions are characterized by a certain distribution, while mass nominal expressions are characterized by another distribution. The alternative is to claim that count and mass expressions have the *same* distribution and that the distinction only corresponds to a systematic difference between the *senses* of expressions.

Modern linguistics often uses "syntactic features" to express membership in grammatical categories, and this usage is retained by Pelletier and Schubert in their discussion, which I present in this section and the next. To distinguish clearly between grammatical categories and distinctions in sense, I will use the term 'syntactic' in connection with the former, and the term 'semantic' in connection with the latter. Pelletier and Schubert call an "expression approach" a theory which assigns the syntactic feature count or mass to nominal expressions (i.e.

syntactically classifies them as count or mass); some syntactic rules must make explicit reference to these features. They distinguish it from a "sense approach", which claims that the difference is only between the *senses* of expressions. As an example, consider the sentences:

(1) 'She ate a whole lamb.'

(2) 'She ate some lamb.'

The "sense approach" claims that there are two words 'lamb' here, spelled and pronounced the same, each having a different sense. Both sentences are *syntactically well-formed*: the count-mass distinction is taken to be one of sense, not one of syntax. This is the position of McCawley (1975: 315-316) and Pelletier (1975: 8).

"Expressions approaches", on the other hand, claim that 'lamb' is syntactically classified as count or mass. "Unitarian expression approaches" consider that the word is either always count or always mass. For instance, one may propose that 'lamb' is always count and 'bits of a' has been deleted from sentence (2). Or one could, like Sharvy (1978), consider that 'lamb' is always mass and that (1) uses 'a whole' to turn 'lamb' into a well-defined entity. In sentences like 'Give me three beers', a nominal measure word such as 'glasses of' or 'kinds of' is supposed to have been deleted.

"Dual expression approaches" consider that 'lamb' has a "dual syntactic life", as count and as mass. 'Lamb' would then have two lexical entries, one syntactically marked as count, the other syntactically marked as mass; these entries would of course also differ in sense. Quine (1960: 91) makes this proposition for the word 'apple'. While LaPalme-Reyes, Macnamara, Reyes and Zolfaghari (1994) offer what they take to be semantic definitions of CNs and MNs, they classify these as syntactically count or mass (p.3). They remark that some nouns belong to both syntactic categories (p.13). So does Wierzbicka (1985: 317-318). These authors are thus proponents of "dual expression approaches".

One can further distinguish an "occurrence approach" from the "expression approach" and the "sense approach". According to the "occurrence approach", lexical items cannot be classified as count or mass: such a classification can be determined only in the context of a longer sequence of words. Such an approach might take count and mass to be syntactic features —call that the "syntactic occurrence approach"— or it might take it to be a semantic characterization —call it the "semantic occurrence approach". No syntactic feature is assigned to nouns. Only longer sequences of words, namely phrases like 'a lamb', can be classified as count or mass. Ware (1975: 17) and Pelletier (1974, footnote 1) seem to be proponents of the "semantic occurrence approach".

What precedes can be summed up in a table (adapted from Pelletier and Schubert).

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

1. Syntax

a. Each noun is either count or mass [unitarian expression approach]

- b. "Dual life" nouns, i.e. nouns that can be used both in a count way and in a mass way, are to be represented twice in the lexicon [dual expression approach]
- c. No (lexical) nouns are count or mass, only longer noun phrases are so classified [syntactic occurrence approach]

## 2. Semantics

Count and mass expressions have the same distribution and...

- a. Mass and count distinguish between different senses of a lexical entry [sense approach]
- b. Mass and count are not semantic properties of lexical items, but of longer phrases [semantic occurrence approach]

### *Evaluating the various approaches*

In this section, I still borrow from Pelletier and Schubert, but add remarks and conclusions of my own. Let's first examine the question of whether there is any syntactic rule that uses the mass or count status of simple expressions in combining them together to form larger expressions. For expression approaches, lexical items are syntactically marked as count or mass and this feature rules in or out (as syntactically well-formed) larger expressions like 'a man' or '\*much man': since 'man' is count, only the first is well-formed.

A syntactic occurrence approach considers instead that it is the entire NP 'a man' which is count, can be pluralized and that this allows for plural agreement with the verb phrase. However, what larger expressions would this alleged syntactic feature of NPs rule out? One may think of the rules of verb agreement, but the features singular and plural suffice to state them. According to Pelletier and Schubert, there is, in fact, no rule of syntax that would use the classification of NPs as count or mass. A syntactic occurrence approach thus does not seem to be called for.

The fact that almost every expression can be used in a mass and in a count way is *prima facie* evidence against the syntactic classification of nouns as count or mass. However, one can argue that the normal usage of 'book' in 'You should always add a little shelf with book' has been stretched; and that this kind of extended use should be distinguished from normal use. If we did not do so, we might have, for instance, to deny a noun/verb distinction, as between 'a comb' and 'to comb' (one's hair). In order to do so, one may claim that there are lexical extension rules which convert nouns that are mass in the lexicon into CNs, and vice versa.

What about a dual expression approach in which *all* nouns have two lexical entries, one syntactically classified as count, the other as mass? This would entail a proliferation of lexical entries which is better avoided. The same point argues against a dual sense approach for which nouns are not syntactically marked as count or mass and *every* noun has two different senses.

So, according to Pelletier and Schubert, we are left with either an expression approach which is unitarian in the sense that any given noun is either syntactically classified as count or mass; or with a semantic occurrence approach which takes the entire NPs as being the bearers of the semantic properties mass and count, and treats them as properties of the NP without comment on whether they have any semantic correlate in the individual lexical items involved.

Pelletier and Schubert remark that, in an expression approach, the features mass and count seem to play no syntactic role. Indeed, given the lexical extension rules, any noun can be used in any type of count or mass construction. If a CN, say, is used in a mass construction, it is simply marked as involving lexical extension. The mass and count features' only role seems to be in directing the semantic representation of the expressions. Why not, then, consider count and mass classifications to be purely semantic? I don't think this argument is decisive: in fact, an expression approach allows us to consider '\*a water' as a priori syntactically ill-formed, and to recognize at the same time that it can sometimes become an acceptable (although perhaps odd) construction.

On the other hand, I find the semantic occurrence approach unsatisfying as it does not classify '\*a water' as a priori semantically (or syntactically) ill-formed.

Let me remark here that Pelletier and Schubert's arguments do not rule out a sense approach in which nouns like 'water' have only one sense (while *some* nouns, like 'lamb', *may* be conceded to have two senses, here, one for the animal, the other for its meat); in this approach, the sense of a NP would be derived from that of the noun and that of the determiner or quantifier or nominal measure word if there is any in the NP. Given the sense of 'a' and of 'water', '\*a water' would be a priori *semantically* ill-formed, even if specific pragmatic contexts might help to make sense of the phrase.

At this point, let us recall what is at issue. As stated at the beginning of this discussion, the question is whether the count-mass distinction is taken to be a grammatical one. To deny it is to claim that count and mass expressions have the *same* distribution but differ systematically in their senses. The temptation to do so comes from the observation that most common nouns can be used both in (alleged) count-specific contexts and in (alleged) mass-specific contexts. If this is so, should we not say that all common nouns have the same distribution? We saw that this is not a conclusive argument, since, by parity of reasoning, it would imply that nouns and verbs form only one grammatical category. Therefore, I will take the oddness of constructions like '\*a furniture', '\*a few/many furnitures' and '\*much/little man' to indicate that count and mass nouns have different distributions, i.e. correspond to two different grammatical sub-categories of common nouns. In the terminology of Pelletier and Schubert, I thus adhere to an expression approach: common nouns are syntactically classified as count or mass. This explains the syntactic ill-formedness of NPs like '\*a furniture', and the grammatical

acceptability of 'a cat' —expression which inherits count status from the status of its head noun 'cat'. Nonetheless, one can, in certain contexts, use MNs (respectively, CNs) in an extended sense, as the head of count noun phrases (respectively, mass noun phrases). Kleiber (1989) formulates similar ideas in a manner which I find very convincing, so I shall say a few words about it now. (Bibliographic note: Weinreich 1966, Allan 1980, and Galmiche 1986 and 1987 seem to share the same basic grammatical intuition as Kleiber, although each of these authors gives it a different emphasis.) For Kleiber, 'the count/mass distinction operates at two levels in grammar: i) at an internal level, that of the noun (or noun plus adjective) not yet modified by a determiner; it is an inherent characteristic of the noun; ii) at an external level, that of the NP, where determiners contribute to establishing the count or mass status of the NP' (p.81, my translation). Consider a CN like 'oeuf' ('egg'). In a sentence like 'Il vend de l'oeuf' ('He sells egg'), 'de l'oeuf' is externally marked as mass, while 'oeuf' is (inherently) marked as count. Because of this inherent marking, what is being sold are *entire* eggs, and not mashed eggs.

As remarked earlier, recognizing the count-mass distinction as *grammatical* leaves entirely open the question of whether the distinction, as observed in a given language, can be semantically characterized. If it can, children's acquisition of the distinction may simply follow from their ability to learn the senses of these expressions and determiners. In the next part, I thus discuss various semantic characterizations that have been proposed, and make explicit the exceptions from which they suffer.

## II. Can the count-mass distinction be semantically characterized?

The count-mass distinction has been tentatively characterized as an opposition between nouns that supply principles of individuation and nouns that do not. It has also been claimed that, in addition, CNs denote kinds the members of which are atomic. Another proposition has been that MNs, and not CNs, 'refer cumulatively'. Some authors have claimed that a MN 'refers divisively', while others have maintained that a MN is simply mute as to whether something is to count as a minimal part of which the MN is true. I introduce and discuss each of these propositions in turn.

### *Individuation*

In his *Philosophy of grammar* (1924: 198-201), Jespersen points out that languages may contain expressions which 'call up the idea of some definite thing with a certain shape or precise limits'. To account for this, Jespersen assumes a 'world of countables', a world which is inhabited by entities like houses, sounds, plans and crimes. In *Word and object*, Quine emphasizes the same idea: 'To learn 'apple' it is not sufficient to learn how much of what goes to count as apple: we must learn how much counts as an apple and how much as another. Such terms possess built-in modes, however arbitrary, of dividing their reference' (1960: 91). In *Names for things* (1982: 139), Macnamara proposes that 'CNs name things that have a characteristic form, and MNs do not. If a substance is referred to in a manner that it is given a characteristic form, its name becomes a CN. Hence 'milks' and 'porridges' because they mean 'glasses of milk' and 'bowls of porridge'.'

The intuition behind all these propositions can also be formulated in terms of principles of individuation and/or in terms of sortals. Consider Macnamara's account in *A border dispute* (1986a: 50-55, 59-62, 124-136; see also 1986b: 216). He argues that CNs supply a principle of application, a principle of identity and a principle of individuation for what *they are true of* (for the sake of convenience, I shall often say in what follows that '*F*' is true of *x*, when 'x is (a) F' is true). The principle of application corresponds to the fact that a noun like 'cat' divides the world into those things that are cats and those that are not. The principle of identity of the CN 'cat' is what decides the matter of whether two cats considered at two different moments of time are the same cat or different cats. The principle of individuation of 'cat' specifies what, in any situation, counts as an individual cat —and what should be counted as several cats.

Contrast that with MNs. They too supply a principle of application and one of identity; for instance, it makes sense to say: 'the water now on the floor is the same water as the water that was in the glass before it fell down'. Saying so, I side against Laycock (1972: 26-31; 1975, reprinted in 1979: 96-98), Griffin (1977: 58-61, 70) and Rundle (1979: 218-226), all of whom deny that MNs supply a principle of identity. Together with Geach (1962, reprinted

1980: 64, 1972: 247), Burge (1972: 272-273) and Gupta (1980: 25), it indeed seems to me that the sentence 'the water now on the floor is the same water as the water that was in the glass before it fell down' makes sense without the need of an implicit CN (like 'a puddle') that would supply its own principle of identity. Be that as it may, MNs clearly possess no principle of individuation. The MN 'water' does not determine what could be \*an individual water, and it does not make sense to ask how many \*waters there could be on the floor.

That count expressions, and not mass expressions, supply a principle of individuation has been remarked by various authors. Jespersen, Quine and Macnamara have already been cited; one could also mention Laycock (*ibid.*), Bunt (1975: 253), McCawley (1975: 320), Gabbay and Moravcsik (1973, reprinted in 1979: 240-241), Rundle (*ibid.*), ter Meulen (1980: 70), Galmiche (1986: 44), McPherson (1991: 316-318, 1995: 39) and Ojeda (1993: 116). Let me now mention that Griffin distinguishes count nouns from *sortals*. 'A general term 'T' is +count if 'There are n Ts' makes sense, where 'n' is a variable taking numerals as values; otherwise 'T' is -count' (1977: 23). 'A term 'A' is a mass term if and only if it is a -count noun and the fusion of any two disjoint parts which are A is A' (p.30). This definition precludes that a noun like 'thing' be taken as mass; this could have happened if a mass term had not been specified as -count, since the sum of two parts that are things is also a thing. 'A term 'A' is a *sortal* if and only if there can be cases in which 'A' provides, without further conceptual decision and without borrowing other principles of individuation, principles for counting As' (p.41). Remark that there would be no answer to the question 'How many reals are there between zero and one?' However, the definition classifies 'real number' as a *sortal*, since I may be able to count how many reals are solution of an equation. It classifies 'thing' (as well as 'entity', 'item', 'object', 'individual', 'element', 'part') as non-*sortal*: in order to say that there are twenty things in this room, I must be borrowing the principle of individuation of some (genuine) *sortal*, since otherwise I would not know whether I should count the twenty volume encyclopedia in the room as one thing or as twenty. 'Thing', nonetheless, is a count noun, since, according to Griffin, it makes *sense* to say that there are twenty things in the room. Similarly, consider nouns like 'quantity' or 'portion': they are not *sortals* because, if there is some water in a glass, one cannot count how many quantities or portions of water there are in the glass: not only is the glass of water a quantity or portion of water, but so is the lower half of the glass (Burge 1972: 272, Griffin 1977: 66). These nouns are CNs on Griffin's definition. Griffin's definition of *sortal* is clearly more precise than Macnamara's. Since Macnamara identifies CNs with *sortals*, his definition of CNs should be replaced by Griffin's definition of *sortal*.

Pelletier (1979, ch.1), too, distinguishes between CNs and *sortals*, and what he contends is very similar to what Griffin says. Pelletier considers as non-*sortal* the following nouns: MNs, measures on MNs (e.g. 'lump', 'quantity'), "dummy *sortals*", as well as abstract nouns. The



reason for excluding abstract nouns is 'that such terms have no "appropriate space" within which to judge whether it is or it is not possible to count how many there are' (p.10). As a test of this, let me consider the noun 'belief'. True, one cannot count all the beliefs one has. Nonetheless, as in the case of 'real', there are circumstances in which one can count beliefs: for instance, a politician may claim 'I have five beliefs about unemployment', and a layman may say: 'I have three beliefs about the big-bang'. The question is whether in different situations of use the same principle of individuation decides how many beliefs one holds.

Holding (as Macnamara does) that CNs, and not MNs, supply a principle of individuation classifies "dummy sortals" like 'thing' and nouns like 'portion' as non-count, hence (presumably) as mass. Consider now mass nouns like 'garlic' and 'rice'. There are clear principles of individuation for the individual physical objects of which they are true. Furthermore, there seems to be no relevant difference between garlic and onions that would entail that 'onion' is count while 'garlic' is mass. Likewise, superordinate mass nouns like 'cutlery' are true of solid objects which are clear individuals. How could we ever explain that? Wierzbicka (1985; see also her paper of 1984) suggests an explanation for why 'cutlery' is mass and why a superordinate noun like 'animal' is count. Both 'cutlery' and 'animal' denote things of different kinds. Yet the important fact is that things of different kinds —like different kinds of animals— can be counted together only insofar as we are thinking of them as belonging to the same kind (namely, as animals). 'When, on the other hand, we subsume spoons, forks and knives under the collective supercategory 'cutlery' we are thinking of them *as things of different kinds which can be used together for a similar purpose*' (p.321). These cannot be counted together, because they are thought *as things of different kinds*. This would explain why cutlery cannot be counted, while animals can, and thus why the corresponding nouns are mass or count. However, I think Wierzbicka's suggestion does not work, since thinking about 'meuble' vs. 'furniture' does not seem to involve different types of categorizations. The fact that many mass nouns are true of solid objects shows that one cannot *predict* the count or mass status of a noun on the sole basis of the nature (object or substance) of its denotatum. Nonetheless, it remains true that these mass nouns do not supply a principle of individuation for what they are true of. Indeed, they are true not only of single objects (like a grain of rice), but also of groups of such objects. As a result, there is nothing that would count, for instance, as \*one rice, \*one garlic or \*one cutlery.

#### *Atomicity and minimal parts*

To the assumption that CNs supply principles of individuation, Macnamara (1991: 55) and McPherson (1991: 316-318; 1995: 39) add the requirement that CNs denote kinds the members of which are *atomic*, i.e. no proper part of which are also members of the kind. No proper part of a giraffe, for instance, is itself a giraffe. The assumption of atomicity is also

made by Link (1983: 306), Gillon (1992: 620) and Ojeda (1993: 116). A weaker assumption is often made in place of atomicity. It is the assumption that CNs have *minimal parts*, i.e. specify what is to count as a minimal part of which they are true. The minimal parts of a CN like 'canary' are just canaries, but those of 'piece of cake' are only those pieces of cake no proper part of which is itself a piece of cake. This assumption is made by (at least) Bunt (1979: 262) and Mufwene (1984: 203-204).

McPherson notes the following exceptions to this characterization. Consider nouns with non-atomic individuals in their extension (e.g. 'steak', 'time' as in 'a good time', 'cloud', 'puddle') and nouns that combine with 'of' plus a MN (e.g. 'drop', 'quantity', and 'lump'), as in 'drop of water', or with 'of' plus a plural CN (e.g. 'flock', 'group'), as in 'a flock of geese'. Syntactically these words behave just like CNs (i.e. admit determiners like 'a' and 'many'); on addition, they individuate their extension; however, the individuals in their extensions are not atomic. McPherson (personal communication) argues that 'flock' and 'drop' are "nominal measure words", *syntactically distinct* from (genuine) CNs. For instance, one can say 'a drop of water', but not 'a dog of inorganic matter'. Now, 'cloud' and 'puddle' also seem to be nominal measure words, for we can say 'cloud of smoke', 'cloud of water vapor', and 'puddle of water', 'puddle of oil' and so on. 'Cloud' itself seems to be understood as 'cloud of water vapor', and 'puddle' as 'puddle of water'. Sharvy (1978: 347-354) argues along the same lines, with more detail.

However, this does not deal with 'steak' and 'time'. A way to take care of all the previous exceptions would be to abandon Macnamara and McPherson's assumption that the individuals CNs are true of are atomic. One may also replace it by the weaker assumption that CNs have minimal parts (which does not suffer from the previous exceptions). Yet another solution, which I find more satisfactory, is suggested by Gillon (personal communication): it is to claim that it is in a given situation of use that a CN specifies what is to count as an atom. For instance, if, in a restaurant, you admire a large piece of cake and order it, you will justly be disappointed if the waiter cuts it in two and serves you a half.

None of this deals with abstract CNs like 'belief'. A belief can have parts, since my belief in equality among men and women is part of my belief in justice. So are there atomic beliefs? This is far from clear.

Superordinate nouns like 'furniture' constitute exceptions of a different type. Although the denotation of 'furniture' is a set of atomic individuals, 'furniture' is not count, but mass.

Let me now turn to a different type of semantic characterization of the count-mass distinction.

### *Cumulative reference*

For Quine (1960: 91): 'So-called mass terms like 'water', 'footwear' and 'red' have the semantic property of *referring cumulatively*: any sum of parts which are water is water'. This is ambiguous because of the ambiguity of the word 'sum'. Indeed, I think that cumulative reference can be understood in a weak and in a strong ways. All authors I have consulted agree upon the fact that MNs have cumulative reference (when they mention it), but it is not always clear whether they adhere to its strong or only to its weak version.

Weak cumulative reference: A (nominal) expression refers cumulatively if, when true of something here and true of something there, it is true of both as a whole. For instance, water here and water there is water. Whereas a dog here and a dog there is not a dog: instead, a dog here and a dog there are two dogs.

Strong cumulative reference: A (nominal) expression refers cumulatively if, when true of an entity here and true of an entity there, both entities can be literally combined to form a third entity of which the expression is true. For instance, the wine in this glass and the wine in that glass can both be poured into a bottle, their combination forming a (larger) portion of wine. Whereas a rhinoceros here and a rhinoceros there cannot be combined to form a (larger) rhinoceros. The expression "literally combine" is crucial here. In the case of physical entities, its intended sense is that two entities merge into a new connected physical entity. In abstract domains, however, the concept of merging seldom applies, if it applies at all.

Cumulative reference can be formalized in terms of join semi-lattice structures, or *sup-lattice structures* for short, as is proposed by Link (1983: 303-304), Lonning (1987: 3), and Macnamara and Reyes (1994: 166 and 170, LaPalme-Reyes, Macnamara and Reyes 1994: 123, and LaPalme-Reyes, Macnamara, Reyes and Zolfaghari 1994: 7). This is done by Macnamara and Reyes in the following manner. A MN denotes a kind, the kind of *portions* of a given substance. The difference between such a kind and a kind denoted by a CN is that only kinds of portions have *sup-lattice structure*, in the sense that any two portions constitute together a third (larger) portion.

A quick remark on Macnamara and Reyes. According to them, to say that a certain object is individuated is to say that it is in a kind: individuation is the membership relation of the kind. So a CN denotes a kind. But a MN also denotes a kind, the kind of portions of a given substance, and a portion of a water seems to be an individual just as much as a dog. One may try to argue that it is not the MN 'water' which provides a principle of individuation for portions of water, but rather the complex CN 'portion of water'. However, 'water' and 'portion of water' denote the same kind, namely the kind PORTION OF WATER; the membership relation of this kind would thus seem to supply a principle of individuation for both expressions, the count expression and the MN. Moreover, the expression 'portion of water' refers cumulatively, and so would be classified as mass by Macnamara and Reyes.

Thus, on their account, the only clear difference between MNs and CNs is that MNs, and not CNs, denote kinds with sup-lattice structure.

The proposal that only MNs refer cumulatively is logically independent from the assumption that the individuals a CN is true of are atomic, and, indeed, the latter assumption is not made by Macnamara and Reyes. They just require that two individuals do not constitute a third individual in combination (1994: 166). This remark suggests that Macnamara and Reyes hold the strong version of cumulative reference, although this is not obvious from the rest of their writings. In fact, sup-lattice structures can be used to model weak cumulative reference as well as strong cumulative reference. *Strong cumulative reference* probably rules out superordinate nouns like 'furniture' since it is unclear what it would amount to "literally combine" furniture here and furniture there. Moreover, the concept of merging does not seem to apply to abstract domains, so abstract nouns would either be classified as count, or they would have to be left unclassified. The assumption that MNs, and not CNs, have strong cumulative reference implies that concrete CNs denote individuals with a characteristic form, since concrete things without characteristic form can be combined (e.g. sand, mud, etc.). That is, it *roughly* implies that concrete CNs, and not concrete MNs, supply a principle of individuation for what they are true of.

Holding to *weak cumulative reference* only, one faces the following potential problem: plural CNs appear to be MNs, as they, too, refer cumulatively in the weak sense. E.g. animals here and animals there are animals. (Note that 'animals' does not seem to refer cumulatively in the strong sense: putting two groups of animals in the same place does not create a new connected physical entity). However, there are syntactic and semantic differences between plural CNs and MNs. 'Much' or 'a little (of)' cannot be combined with 'animals' for instance. A MN denotes the set of portions of which the MN is true. The denotation of a plural CN is slightly more structured: it is the "plural set" of the set denoted by the corresponding singular CN, i.e. the set of subsets of two or more members of the set denoted by the singular CN. I suggest taking the following position on this question: plural CNs should simply be recognized as one of the morphological forms of the corresponding singular CNs, and thus should not be given a separate count or mass classification.

Another difficulty appears with abstract nouns. Does weak cumulative reference apply to abstract mass nouns like 'justice', 'chastity', or 'heavenness'? An idealist may say 'Justice in Europe and justice in America is justice', and the same construction applies with 'chastity'. The question is: are these cases of (weak) cumulative reference? I.e. can justice in Europe and justice in America be considered *as a whole* and 'justice' be seen as true of such a whole? Distributionally, such nouns behave like other MNs (indeed, it is common to ask for *more* justice).

Words like 'puddle', 'group' and 'quantity' refer cumulatively, at least weakly. As McPherson and Sharvy suggest, they may be taken as a distinct grammatical category, that of "nominal measure words". Finally, "dummy sortals" like 'thing' and 'entity' also refer cumulatively yet syntactically behave like CNs.

#### *Divisive reference and homogeneous reference*

Since the property of cumulative reference fails to distinguish MNs from plural CNs, authors like Cheng (1973: 286-287), ter Meulen (1980: 69), Galmiche (1986: 46), Lonning (1987: 8), Ojeda (1993: 122-123) and Higginbotham (1995: 391) have proposed that MNs also have *divisive (or distributive) reference*, or, equivalently, that they have *no minimal parts*: when true of some entity, they are also true of (at least) a proper part of this entity. According to this hypothesis, any part of a portion of water would itself be water. Cumulative and divisive reference taken together are sometimes referred to as *homogeneous reference* (e.g. by ter Meulen and Lonning).

Divisive reference is in contradiction with modern science, which considers H<sub>2</sub>O molecules to be the smallest quantities of water. However, scientific knowledge does not seem to have changed the sense and use of 'water' in common English, so it is not a solid argument against the hypothesis that MNs have no minimal parts. Nonetheless, MNs like 'furniture' and 'footwear' do have minimal parts: the leg of a table does not constitute furniture and half of a shoe is not footwear. So, clearly, the assumption of divisive reference is not true of MNs in general and should not enter a theory of MNs.

### *Mute mass nouns as linguistic wisdom*

This has led Bunt (1979: 256-262; 1985: 129), Roeper (1983: 256), Mufwene (1984: 203-205), and Gillon (1992: 598-599, 1994) to propose the following linguistic wisdom. A CN specifies what is to count as a minimal part of which it is true. A MN is *mute* as to whether or not something is to count as a minimal part of which the noun is true. The assumption of having minimal parts is weaker than the assumption of atomicity: atoms, like dogs say, have no proper part and thus are their own minimal parts; but an entity like a steak may have minimal parts, without necessarily being atomic: one may call half of a steak a steak, but refuse the name to an eighth of the steak. (Gillon remarks that what the position I refer to by the expression "mute mass nouns as linguistic wisdom" is *not* the dominant credo in linguistics. But he should know that wisdom is not necessarily shared by the majority! Hence I will stick to my phrase.)

One potential problem is whether it is true that all CNs have minimal parts: does a belief have minimal parts, even if one considers a specific situation? Note also that in such an approach, nouns like 'furniture' cannot be classified as count or mass since they have minimal parts and refer cumulatively (remember that singular CNs do *not* refer cumulatively).

Let us now consider Gillon's arguments against the possibility of a semantic characterization of the count-mass distinction.

### *Gillon on semantic characterizations of count and mass nominal expressions*

Gillon remarks that in English, say, only CNs admit of the contrast, not MNs (note that this is the syntactic side of what I have claimed in connection with Macnamara and Reyes). Concerning semantics, Gillon holds that a mass expression denotes the set whose sole member is the greatest *aggregate* of which the NP (in the case of demonstrative NPs) or the noun (in the case of quantifier NPs) is true. For instance, 'water' denotes the "scattered individual" (aggregate) which consists of all the water in the world. This aggregate is of the same logical type as its parts, which are portions of water (on the difference between aggregates and sets, see Simons (1982a, 1982b, 1987)). On the other hand, a count expression requires that the associated denotation be the set whose members are all and only those minimal aggregates of which the NP (in the case of demonstrative NPs) or the noun (in the case of quantifier NPs) is true. A minimal aggregate is such that it has no sub-aggregate has a proper part. Thus, 'dog' denotes the set of all dogs, each dog being a minimal aggregate.

Gillon takes these to be *necessary conditions* for count or mass status, *not sufficient ones*. Indeed, because nouns like 'furniture' can be mass in English and translated in French as 'meuble', which is count, Gillon holds that *no necessary and sufficient semantic conditions* can be stated for deciding whether an expression is count or mass (Ware (1979) expresses similar doubts). Another reason for his claim is the fact that 'machines' and 'machinery' seem

to have the same extension, as do 'furnishings' and 'furniture', 'cops' and 'police', etc. Therefore, a semantic characterization of the count-mass distinction will fail to classify all of them correctly. I agree with Gillon that the syntactic status of nouns like 'furniture' is arbitrary, in the sense that it cannot be predicted from the sole nature of what these nouns denote. Yet, it remains true that such mass nouns refer cumulatively and, as a result, do not supply a principle of individuation for what they are true of. Concerning plural CNs, I think that they should simply be recognized as one of the morphological forms of the corresponding singular CNs, and, for this grammatical reason, they should be classified in the same manner as these. Pairs of nouns like 'machines' and 'machinery' then lose their seemingly problematic character.

### *Summary and conclusions*

We saw that there is no reason to suppose that, in general, MNs have divisive reference. Some linguists consider that MNs are mute as to whether something counts as a minimal part of which they are true; as a consequence, they cannot (using this sole criteria) classify nouns which, like 'furniture', have minimal parts, since these nouns could as well be count or mass.

A semantic characterization of CNs as those common nouns that supply a principle of individuation for what they are true of allows one to classify many nominal expressions as count or mass. Whether a noun does supply a genuine principle of individuation is made more precise in Griffin's definition of a sortal. It may therefore be used (in a slightly adapted form) to define count nouns: A (grammatically singular) nominal expression 'A' is *count* if and only if there can be cases in which 'A' provides, without further conceptual decision and without borrowing other principles of individuation, principles that specify what counts as one A and what as several. Doing so, nominal measure words like 'quantity' or 'portion' and "dummy sortals" like 'thing' and 'individual' are classified as non-count (hence presumably as mass). Moreover, in the case of an abstract noun like 'belief', it is unclear whether in different situations of use the same principle of individuation decides how many beliefs one holds.

Several authors hold that CNs not only supply a principle of individuation but also specify what is to count as an atom or minimal part of what they are true of. Nominal measure words do not denote atomic individuals; they can perhaps be classified in a distinct grammatical category (as suggested by McPherson and Sharvy). Other problematic cases are nouns like 'rock', 'steak' or 'time' (and their translations in other languages). A satisfying solution to all these exceptions is obtained by stating (as proposed by Gillon) that it is in a given situation of use that a CN specifies what is to count as an atom.

Holding that MNs refer cumulatively in the strong sense is, as we saw, *roughly* equivalent to claiming that *concrete* CNs have a characteristic form, i.e. supply a principle of individuation.

This approach fails to classify superordinate MNs like 'furniture' as mass. Moreover, strong cumulative reference does not seem to apply to the denotations of abstract nouns.

Holding that MNs refer cumulatively in the weak sense may lead one to classify plural CNs as mass. However, I suggest that plural CNs should simply be recognized as one of the morphological forms of the corresponding singular CNs, and thus should not receive a separate count or mass classification. As previously noted, it is unclear whether weak cumulative reference applies for abstract MNs like 'justice' and 'nearness'. Nominal measure words and "dummy sortals" like 'thing' or 'entity' refer cumulatively and thus would be classified as mass.

Gillon thinks it is impossible to characterize the count-mass distinction (observed in English) semantically; indeed, the syntactic status of nouns like 'furniture' and 'footwear' as well as that of 'garlic' and 'onion' seems to him as arbitrary; moreover, 'machinery' and 'machines', 'clothing' and 'garments', and numerous other such pairs seem to have the same extension. I agree with him that the syntactic status of these nouns is arbitrary, in the sense that it cannot be predicted from the nature of what these nouns denote. Yet, it remains true that those of these nouns that are mass refer cumulatively. As a result, there is nothing that would count, for instance, as \*one garlic, \*one rice or \*one furniture, and so these nouns do not supply a principle of individuation for what they are true of.

*So, can the count-mass distinction be semantically characterized?* Many or most common nouns are satisfactorily classified by characterizations in terms of individuation and in terms of weak cumulative reference. The exceptions mentioned above aside, the following semantic characterizations hold:

- A (grammatically singular) nominal expression 'A' is *count* if and only if there can be cases in which 'A' provides, without further conceptual decision and without borrowing other principles of individuation, principles that specify what counts as one A and what as several. Correlatively, 'A' does not refer cumulatively (otherwise, one would not know what is to count as an individual A).
- A nominal expression (which is not the plural of a singular count expression) is mass if and only if it refers cumulatively and does not supply a principle of individuation for counting what it is true of.

### **III. How may we represent the interpretations of mass and count nominal expressions?**

Understanding the sense of an expression is interpreting it correctly as it occurs in an utterance. Formal characterizations of our interpretations help clarifying what abilities are involved in understanding these expressions. They are thus of interest to the psychologist who studies adults' and children's acquisition and use of particular types of expressions like count nouns and mass nouns. In this part I examine several formal characterizations that have been



offered of our interpretations of mass and count nominal expressions, as they occur in different positions in various types of sentences. My strategy is to highlight the interesting characteristics as well as the (eventual) insufficiencies of each of these proposals. My purpose in doing so is to find, or at least characterize what would be, an adequate representation of the interpretations of these expressions. I concentrate on mass expressions, as they pose the most acute problems to a formal characterization. Three general ways of interpreting mass expressions are found in the literature, and I examine exemplar instances of each (several other interesting models are not discussed in this part, but are described in an appendix to be found at the end of this paper). Mass expressions can be interpreted as *predicates*, as is done by Pelletier and Schubert; as *mereological wholes*, as in Moravcsik's and Bunt's models; or as *sets of portions* of what they are true of, as proposed by Macnamara and Reyes.

### *Mass expressions interpreted as predicates*

**Pelletier and Schubert** (1989) propose two competing theories. Their *p-theory* is a semantic occurrence approach, in which the count-mass distinction appears only in the semantic representation of NPs. Their alternative *s-theory* is a (syntactic unitarian) expression approach: in the lexicon, nouns are syntactically marked as mass or count. Lexical extension rules are used to interpret count (or mass) expressions with a MN (or a CN) at their head.

Both theories distinguish "ordinary objects" (like tables and sofas) from "kinds", i.e. "kinds of stuff" like wine, and kinds of standard servings (like *a* beer). They recognize two types of predicates: those that can be predicated only of "kinds" (e.g. 'is a substance') and those that can be predicated of both "kinds" and "objects" (like 'is wine' and 'is a cat'). 'is a wine' for instance is true only of conventional kinds, such as BORDEAUX, and of individual servings such as a bottle of wine on the table. 'is wine' is true of the (non conventional) kind CHEAP WINE, of an individual quantity such as the contents of this glass and of an object such as a drop of wine (which occupies the same region as a quantity of wine).

A predicate is identified with a function on possible situations (or possible worlds), which, in every given possible situation, picks out what it is true of. A mass noun *M* is then translated as a predicate *M'*. Such a mass predicate is taken to have "comprehensive extension", i.e. to be true of kinds (of stuffs or things), true of conventional kinds of servings, true of quantities of stuff, and true of objects coinciding with quantities of stuff. Because of this, from 'everything edible is food', it follows both that 'rice is food' and that 'this sandwich is food'. The name of the kind *M* is formed from the predicate *M'* by way of an operator *m*, and represented as: *m(M')*. Thus 'water is wet' is translated as: *Wet'(m(Water'))*, and 'tap water is water' as: *Water'(m(TapWater'))*. Three other operators, *b*, *g*, and *p*, are introduced; they respectively take a mass noun *M* and form a predicate true only of *M*-kinds/varieties, a predicate true only

of conventional portions of M and kinds of M, or a predicate true only of M-objects/quantities.

How do the p- and s-theories differ? The s-theory assigns comprehensive extension to mass predicates, but takes count predicates to be true only of individuals and kinds of individuals. 'It marks this difference in the lexicon with the syntactic features +mass and +count respectively' (p.387). A lexical extension rule allows to use a count noun as a mass noun. The p-theory takes all predicates, 'animal' as well as 'water', to have comprehensive extension. It makes no use of syntactic features, and instead interprets certain occurrences of entire NPs as being (semantically) mass or count. I find the p-theory unappealing because it does not classify a phrase like '\*a water' as a priori semantically (or syntactically) ill-formed.

A nice characteristic of these theories is that predicates are true of more than one type of thing, which allows them to represent simply such statements as 'everything edible is food, hence rice and sandwiches are food'. Let me note that Pelletier and Schubert do not seem to have to means to represent abstract MNs like 'speed', 'justice', 'intelligence', 'nearness', 'brotherhood' or 'chastity'. A more crucial drawback is that they take predicates as primitive and define expressions in subject position from predicates —why this is problematic will be made clear when describing the model offered by Macnamara and Reyes.

I now turn to the formal characterizations of Moravcsik and Bunt, which interpret mass expressions as mereological wholes.

*Mass expressions interpreted as mereological wholes*

**Moravcsik** (1973) represents mass terms as denoting mereological wholes (for a detailed discussion of mereology, its axiomatization and its philosophical interpretations and difficulties, see Simons, 1987). He holds that mass terms have minimal parts. 'Water' in subject position denotes the mereological sum, *WATER*, of all the water in the world. Moravcsik proposes two ways in which to interpret mass expressions...

i) Each mass term has its own minimal parts defined by its specific structural properties (SP). Thus, to say 'x is water' is to say that x is a part of that part of *WATER* that has the structural properties SP. *WATER-SP* would be the restricted mereological whole made up by all water-parts of at least the size of a molecule.

As pointed out by Bunt (1985: 26-29), this proposal does not account for the analyticity of 'Water is water', which it represents as: *WATER* is a part of *WATER-SP*, which is invalid. Moreover, it is incoherent: suppose x is a minimal part of *WATER-SP*, like a molecule of H<sub>2</sub>O; then if y is a proper part of x, y is not water (under the hypothesis of minimal parts), but, by transitivity of the part-whole relation, it is a part of *WATER-SP*!

ii) The second proposal is to put restrictions on the part-whole relation itself. 'x is M' is then represented as: x is a *M*-part of *M* ('M' is a mass term and *M* the mereological whole it denotes).

This does not account for the validity of the following "puddle-syllogism": This puddle is water, water is wet, therefore this puddle is wet (mentioned by Burge (1972: 266-267) and by Pelletier (1974)). Indeed, it will be represented as: *PUDDLE* is a *WATER*-part of *WATER*, *WATER* is a *WET*-part of *WET*, therefore *PUDDLE* is a *WET*-part of *WET*. This is invalid because there is no uniform 'part of' relation to attribute transitivity to. However, let me remark that this is simply a general fact about natural languages. In English, say, the (every day) notion of part is not transitive: a cell is a part of an organ, and an organ is a part of the body, but a cell is not a part of the body. In fact, I think it necessary to specify, by way of sense postulates, in which cases the part-whole relation is transitive when applied to two different nouns. For consider the following pseudo-syllogism: Tonic is part of gin-and-tonic, gin-and-tonic makes you drunk, therefore tonic makes you drunk! This shows that the part-whole relation needs to be typed kinds before receiving a precise sense that grounds truth conditions for a proposition (this point is made in the case of predicates by Macnamara and Reyes 1994).

Let me cite here two other arguments against mereological approaches in general. The first is Parsons' (1968, reprinted in 1979: 150). Suppose that all the furniture in the world is made of wood, and that all the wood in the world is turned into furniture. On a mereological theory, we

would conclude that: Wood = Furniture, since x is a part of Wood if and only if x is a part of Furniture. This, however, is clearly false, as a table's leg is not furniture.

The second argument is Pelletier and Schubert's (1989: 358) "paraphrase problem". For these authors, if we take the MN 'water' in subject position to denote all the water in the world, then we should be paraphrase 'all the water in the world' by 'water'. But while 'All the water in the world weighs billions of tons' is correct, 'Water weighs billions of tons' is not. Let me add that, similarly, 'water is H<sub>2</sub>O' states something about the constitution of water, rather than that all the water in the world is part of all the H<sub>2</sub>O-stuff of the world! Likewise, although 'water is liquid' is true, all the water in the world is not liquid, since ice is water. Let me remark first that this simply points out that there is no uniform translation of 'water', at least when it occurs in subject position in a sentence. But moreover, Pelletier and Schubert's argument seems to me misguided. Unless meaning were equated with denotation, it is only to be expected that a description of the denotatum of an expression should have a different sense than the expression itself —which is to say that the description of the denotatum cannot be taken as a paraphrase synonymous with the expression.

**Bunt** (1979, 1985) proposes to abandon the minimal part hypothesis, since it is this hypothesis which creates the problems that Moravcsik was facing. Moreover, the hypothesis does not seem to play any role in the *linguistic usage* of terms like 'water': we use them *as if they had no minimal parts*. Bunt (1979) formulates his *own* homogeneous reference hypothesis: 'A mass noun refers in such a way that no particular articulation of the referent into parts is presupposed, nor the existence of minimal parts' (p.256 ; this is also stated in his book of 1985, p.46 for instance). 'The only difference between CNs and MNs is that the latter refer homogeneously and the former do not: count nouns are taken to refer to discrete ensembles, which do have minimal parts (their atomic sub-ensembles), while mass nouns may refer to any kind of ensemble, with or without minimal parts' (1979: 262). This hypothesis is what I dubbed "mute MNs as linguistic wisdom" in the previous part. Since Gillon (1992: 599) argues, mistakenly I think, that Bunt holds to a 'strong version of the homogeneous reference hypothesis' in which MNs have divisive reference (as usually understood), I will devote enough space to clarify Bunt's position.

Bunt interprets mass terms within his Ensemble theory, which resembles and may be seen as an extension of mereology. It uses a primitive 'part-of' relation. An ensemble is defined by its parts, which are other ensembles. An ensemble is *continuous* if any of its parts has a proper part (x is a proper part of y if x is a part of y and x is distinct from y). An ensemble is *atomic* if it has no proper parts. An ensemble is *discrete* if it is the fusion (or sum) of atomic ensembles. Discrete ensembles are equivalent to sets. Finally, an ensemble may be *mixed*, partly continuous and partly discrete. In accordance with Bunt's homogeneous hypothesis,

MNs are interpreted as denoting ensembles, without specifying whether the ensemble is discrete, continuous or mixed. CNs, on the other hand, are interpreted as denoting discrete ensembles, i.e. sets.

As interpreted in Ensemble theory, cumulative and divisive reference are true of any ensemble, so these properties are not characteristic of MNs or CNs (p.254, p.262). That a noun has divisive reference is represented as: Given any part  $y$  of the ensemble denoted by the noun, every part  $x$  of  $y$  is also part of the ensemble (p.262). This is not strong enough, though, as this property is trivially satisfied by discrete ensembles (which are the denotations of CNs), whose only parts are the atoms of the ensemble. Therefore, I think that the condition should be restated as: For any part  $y$  of the ensemble denoted by the noun, there exists a proper part  $x$  of  $y$  which is also part of the ensemble. This is in effect claiming that the noun denotes a continuous ensemble. When this is done, CNs will not refer divisively, and neither will MNs like 'furniture'.

As for a noun referring cumulatively, it is represented as: Given any parts  $x$  and  $y$  of the ensemble denoted by the noun, the fusion (or union) of  $x$  and  $y$  is also a part of the ensemble (*ibid.*). This is also trivially satisfied by CNs, since it is equivalent to stating that the union of any two subsets of the set denoted by the noun is itself a subset of this set. This does not correspond to what is usually understood by cumulative reference. As a way to represent cumulative reference properly I suggest the following. Besides the relation of part to whole, Ensemble theory uses a primitive relation of 'unicle' to whole (see 1985: page 60 and following ones). This allows one to define a member-whole relation. Every discrete ensemble then appears as equivalent to a set. Its members are the unicles of its atomic parts. A CN like 'cat' is interpreted as a discrete ensemble CAT, therefore a predicate like 'is a cat' may be considered true of  $x$  if and only if  $x$  is a *member* of CAT (CAT '  $x$ ). Now, suppose, for *reductio*, that 'cat' refers cumulatively. This means that a cat  $x$  and a cat  $y$  constitute together another cat  $z = x''y$  —which is represented as: CAT '  $x$ , CAT '  $y$ , *ergo* CAT '  $x''y = z$ . But since CAT is a set,  $x''y$  is a subset of CAT which has two members, and thus cannot be *one member* of CAT. Thus CNs do not refer cumulatively. On the other hand, MNs do refer cumulatively. The reason is that 's is some water' is true if and only if  $s$  is a *part* of WATER (WATER ...  $s$ ). Consider: some water  $s$  and some water  $t$  constitute together some water  $v = s''t$ . This is represented as: WATER ...  $s$ , WATER ...  $t$ , *ergo* WATER ...  $s''t = v$ , which is true.

Bunt (1985) further develops this model by interpreting natural language sentences in a two-level model-theoretic semantics. A first level, the *formal level*, is used to represent the semantic implications of syntactic distinctions like the count-mass distinction. This distinction is taken to be 'a formal phenomenon, not a referential one' (p.129). Bunt is worth quoting in full here. 'The use of a mass noun constitutes a way of referring to something *as if it is a*

*homogeneous part, as opposed to a discrete collection of objects.* [...] Although we may have different actual beliefs about the 'homogeneity' of the referents of such words as 'furniture', 'luggage' [...], 'time', 'rice', from a formal semantic point of view these mass nouns should all be treated alike. In other words, in our two-level framework all mass nouns should be treated at the formal level as entities having a part-whole structure, without any commitments concerning the existence of minimal parts' (*ibid.*, italics are mine). MNs are therefore interpreted as denoting general ensembles, without any further specification. It is only at the second level, the *referential level*, that the ensembles interpreting MNs are specified as being discrete (in the case of 'furniture'), continuous (for 'time') or eventually mixed.

In what precedes, Bunt *may* seem to hesitate between two readings of homogeneous reference (compare the italics to the more neutral proposition that MNs denote any kind of ensemble). Yet, his two-level semantics simply formalizes the claim that grammar is mute as to whether something is to count as a minimal part of what a MN is true of. However, I don't think that distinguishing two such levels is needed to that effect. With a single level of interpretation, one could directly interpret a given MN into an appropriate ensemble (either discrete or continuous), and a given CN into a suitable (discrete) ensemble. Since Bunt holds that, at the formal level, MNs are not specified as having minimal parts, he escapes the Wood = Furniture argument. This is at the cost of claiming that, *at the formal level*, everything is as if a table's leg were furniture.

Finally, let me examine a model which interprets mass expressions as sets of portions of what they are true of.

#### *Mass expressions interpreted as sets of portions*

**Macnamara and Reyes** (1994 and LaPalme-Reyes, Macnamara, Reyes and Zolfaghari 1994) offer a theory which represents referring expressions differently from predicative expressions. A referring count term (like 'person') is interpreted as a kind (e.g. the kind PERSON). A kind is a situated set, i.e. a set together with a constituent relation that associates to every member of the set (e.g. every person) the *situations* of which it is part. The notion of *situation* is taken as an unanalyzed primitive in the theory. Similarly, a referring mass term (like 'water') is interpreted as a *situated sup-lattice*, where the sup-lattice is the partially ordered set of portions of which the mass term is true (e.g. the set of portions of water). As remarked in the previous part when discussing the notion of cumulative reference, Macnamara and Reyes take plural CNs to be mass expressions, and this is unsatisfying from a grammatical standpoint. This problem disappears when one remarks that plural CNs are one of the morphological forms of singular CNs, and therefore should not receive a separate count or mass classification.

Predicables like 'is red', 'is a dog' or 'is water' have their sense specified only when *typed* by a particular noun. The reason for this is that the sense of a predicable often varies depending on the noun it is predicated of: 'white', for instance, has a different sense in 'white paper' and in 'white person'. Following Geach, Macnamara and Reyes sharply distinguish referring expressions from predicables (more on this below).

A predicable predicated of a noun (e.g. 'is white' predicated of 'paper') is interpreted as a *predicate of the kind* that the noun denotes. Such a predicate associates to every member of the kind the situations in which the predicable (e.g. 'is white') is true of the member (e.g. a given piece of paper).

A common noun like 'animal' may give rise to the predicable 'is an animal' predicated of members a specific kind, like the kind CAT. This predicate is true of a cat in a given situation precisely if, at this situation, the cat coincides with the animal in question. Likewise, 'is water' can be predicated of portions of ice, as in 'Ice is water'. 'Is water' is true of a portion of ice in a given situation if the portion of ice coincides with a portion of water in the situation.

The theory also represents how mass expressions can be used as count expressions, and vice versa. To do so, specific relations of 'constitution' are introduced, to relate an individual in a kind with the matter that may be obtained from it in various ways. For example, the relation between chickens and the food obtainable from them is represented as a relation Qfood that associates to every member of the kind CHICKEN the portion of FOOD that may be obtained from it in every situation. The mass expression 'chicken' can then be defined as the situated sup-lattice of all the food that can be extracted from chickens in any situation.

A mass noun used as a count expression (like 'wine' in 'a wine') often has the sense of 'is a kind of' (here, 'is a kind of wine'). In this case, the count expression 'wine' (in 'a wine') is interpreted as the kind KIND OF WINE, in which one finds Sauterne, Bordeaux, Côtes-du-Rhones and their likes. 'Sauterne' is a proper name for an individual in that kind, i.e. a given kind of wine. One can then evaluate the validity of syllogisms like: Sauterne is a wine, wine is a liquid, hence Sauterne is liquid.

An essential characteristic of Macnamara and Reyes' theory is that it sharply distinguishes referring expressions and predicables, which it interprets as kinds and predicates of kinds respectively. Indeed, it rejects the notions of *bare particular* and *bare substance*. All other models of count and mass nominal expressions explicitly or implicitly accept the existence of such bare particulars and bare substances. Expressions like 'black cats' are supposed to denote the intersection of all those things that are black with all those things that are cats. Similarly, the translation of 'red water' (see below) makes use of bare substances. Why should appeals to such notions be avoided? Geach (1962, reprinted 1980; 1972a, 1972b, 1972c) has long insisted that talk of identity makes sense only in association with a sortal. He has argued that it makes no sense to ask whether a and b are the same absolutely. We have to

ask whether a is the same dog or bicycle as b. This is saying that there is no principle of identity for a bare particular. As a consequence, the same is true for predicates. One cannot ask whether x which is black is the same as y which is black. One must ask: is the cat x, which is black, the same cat as the cat y, which is black? Likewise, there is no principle of identity for a bare substance. Therefore, it makes no sense (like Quine for instance does, in *Word and object*) to represent 'red water' as the intersection of all that stuff that is red with all that stuff that is water. That the notions of bare particulars and bare substances should be rejected is crucial to logic. It marks most of the other theories discussed in this part (and in the appendix) as partly unsatisfactory.

Several authors have objected to the interpretation of mass expressions as set of portions (or quantities) of what they are true of. For ter Meulen (1980: 7, 47-48), this is conflating the substance with its quantities (or portions). What quantities of water there are varies from possible situation to possible situation, yet the substance water remains the same. The latter point is correct, but not necessarily the former: as is proposed by Macnamara and Reyes, one may take 'water' in subject position to denote the *situated set* of portions of water (i.e. the set of portions of water indexed by the situations of which they are constituent), which is constant.

Bunt (1985: 41) argues that if one interprets MN as sets of quantities, one cannot represent correctly a noun phrase in subject position like 'The gold on the table'. It will be translated either as *the portion* (or quantity) which is gold and is on the table or as *the portions* (or quantities) which are gold and are on the table. The first translation is incorrect since it makes no sense to claim that there is exactly *one quantity* of gold on the table. As for the second, consider the complete sentence 'The gold on the table weighs two grams'. The set of quantities that are on the table contains many overlapping quantities; therefore, the weight of this set of quantities will far exceed two grams! Taking a MN to denote the set of all quantities of M does not allow us to consider them as a group in a way that does not involve the same quantity being in two distinct quantities. For Bunt, solving this problem requires that one interprets a mass term as a mereological whole. Yet, another solution is to use sup-lattice structures, like Macnamara and Reyes, which allows to define the maximal portion (or quantity) of gold which is on the table (with the understanding that it is this maximal portion which is weighted).

For Laycock (1972, 1975), quantities or portions should not be taken as individuals. If they were individuals, quantities of a substance simply could not be combined. 'An object must have a unity. The loss of the unity [...] must therefore involve the loss of its objecthood. [...] the bronze has no such unity to be destroyed' (1975: 97). Thus, 'There is water here' does not imply 'There is a body of water here'. The idea of a bit of stuff is secondary to the idea of stuff *simpliciter*. To these remarks, let me add the following ones. In most sentences where one



finds 'a portion of water', one can replace it with 'some water' or 'water'. A sentence like 'What is now on the floor is the same portion of water as what was on the table' is not clearer as 'What is now on the floor is the same water as what was on the table'. The expression 'a portion of' seems to do no work above the work done by the rest of the sentence, i.e. its definite descriptions (like 'the water on the table'). This shows that talking of 'a portion of water' is a convenient way of *singling out some water*, often for the purpose of statements of identity. Yet, we should be conscious that 'portion of water' supplies by itself no principle of individuation —since we could never say how many portions of water there are in a given situation— and that a portion (or a quantity) of water is just *some water*.

### *Conclusions*

Although I did not mention it in each case, none of the approaches here examined (or discussed in the appendix) seems able to represent abstract nouns, in particular abstract MNs like 'speed', 'justice', 'intelligence', 'nearness', 'brotherhood' or 'chastity'. The difficulty of course is that of assigning a (reasonably clear) denotatum to these expressions.

Most approaches, except that of Macnamara and Reyes I think, seem implicitly committed to the existence of bare particulars and bare substances. For instance, Pelletier and Schubert take as primitive predicative terms, which they interpret as **predicates** over possible worlds or situations, and define (mass or count) terms in subject position from the predicates. Doing so implies that they implicitly postulate the existence of bare particulars and bare substances. Geach and Macnamara and Reyes give convincing reasons to reject such notions.

A nice characteristic of the models proposed by Pelletier and Schubert is that *predicates* are taken to be true of more than one type of thing, which allows to represent simply such statements as 'everything edible is food, hence rice and this sandwich are food'.

The assumption that MNs have minimal parts creates problems for an interpretation of MNs as **mereological wholes**: it makes it difficult to explain why 'Water is water' is analytic, and why the "puddle syllogism" is valid. Giving up the assumption allows to formulate a mereological theory that, like Bunt's, does not suffer of these problems. Concerning Bunt's specific proposal, we saw that Ensemble theory does not represent in a satisfactory manner the properties of cumulative and divisive reference. I have suggested ways to revise the representation of both. Bunt's two-level model-theoretic does not seem to be needed to translate the "linguistic wisdom" slogan that mass expressions are mute as to whether something is to count as an atom of which they are true; one can directly interpret a given MN as a continuous or as a discrete ensemble.

More generally, a mereological approach still faces two potential problems when it abandons the minimal part hypothesis. The first one is Pelletier and Schubert's paraphrase problem : one cannot paraphrase the bare NP 'water' by 'all the water in the world', although a mereological

approach represents the former by the latter. But this argument seems to me misguided. Unless what an expression means and what it denotes are equated, it is only to be expected that a description of the denotatum of an expression should have a different sense than the expression itself —which is to say that the description of the denotatum should simply *not* be taken to be synonymous with the expression.

The second difficulty comes from what happens in case all wood is made into furniture, and all furniture is made of wood. 'x is wood' translates as: x is part of Wood. But Wood is part of Furniture, therefore, by transitivity of the part-whole relation, x is part of Furniture, which means that x is furniture. Of course this is false, because a table's leg is not furniture. Is there any escape to this argument? One is Bunt's denial that MNs have minimal parts (as we saw previously, at his "formal level", they function "as if they were homogeneous masses"), which implies that a table's leg should be considered to be furniture *at the "formal level"*. The other solution is to deny a uniform part-whole relation, i.e. to adopt Moravcsik's second proposition. This does not account for the validity of the "puddle syllogism". But that no *purely formal* rule validates such a syllogism simply corresponds to the fact that a relation must be typed by kinds, as argued by Macnamara and Reyes in the case of predicates. This is true of the relation 'is a part of'. In English, say, the (every day) notion of part is not transitive: a cell is a part of an organ, and an organ is a part of the body, but a cell is not a part of the body. Thus, it is necessary to specify, by way of sense postulates, in which cases the part-whole relation is transitive when applied to different kinds. I think that this can be done with any kind of mereology, as well as with Bunt's Ensemble theory, although, to be sure, doing so is not in the spirit of these theories.

Viewing MNs as denoting **sets of portions** of what they are true of, one escapes the Wood = Furniture problem, since no uniform notion of part is introduced. What is used is only the notion of a portion *of a given stuff*.

A potential problem remains. If a mass term in subject position like 'the gold on the table' refers to the set of all portions that are on the table, can we ever represent the hypothesis that it weighs two grams? The solution is to equip portions with a sup-lattice structure, as is done by Macnamara and Reyes. This allows to define the maximal portion of gold on the table, which is the portion to be weighted.

*In sum*, what would be adequate representations of the interpretations of count and mass nominal expressions? An approach like that of Macnamara and Reyes and also a mereological approach seem viable. One could, for instance, use Bunt's notion of ensemble to represent the denotata of nouns: CNs would be interpreted as discrete ensembles, and mass nouns as continuous or discrete ensembles, depending on the case. The crucial point would be to associate a *specific* part-whole relation with each noun. Predicates would be obtained from the denotata of nouns: a mass predicate 'is M' is true of x just in case x is a *M*-part of *M*

(where  $M$  is the denotatum of 'M'); a count predicate 'is C' is true of  $x$  just in case  $x$  is a  $C$ -member of  $C$  (where membership is defined as in Ensemble theory). One could also, as remarked by Bunt (1985: 49), "intensionalize" Ensembles, in order to represent statements about possible situations: one would simply equip the theory with a primitive notion of situation which associates to every part of an ensemble the situations of which it is a constituent.

The resultant model would look very much like the theory offered by Macnamara and Reyes, the notion of  $M$ -part corresponding to the notion of a portion of a given stuff  $M$ . The difference between these models would thus be mainly that between Ensemble theory and Category theory (in which the model of Macnamara and Reyes is couched). It seems only safe to prefer Category theory, insofar as it is more general and more flexible than Ensemble theory (for an excellent introduction to the former, see Lawvere and Schanuel 1991).

Pelletier and Schubert point out that mass *predicates* are true of quantities of stuff (the coffee in my cup), kinds of stuff (a kind of coffee), kinds of servings (a coffee ordered in a restaurant) and objects that coincide with quantities of stuff (e.g. a frozen quantity of coffee used as a projectile; or a sandwich, which coincides with a quantity of food). On the other hand, I think that count predicates are naturally taken to be true only of objects (e.g. a particular sole) and kinds of objects (the kind SOLE), as well as of kinds of standardized servings in some cases (a sole, as in 'this was a delicious sole'). These facts should be the consequences, respectively, of the derivation of a mass predicate from the corresponding referring mass term and of the derivation of a count predicate from the associated referring count term. Macnamara and Reyes' model can, I think, be enriched to get these results.

#### **IV. How may children acquire the count-mass distinction?**

The conclusions reached in the previous parts have consequences for understanding the acquisition of the count-mass distinction. As I draw these consequences, a picture of how a child learns the distinction will emerge. This picture is distinct from earlier views of acquisition in several respects. I thus describe these, presenting first distributional accounts, then innate semantic views, and then Gordon's theory. I highlight the way in which my proposal differs from these views and defends it against a criticism by McPherson.

*What does a child have to learn and what abilities need she have when acquiring the count-mass distinction?*

The first part of this paper studied the questions of whether the count-mass distinction was grammatical and whether it concerned nouns, their senses, their occurrences or noun phrases. I concluded from an examination of various proposals that CNs and MNs really form two distinct grammatical subcategories of English nouns, distinguished by their respective distributions. This is simply claiming that '\*a furniture' and '\*much man' are *a priori*

grammatically unacceptable in English. Nonetheless, one can, in certain contexts, use MNs (respectively, CNs) in an extended sense, as the head of count NPs (respectively, mass NPs).

In my second part, I examined various tentative characterizations of the count-mass distinction in purely semantic terms. Although exceptions were found to all definitions, some of these definitions are true of many or most CNs and MNs: for these nouns, there is a systematic difference in sense between the two types of nouns. This difference can be described in terms of individuation and cumulative reference. A (grammatically singular) nominal expression 'A' is *count* if and only if there can be cases in which 'A' provides, without further conceptual decision and without borrowing other principles of individuation, principles that specify what counts as one A and what as several. Correlatively, 'A' does not refer cumulatively (otherwise, one would not know what is to count as an individual A). A nominal expression (which is not the plural of a count singular expression) is *mass* if and only if it refers cumulatively and does not supply a principle of individuation for counting what it is true of. The common nouns that fall outside the purview of these semantic characterizations are "dummy sortals" like 'thing' and nominal measure words like 'drop' and 'puddle', and probably abstract nouns like 'belief', 'justice' and 'nearness'.

In my third part, I looked at formal characterizations of our interpretations of count and mass nominal expressions. To understand the sense of an expression is to interpret it correctly as it occurs in an utterance. Formal characterizations help to clarify what is involved in learning and understanding count and mass expressions. When interpreting an utterance, a child must decide which expressions in the utterance are referring and which are predicating, and she must understand what is being referred to. She must thus be able to identify phrases within a sentence. It seems that infants can do so because of prosodic cues and the existence of "function words" that signal phrase boundaries (cf. Morgan and Newport 1981, Morgan 1986, Morgan et al. 1987). Suppose the child has identified 'the cats' within the utterance 'The cats are eating' as a phrase referring to given cats. The child has to know, or learn on this occasion, that 'cat' is a noun that applies to all the members of the kind CAT, and that 'the' is a word and '-s' a morpheme that modify nouns, 'cat' in this case. Hence the child must be able to categorize cats as belonging to the same kind, and she must understand that pluralization implies quantification over several individuals of the kind CAT. Likewise, to understand a sentence like 'Eat a little soup', the child has to understand that the phrase 'a little soup' is referring, and what it refers to. She has to realize that 'soup' is a noun which applies to all the members of the kind SOUP, that is all portions of soup, and that 'a little' is an expression that modifies 'soup' and implies quantification over (portions of) soup.

Now, since the count-mass distinction is grammatical, *acquiring it is learning to use CNs and MNs in the appropriate grammatical contexts*. In particular, the child has to learn which determiners can be used with which nouns, which nouns can be employed without a

determiner, and which can be pluralized. Let me call noun plural endings, determiners, quantifiers, numerals, as well as use of bare nouns in bare noun phrases *grammatical markers* of nouns. A marker which can occur only with CNs I will call a *count* marker, and a marker specific to MNs a *mass* marker. The use of each marker has specific quantificational implications; these indicate whether the marker can be used with CNs or with MNs. For instance, the determiner 'a' implies individuation, hence it cannot be combined (in usual contexts) with 'water', which supplies no principle of individuation, but it can be used with 'dog'. *I make the hypothesis that the child's use of count and mass markers is governed by her understanding of their senses, in particular of their quantificational implications, and of the senses of nouns.* To grasp these quantificational implications, the child must be able to quantify over individuals of specific kinds as well as over portions of specific stuff. Now, the child will probably have difficulties learning the sense of "atypical" CNs which are true of non-solid substances (like 'puddle'), and of "atypical" MNs which are true of solid objects (like 'furniture'). This should lead the child to use mass markers together with the atypical CNs which she does not construe as being true of individuals, and count markers with the atypical MNs which she believes to be true of individuals.

This picture of the acquisition of the count-mass distinction stems from the conclusions reached concerning the grammatical status of the distinction and the extent to which it can be semantically characterized, and from the hypothesis that the child's use of markers together with nouns is governed by her understanding of the senses of nouns and markers. This account differs in several respects from earlier views. Let me describe these and highlight the differences.

### *Distributional accounts*

Count nouns form a grammatical subcategory of English common nouns. This subcategory has its own distribution, which differs from that of the subcategory of mass nouns. It is therefore possible that children learn the count-mass distinction on a purely distributional basis. Children would learn which grammatical markers can be used with which nouns *before* being sensitive to the senses of grammatical markers. Like the acquisition of gender subcategories in several languages, learning the count-mass distinction would thus be based primarily on children's ability to recognize distributional regularities (cf. Maratsos 1988, Schlezinger 1988). However, let me remark that learning of gender is greatly helped by the existence of *phonological cues*, at least in French (Tucker, Lambert, Rigault & Segalowitz 1968), Hebrew (Levy 1988a, 1988b), and Russian (Popova 1973) —languages in which gender is correlated with such cues. In languages in which gender has no strong phonological correlates (e.g. Icelandic; cf. Mulford 1985), gender categories are learned relatively late, after children acquire the concept of natural gender (as late as age 3; cf. Bem, 1981). There are no

phonological cues correlated with the count-mass distinction, at least in English and in French. As a result, it is hard to estimate how easy, or hard, it could be to discover the count-mass distinction through a purely distributional analysis.

Gathercole (1983, 1985) argues that children first learn to use the quantifiers 'much' and 'many' on a distributional basis, and understand their senses only later. Gathercole (1986) further claims that this is the case for the acquisition of plural endings and of the modifiers 'one' and 'another': 'Both these developments are based primarily on the distributional properties of nouns and modifiers' (p.176). And these conclusions are restated by Levy in a stronger form: 'children first learn the linguistic [count-mass] distinction as a morpho-syntactic rather than semantic distinction' (1988a: 186).

All this is in marked opposition with what precedes, since I hypothesize that the child will start by learning noun and marker's senses and this will tell her whether marker and noun can be used together. Another difference is that, under my proposal, errors are expected in the case of atypical MNs and atypical CNs. Indeed, the child will probably have difficulties grasping what these nouns are true of. She will at first employ mass markers with the atypical CNs that she does not construe as being true of non individuated stuff, and count markers with the atypical MNs the denotation of which she believes to consist of individuals. By contrast, according to distributional views, children should make just as many errors with atypical CNs and MNs as with typical CNs and MNs.

### *Innate semantic views*

Several authors have proposed that the acquisition of the count-mass distinction is based not on a distributional analysis, but on children's understanding of the sense of nouns. In *Names for things*, Macnamara argued that the mass-count distinction is basically a semantic distinction: 'count nouns name things that have a characteristic form, and mass nouns do not' (1982: 139). He mentioned a study by Brown (described in the next part) that showed that young children were sensitive to the covariation of semantics and linguistics related to count and mass nouns. This led him to propose that 'a semantic classification [of nouns as naming individuals with characteristic form or naming stuff without characteristic form] will serve the child well in learning [...] the mass-count distinction' (p.142). In *A border dispute*, Macnamara expressed the intuition that CNs name things with a characteristic form in terms of individuation: CNs supply a principle of individuation that specifies what counts as an individual of which they are true (1986a). Macnamara (1986b) proposed that MNs do not themselves provide any means for individuation. Following Gupta (1980), he also offered a definition of nouns as words that supply a principle for tracing the identity of what they are true of across times and situations.

Building on this, McPherson (1991: 322-323) proposed that 'some kind of *perceptual information* gives rise to intuitions relevant to these semantic definitions of the categories count noun and mass noun, and that classification of a word is guided by those intuitions. [...] An object presents itself as a perceptually distinct individual, and two objects do not coalesce to form one larger object; it follows that the basic-level kind to which an object belongs should be designated by a CN (which has atomic individuals in its domain). A substance does not have any characteristic form (i.e. masses of substances are not individuated in any characteristic way that is available to perception), and so the basic-level kind to which a mass substance belongs should be designated by a mass noun (which does not provide any means for individuating its extension'.

Macnamara and Reyes (1994) argued that the distinction between CNs and MNs is that only MNs denote kinds with sup-lattice structure. By that they meant that any two portions of a substance can be combined together to form another (larger) portion of the substance. They proposed the following rules: 'Assign a word to the syntactic category CN if it is taken as applied to perceptual entities that in combination do not yield another entity of the same kind' (p.166). 'Assign a word to the syntactic category MN if the samples to which it is applied are taken as constituting in combination a larger sample' (p.170). These propositions are not equivalent to those of Macnamara and McPherson; yet, as is clear from the second part of this paper, they will classify many common nouns as count or mass in the same way.

In his Ph.D. thesis (1990), Bloom proposed that the fundamental semantic contrast between CNs and MNs is in terms of reference to individuals. That is, 'count nouns interact with determiners to form noun phrases that denote individuals, and mass nouns interact with determiners to form noun phrases that denote portions. By "portions", I mean that they refer to entities that are not specified as being composed of individuals' (p.89). Bloom distinguished three levels of 'cognitive architecture', linked with one another: a conceptual level, a semantic level and a syntactic level. Nouns are semantically marked as [+Individual] or [-Individual], which determines their syntactic status as count or mass. The semantic feature [+Individual] maps onto a corresponding cognitive notion of individual, which 'is roughly equivalent to "discrete bounded entity"'(p.94). For instance, *day* is a count noun because it denotes a bounded unit of time, and *race* is a count noun because it denotes a bounded event' (*ibid.*). Bloom's semantic characterizations of CNs and MNs create an inextricable problem for the child. Indeed, a noun denoting a kind of individuals may be a MN or a CN. Hence the child would be at a loss as to how to classify such nouns!

Note: In his more recent publications (e.g. 1994, 1996), Bloom no longer invokes "semantic features", but still talks of "syntax-semantic mappings", like the following ones: 'Count nouns refer to kinds of individuals', 'Mass nouns refer to kinds of portions' (1994: 310). The reason

is that the "semantic features" did not seem to do much work: they just reduplicated the "syntactic features".

To me, the only substantial difference between Bloom's view of the count-mass distinction and that of Macnamara, McPherson and Reyes is that Bloom holds that a MN is simply *mute* as to whether something is to count as an individual of which it is true. As mentioned, this makes it impossible, on a purely semantic basis, to classify a noun with individuals in its denotation.

All the authors considered in this section share the claim that children learn which nouns are count and which are mass on the basis of the senses of nouns. In fact, it is time to note that they claim that some innate knowledge is necessary to that effect: the child is *innately endowed* with the knowledge that, for instance, a noun denoting a kind of individuals should be classified as belonging to the grammatical category of count nouns. These accounts are significantly different from the picture I have drawn of the acquisition of the count-mass distinction. First of all, they claim that the child is innately endowed with knowledge that MNs name kinds of non-individuated stuff, and CNs kinds of individuals. In my view, there is no need for this innate knowledge. The acquisition of the count-mass distinction stems from the ability to categorize something as belonging to a specific kind of solid objects (like the kind CAT) or to a specific kind of non-solid substance (like the kind WATER); to quantify over individuals and over portions of stuff; and to understand the intention of the speaker and in particular what she is referring to. Second, the authors just mentioned claim that common nouns are classified as count or mass on the basis of their sense. Such a classification would therefore be done by the child even when she neither uses nor comprehends any count or mass grammatical marker (e.g. before one year and a half), since, at that age, the child already knows the sense of nouns for kinds of individuals and for kinds of non-individuated stuff. In my view, the child's mastery of the count-mass distinction is gradual, and it is nothing more than the way in which the child uses nouns together with grammatical markers. A child does not classify a noun as count or mass. Rather, the child comes to know whether the noun can be used together with a specific marker through an understanding of their senses. Related to what precedes is the following point. Innate semantic characterizations of CNs and MNs would lead the child to *misclassify* the common nouns which do not conform to these characterizations. In my opinion, since the child does *not* classify common nouns as count or mass, she cannot *misclassify* these nouns. Rather, the child should at first use inappropriate markers together with these nouns because of an incorrect or imperfect understanding the senses of these nouns.

*Gordon's theory*



Yet another view on acquisition is that of Gordon (1985, 1988). He concluded from a series of experiments that the count-mass distinction is 'primarily syntactic': *syntactic* cues are clearly the most effective and *predominate over semantic cues* as a basis for sub-categorization [of nouns as count or mass]' (1985: 209, my italics). Indeed, young children did not seem to be able to use the semantic properties of nouns as the sole basis for category assignment; and children did not miscategorize nouns that possessed semantic properties that conflicted with the syntax in which they were presented. Therefore, 'the count/mass distinction is not acquired via an object/substance distinction although semantic properties of quantification are probably important for the acquisition process' (p.209). In fact, Gordon explicitly supposed that children first learn the quantificational properties of some grammatical markers, like 'a', 'another', numerals and plurals. This then allows for the appropriate bifurcation of the noun category into those nouns that are individuated when quantified (count) and those that are not (mass). Such a method 'does not require the child to recast categories in terms of referential properties, only to recognize the proper function that the syntactic categories play in quantification' (p.240). The count-mass distinction is 'based on how nouns are quantified, either as individuals (count nouns) or non-individuals (mass nouns)' (1988: 126). For Gordon, the acquisition of the count-mass distinction is based neither on an object/substance distinction nor on the senses of nouns *per se*. It is a 'primarily syntactic distinction', the acquisition of which is based on learning the semantic properties of grammatical markers. Like the semantic views described in the previous paragraph, Gordon also postulates some kind of innate knowledge: 'If individuation is one of a relatively narrow set of parameters available to the language learner for sub-categorization, and the learner is on the lookout for this distinction, then the present evidence that the learning is very rapid may not be quite so mysterious' (1988: 127).

Gordon's view of acquisition, clearly, has points in common with my own. However, Gordon does not accord any role to the learning of the nouns' senses in the acquisition process, while I do, since I hypothesize that a child will know whether a noun and a marker can be used together through an understanding of the senses of *both*. I predict that the child will at first make specific errors when employing markers together with the atypical CNs that she does not construe as naming individuals, and with the atypical MNs which she believes to be only true of single individuals. On the contrary, Gordon thinks that the child should have no more difficulty using markers with these nouns than with typical ones. Moreover, Gordon presupposes that the child is innately endowed with knowledge that the distinction individuated/non-individuated could play a role in the grammar of the language she is learning. Again, I do not see the *necessity* of this innate knowledge.

*Is knowledge of the count-mass distinction necessary to learn the sense of count and mass grammatical markers?*

Let me now present and discuss an argument of McPherson; it is directed against Gordon's view but it also applies to my own position. For Gordon, as we saw, the acquisition of the count-mass distinction is based not on the sense of nouns per se, but on the semantic properties of grammatical markers. McPherson (1991) argues that Gordon's account presupposes that children already know that CNs denote kinds of individuals, while MNs denote kinds of non-individuated stuff. Indeed, how do children learn the quantificational properties of specific grammatical markers like 'a' and 'much'? Plausibly, they learn the sense of 'a' by noticing that it is used to modify a word that they take as denoting a kind of individual. Similarly, a child will probably learn the quantificational properties of 'much' by grasping how it modifies nouns that name kinds of homogeneous substances. Therefore, 'it seems children cannot learn the distinction between discrete and continuous quantification [...] unless they have *a categorical distinction* between nouns that individuate their extension and nouns that do not individuate their extension. If children have such a categorical distinction, then they do have a count/mass distinction' (p. 321, my italics).

The crucial point here is the suggestion that children *must* already have a categorical distinction between two types of nouns. However, all that is strictly required is that children know the *senses* of some nouns that are count for adults, and the senses of some nouns that are mass for adults. Soja's experiments (described in the next part) show that when presented with a solid object, 2 year olds will take a novel word to be denoting a kind of solid object; and when presented with a non-solid substance, they will take a novel word to be denoting a kind of non-solid substance. Therefore these experiments establish that young children correctly understand the sense of nouns for solid objects and nouns for non-solid substances.

This leads one to ask: How do two year old children know that some words name specific kinds of objects and some other words name specific kinds of non-solid substances? McPherson, Macnamara, Reyes and Bloom argue that the child *must* innately be endowed with the knowledge that common nouns either denote kinds of individual or kinds of non-individuated stuff. I do not see the *necessity* of this innate knowledge. The child daily encounters solid objects and non-solid substances, like apples and soups. These behave in different ways, hence it is not surprising that the child learns to distinguish between the two, and categorizes them into different kinds (e.g. the kinds APPLE and SOUP). Abilities of this type are indeed demonstrated by infants before they start speaking —see Carey (1993), Huntley-Fenner & Carey (submitted), and Huntley-Fenner, Carey, Klatt & Bromberg (1996). So imagine that there is some soup in front of the child; if the parent says: 'Eat your soup!', we can expect the child to know that her parent is referring to the soup, and what soup is. Similar remarks would obtain if the parent had said 'Here is an apple'. In such contexts, the child

knows what her parent is referring to, which she categorizes either as an instance of a specific kind of solid object or as an instance of a specific kind of non-solid substance. The innate knowledge postulated by Macnamara, McPherson, Reyes and Bloom does not seem *necessary* to account for the child's learning of the senses of common nouns, nor for her acquisition of the count-mass distinction.

It should be noted that McPherson's argument shows that children cannot learn the sense of grammatical markers independently of the sense of common nouns. The way in which Gordon presents his theory suggests that he considers children's mastery of the quantificational properties of grammatical markers to be independent of their understanding of the sense of nouns. Insofar as this interpretation is correct, McPherson's argument is a sound criticism of Gordon's proposal.

## **V. Empirical evidence concerning the acquisition of the count-mass distinction**

In this part, I present the empirical evidence that bears on the learning of the count-mass distinction. I first indicate what would constitute evidence against each of the views on acquisition. I then describe and discuss the experimental findings cited in favor of some of the views on the learning of the count-mass distinction, as well as some studies on noun pluralization.

*What empirical evidence would help distinguish between the competing accounts?*

What type of experimental findings would constitute evidence against each of the various proposals on acquisition? Under *all* accounts, the child eventually has to *learn* both the sense and the distributional properties of each grammatical marker. It is logically possible that the child learns one before the other, or both at the same time. Evidence against purely distributional accounts will be provided if children master the distributional properties of many or most markers only when they fully grasp their senses. Evidence against innate semantic views, Gordon's theory and my own proposal will be provided if children master the distributional properties of many or most markers before understanding their senses.

Another type of evidence will be provided by children's errors with common nouns. Indeed, innate semantic views and my own proposal predict specific errors in the use of atypical CNs and MNs, a prediction which is made neither by distributional accounts nor by Gordon. Innate semantic characterizations of CNs and MNs would lead the child to misclassify the atypical CNs which she misconstrues as denoting non-individuated stuff, and the atypical MNs which she takes to be true of single individuals. Therefore, she should at first make more errors in her use of markers together with atypical CNs and MNs, than with typical CNs and MNs. I make the same prediction, but for a slightly different reason: these atypical common nouns will not be *misclassified* by the child; the child will simply use inappropriate markers together with

these nouns because of an incorrect understanding of the senses of these nouns. In contrast to these two positions, and according to distributional views and Gordon's, learning which markers can be used with atypical CNs and MNs should be as easy as learning with which markers typical CNs and MNs should be employed; there should be as many errors with these types of nouns.

In what follows I examine whether the existing evidence helps to distinguish between the competing accounts. I consider first the results obtained with children older than three. I describe studies on their use and understanding of 'much' and 'many'; then of 'a', 'another', 'some' and bare noun phrases. Turning to children younger than three, I indicate what is known about their use and understanding of 'a', 'another', 'some' and bare noun phrases. Then I examine children's understanding and use of noun pluralization; and finally, children's errors with typical and atypical MNs and CNs.

#### *How children older than three use and understand 'much' and 'many'*

**Gathercole** (1983, 1985) asked children aged 3;6 to 9 to judge sentences in which 'much' and 'many' modified prototypical and non-prototypical mass and count nouns, and to correct those sentences judged to be deviant. Each child received each type of noun once in the singular and once in the plural, with both 'much' and 'many'. Gathercole reasoned as follows. If the correct use of 'much' and 'many' was based upon the properties of nouns' referents, children should first learn to use quantifiers correctly with typical MNs and typical CNs. But if correct use was based upon surface co-occurrences, children should learn to use 'much' and 'many' at the same time. The results showed an equivalent performance on the four types of nouns. Gathercole concluded that children were responding according to the surface distributions of forms. Children's performance was higher with 'many' than with 'much'. Children showed the poorest performance on plural CNs, which seemed mainly due to the fact that many children used 'much' together with these nouns. Children responded according to the number of the noun at an earlier age than they responded according to the choice of the quantifier. They learned that 'many' could be used only with CNs and 'much' only with MNs only around 7 or 7;5. Children's equivalent performance on the four types of nouns suggests that between 3;6 and 9, children's use of 'much' and 'many' in connection with nouns is not based on the sole basis of the nature of the noun's referent. However, the fact that, for a long time, children use 'much' in contexts where 'many' is required is consistent with the hypothesis that they understand the component of meaning which is shared by 'much' and 'many', but do not grasp what is the (slight) semantic difference between the two. Gathercole's conclusion that children learn the distributional properties of 'much' and 'many' before grasping their senses is therefore unwarranted.

*Understanding of 'a', 'another', 'some' and bare noun phrases shown by children older than three*

While the semantic and distributional properties of 'much' and 'many' are mastered late, those of 'a', 'another', 'some' and bare noun phrases are acquired much earlier. Studies examining children older than three have consistently shown that they are strongly influenced by the linguistic cue provided by the use of these count- and mass-specific markers when learning novel nouns. The influence of the use of 'a', 'another', 'some' and bare noun phrases is the clearest when children are presented with ambiguous stimuli, which can be conceptualized as object-like or substance-like. For instance, **Bloom** (1990) studied the sensitivity of children aged 3;1 to 4;1 (mean age: 3;7) to count-mass syntax in material and non-material domains. Besides using 'a', 'another', 'some' and bare nouns, Bloom also employed the expressions 'a lot of gav' (mass syntax) and 'a lot of gavs' (count syntax). He taught children nouns for food stimuli (lentils and spaghetti), and for sounds of a bell that was repeatedly struck. The nouns could as well be taken to refer to one lentil, one spaghetti, or the sound of a bell stroke just once, or to several lentils, spaghetti or bell sounds. With food stimuli, children were asked to 'give a zav' or to 'give zav' to the experimenter. They predominantly gave one stimulus when count syntax was used, and several stimuli in response to mass syntax. With sounds, children were asked to 'make a moop' or to 'make moop' for the experimenter. The majority of the children made one sound when the noun was used as a CN; and more than one sound when the noun was used as a MN.

The marker used also influences children's interpretations of novel nouns with non-ambiguous stimuli. Consider **Gordon's** experiments (1982, 1985), with children aged 3;5 to 5;5 (mean age: 4;3). Children were presented cards that contained either one entity or several similar entities. The entities were either unfamiliar solid objects or unusual-looking liquids presented in sets of four test-tubes. Children were taught nouns for these entities, with both linguistic cues (use of 'a', 'another', 'some' and bare noun phrases) and semantic cues (nature of the noun's referent: object or substance). These cues were either in accord or in conflict (in the latter case, children would for instance be presented with a card depicting an object and told 'This is some garn'). To test how children had subcategorized the new noun, they were required to complete the following sentence: 'So, here we have a/some garn, over there we have more ... what?', said as the experimenter pointed to a group of additional objects or substances of the same kind. The results showed that when the linguistic and the semantic cues were in conflict, children at all ages mainly answered on the basis of the linguistic cue. However, their performance was higher when there was no conflict between cues.

In another experiment, Gordon tested children aged 3 to 5;11 (mean age: 4;5) on their sensitivity to the same semantic and linguistic cues *in isolation*. While all children were sensitive to the linguistic cue, only older children showed significant ability to subcategorize the

new noun solely on the basis of the semantic cue: children aged 3 to 4;5 could not. This second experiment thus confirmed the results of the first: four and a half year old children are sensitive to the use of 'a' and 'another' *versus* 'some' and bare noun phrases when interpreting novel nouns for unfamiliar objects and substances, and this influences their response to the question 'more what?', while the nature of the noun's referent has only a limited influence.

Similarly, **Dickinson** (1988) taught nouns for unfamiliar solid objects and unfamiliar substances to children aged 3;4 to 5;4 (mean age: 4;3), with neutral, count or mass markers ('the', 'a' and 'some'). Half of the children he tested interpreted a novel word for an unfamiliar non-solid substance introduced by the determiner 'a' as denoting a kind of individuals, rather than stuff of the same kind. However, 'some' had little influence when it was used to introduce a noun true of solid objects. This is in marked contrast with Gordon's finding. Due to these conflicting data, what exact influence use of the mass determiner 'some' has when it is in conflict with the nature of the referent remains indeterminate.

Since children were already four year and a half on average in all these studies, they may have mastered the distributional properties of markers well before that age. And they may also have grasped the semantic implications of these markers at an earlier age. Let me thus examine the understanding of the same count and mass markers shown by children younger than three in connection with the acquisition of novel nouns.

*Understanding of 'a', 'another', 'some' and bare noun phrases demonstrated by children younger than three*

As with older children, the interpretations of a novel noun made by children younger than three are influenced by the nature (object or substance) of what the noun denotes, as well as by the fact that the novel noun is used together with 'a' and 'another' *versus* with 'some' and as a bare noun. However, the strongest cue is by far the nature of the referent. For children aged two or younger, these markers have *little* influence on children's interpretations, as was shown by **Soja, Carey and Spelke** (1991). They taught two year old children a novel noun in connection with an unfamiliar entity shaped like an T, either a solid object or a non-cohesive substance in a container. The utterances used to teach these nouns contained either 'a' and 'another', or 'some' and bare noun phrases. The results were that count or mass syntax had no effect on two year olds' responses. Children took a noun applied to an unfamiliar solid object to denote objects of the same shape, ignoring its substance. They took a noun applied to an unfamiliar non-solid substance to denote the (same) material, ignoring configuration.

These findings are cited by Macnamara, Reyes, McPherson and Bloom as evidence that children are innately endowed with the knowledge that CNs denote kinds of individuals and MNs kinds of non-individuated stuff (*nota bene*: on their view, a child is innately endowed with the count-mass distinction, but still has to learn the senses and distributions of

grammatical markers). As remarked in the previous part, I do not see the necessity of this innate knowledge: I find it plausible that children's interpretations of novel nouns result from how they have *categorized* objects and non-solid substances, independent of language.

As children grow slightly older (two year and a half), what marker is used has more influence, as was demonstrated by **Soja** (1992). Soja extended the previous study with children aged 2;0 and 2;5 and in a situation where the linguistic cue conflicted with the nature of the referent: in the object trials, an object was introduced with 'some' and with a bare noun; while in the substance trials, a substance was introduced with the determiners 'a' and 'another'. She found that the nature of the referent had more influence on children's responses than the marker used. By comparison to the results obtained in the previous study, upon observing an unfamiliar object being labeled by a MN, children were pulled somewhat towards a substance construal —however, on the majority of trials, they still took the noun as denoting a kind of object. By contrast, when children observed an unfamiliar non-solid substance, they were quite strongly affected by the syntax used: 'a' and 'another' pushed the children towards an object interpretation (probably like 'puddle'), and resulted in an overall chance performance for this condition. The markers' influence was greater for 2 and a half year old children than for children younger, but it remained limited.

**What can we conclude** from these findings concerning the different accounts of the learning of the count-mass distinction? The evidence described in this section is inconsistent with Gordon's view, since he claims that the nature of what a noun denotes should have only a limited influence compared to that of grammatical markers. Yet, two and a half year old children, who were sensitive to the senses of markers, were heavily influenced by what the noun denoted. Given what precedes, according to distributional views, children would have to master the distributional properties of 'a', 'another', 'some' and bare noun phrases before grasping their senses, sometimes before two year and a half . That this would be so is a possibility that we must consider. To resolve this question, a longitudinal study of children aged, say, between 1;8 and 2;8, is needed.

Other information about children's use and understanding of count and mass markers is provided by studies on noun pluralization, which I now describe.

#### *Children's use and understanding of noun pluralization*

**Brown** (1973) studied the speech of three children for their use of plural endings, to investigate when they were employed in appropriate versus inappropriate grammatical contexts. The children reached a level of 90% correct use of plural endings at 1;11, 2;6, and 2;10 respectively. He also gave tests of comprehension to the three children. Several pencils were laid down in front of the child, and the child was asked 'Give me the pencil' and 'Give me the pencils'. To respond correctly a child had to attend and interpret correctly the presence or

absence of the plural morpheme. Children failed to respond in a consistent manner to the controlled inquiry well after they had attained the 90% criterion in spontaneous speech. Taken alone, these findings are evidence in favor of distributional views, since correct use seems to precede comprehension. However, these results may be due to the fact that to say 'the pencil' without prior introduction is to presuppose that there is only one. Since several pencils were visible, the instruction may have confused the children.

**Mervis and Johnson** (1991) reported data from an extensive diary that was kept of Mervis' first son, Ari. The first occurrences of pluralization appeared at 1;6, very soon followed by use of the quantifier 'many' in a situation where many birds were present. Very few pluralizations of words that were not nouns were observed. Only three MNs were pluralized, at a time when Ari knew around eighty MNs. The fact that MNs cannot be pluralized is likely to be one of the first distinguishing features of MNs that a child learns. These data suggest that as soon as Ari used pluralization, he understood its semantic implications: he knew that pluralization implied the presence of a number of individuals, and could not be used with MNs that do not refer to individuals.

**Tomasello and Olguin** (1993) tested eight 20 to 26 month olds. Children were presented with novel stuffed animals performing actions in several conditions. For instance, in an Agent condition, the experimenter said: 'Look, the *peri* is kissing Cookie Monster'. In a Patient condition, he said: 'Look, Big Bird is pushing the *gazzer*.' Then the actions were repeated, with the role of the characters reversed, and the experimenter asked 'what happened?' To test for productive use of the plural morpheme, children were told 'Look! A *toma*. Hey! Here is another one. What are these?' It was found that children pluralized novel nouns for unfamiliar creatures, and used them in new argument structures, i.e. as agent and as patient. The authors concluded that these children possessed a syntactic category of noun (p.460). In this study, as in the case of Mervis' son, children younger than two demonstrated an understanding of the semantic implications of pluralization.

**Overall**, these studies show that nouns are pluralized by children as young as 1;6, and that noun pluralization is mastered very early, during children's third year. Mervis and Johnson's longitudinal study (1991) and the experiment of Tomasello and Olguin (1993) suggest that the semantic implications of pluralization *may* be evident from the moment at which the child starts pluralizing (i.e. at one year and a half). These findings are in marked contrast with the (apparent) lack of comprehension of the children in Brown's study (1973). Clearly, a detailed investigation of children's *understanding* of pluralization is called for.

Finally, let me examine children's errors when employing grammatical markers with typical and atypical common nouns.

*Children's errors with typical and atypical count nouns and mass nouns*



**Gordon** (1985) tested the hypothesis that children categorize nouns on the basis of the nature of their denotata, and as a result miscategorize MNs describing objects as CNs, and CNs describing non-solid substances as MNs. He asked 2, 3 and 4 year olds questions like: 'Do you know what you get in a toy store?' Gordon assumed that if children categorize 'toy' as count they should answer: 'toys'. Children were tested on mass superordinates like 'furniture', count superordinates like 'toy', mass food terms (e.g. 'rice') and count food terms (e.g. 'beans'). At each age, there were very few errors. Only 4 year olds made errors with mass superordinates, and they made a comparable number of errors for count superordinates; younger children made almost no error for superordinate nouns. 2 year olds made errors only with food terms that were count nouns. Gordon hypothesizes that the difference between count and mass food terms is due to the fact that 2 year olds are not perfect at pluralizing and sometimes omit plural endings. This experiment suggests that children as young as two do not make specific errors with atypical CNs and MNs.

Using the Childes database, **Bloom** (1990) examined the longitudinal speech samples of 5 children. Their ages ranged from 1;6 to 5;2. Children made significantly more errors when using atypical MNs that describe objects (e.g. 'bacon', 'cheese', 'furniture') than when using typical MNs that describe substances (e.g. 'juice', 'milk', 'sand').

**While** Bloom found that children made more errors with atypical CNs and MNs than with typical ones, Gordon found that there was no difference in children's errors with the two types of nouns. Given their conflicting nature, these data are inconclusive as to whether children make more errors when employing markers with atypical CNs and MNs than with other common nouns. A detailed examination of children's use and understanding of atypical and typical CNs and MNs is therefore needed. Its objective would be to tell us if children use grammatically inappropriate markers with the atypical CNs and MNs of which they do not fully understand the sense.

To conclude this paper, let me summarize the experimental results just reviewed together with the conclusions drawn in the preceding parts.

### **Summary of the paper**

English grammar distinguishes count nouns from mass nouns. They form two grammatical subcategories of common nouns, identified by their respective distributions. Corresponding to this are the facts that a phrase like 'a man' is well-formed, while '\*a water' is a priori grammatically unacceptable. Yet, one can, in certain contexts, use MNs (respectively, CNs) in an extended sense, as the head of count NPs (respectively, mass NPs).

The following semantic characterizations of CNs and MNs were found to be true of many or most common nouns. A (grammatically singular) nominal expression 'A' is *count* if and only if there can be cases in which 'A' provides, without further conceptual decision and without

borrowing other principles of individuation, principles that specify what counts as one A and what as several. Correlatively, 'A' does not refer cumulatively (otherwise, one would not know what is to count as an individual A). A nominal expression (which is not the plural of a singular count expression) is mass if and only if it refers cumulatively and does not supply a principle of individuation for counting what it is true of. Exceptions to these characterizations are nominal measure words, "dummy sortals", and probably abstract nouns, like 'belief', 'justice' and 'nearness'.

In my third part, I examined several formal characterizations of our interpretations of CNs and MNs as they occur in various types of sentences. Most of them do not fully recognize the distinction between referring and predicative expressions, and also have other specific problems. The model proposed by LaPalme-Reyes, Macnamara, Reyes and Zolfaghari appears to be the best yet at our disposal. Referring common nouns are interpreted as kinds. Predicables are interpreted as predicates defined over specific kinds.

The conclusions reached in the first three parts of my paper have consequences for understanding the acquisition of the count-mass distinction. When interpreting an utterance, a child must decide which expressions in the utterance are referring and which are predicating, and she must understand what is being referred to. For instance, she must realize that in the utterance 'The cats are drinking a little milk', 'the cats' is referring, the expression 'are drinking a little milk' is predicating, 'milk' is a noun for all portions of milk, 'cat' is a noun true of all cats, 'the', '-s' and 'a little' are expressions that modify nouns. She must thus be able to categorize some milk as being a portion of milk and a cat as belonging to the kind CAT. She must also understand that, in the sentence, pluralization implies quantification over individuals of the kind CAT, and use of 'a little' implies quantification over portions of milk.

Now, since the count-mass distinction is grammatical, *acquiring it is learning to use CNs and MNs in the appropriate grammatical contexts*, in particular with the appropriate markers. The quantificational implications of a marker indicate whether it can be used with CNs or with MNs. For instance, the determiner 'a' implies individuation, hence it cannot be combined with 'water', which supplies no principle of individuation. I make the hypothesis that the child's use of count and mass markers is governed by her understanding of their senses, in particular of their quantificational implications, and of the senses of nouns (including knowing whether the nouns refer cumulatively). Now, the child will probably have difficulties learning the sense of atypical CNs which are true of non-solid substances, and atypical MNs which are true of solid objects. This should lead the child to use mass markers together with the atypical CNs which she does not construe as individuals, and count markers with the atypical MNs which she believes to be true only of single individuals. Such errors will disappear when the child fully understands what these nouns are true of and whether they refer cumulatively.

This picture of the acquisition differs from earlier views. Distributional accounts inspired by Gathercole's work claim that for *many or most* grammatical markers, children learn which nouns can be used with which markers *before* being sensitive to the senses of these markers. Innate semantic accounts like those of Macnamara, Reyes, McPherson and Bloom claim that the child is innately endowed with the knowledge that MNs name kinds of non-individuated stuff, and CNs kinds of individuals. In my view, there is no need for this innate knowledge. The acquisition of the count-mass distinction stems from the child's ability to learn the senses of nouns and grammatical markers.

There is no evidence that children learn the distributional properties of markers before learning their senses. For a long time, children use 'much' in contexts where 'many' is required; this is consistent with the hypothesis that they understand the component of meaning which is shared by 'much' and 'many', but do not grasp what is the slight semantic difference between the two. The semantic and distributional properties of 'a', 'another', 'some' and bare noun phrases are acquired much earlier. Studies with children younger than three show that their interpretations of a novel noun are largely determined by the nature of what the noun denotes. Use of the novel noun together with 'a' and 'another' *versus* with 'some' and as a bare noun has *little* influence on the interpretations made by children aged two or younger. The influence of these markers is greater with two year and a half children, but remains limited. These findings are inconsistent with Gordon's view, since he claims that the nature of what a noun denotes should have only a limited influence compared to that of the markers.

Yet it remains *possible* that children master the distributional properties of 'a', 'another', 'some' and bare noun phrases before grasping their senses, sometimes before two year and a half. To resolve this question, a longitudinal study of children's *use and understanding* of these markers is needed, with children aged, say, between 1;8 and 2;8. The studies on pluralization show that nouns are pluralized by children as young as 1;6, and that noun pluralization is mastered very early, during children's third year. A detailed investigation of children's *understanding* of pluralization is necessary because of the existence of conflicting evidence about this. Likewise, we need to examine children's use and understanding of atypical and typical CNs and MNs more thoroughly, to discover whether children use grammatically inappropriate markers with the atypical CNs and MNs of which they do not fully understand the sense.

## Appendix: Other formalizations of the interpretations of count and mass nominal expressions

In this appendix, I describe several formal characterizations of our interpretations of CNs and MNs which, for ease of exposition, were not included in the third part of this paper. I first present two models of mass expressions interpreted as predicates (Montague's and ter Meulen's); then Link's formalization, in which MNs are interpreted as sets of portions of what they are true of; Quine's proposal; and finally, several models that have recourse to mereological theory: those of Cartwright, Parsons, Roeper, Lonning, Simons and Ojeda.

### *Mass expressions interpreted as predicates*

For **Montague** (1973a, reprinted in 1979; 1973b), MNs denote properties of individuals. For instance, 'water' denotes the property of being a body of water. 'In general, a mass term denotes 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 [...]) of the substance in question in that world' (1973a: 173). Samples or portions of water are taken to be ordinary individuals.

A mass term 'M' in predicative position is taken to be synonymous with 'is of portion of M'. On the other hand, a bare mass nouns phrase, like 'water' in 'water is liquid', is considered as equivalent to 'all water' (i.e. 'all water is liquid'). The latter is, in fact, quite different from the former, as ice, though not liquid, clearly is water.

Phrases like 'the gold in my ring' are to be analyzed as 'the gold constituting my ring', which 'denotes the set of maximal portions of gold' in the ring (p.175). ter Meulen (1980: 57) has pointed the following problem with such an approach (in connection with Parsons' theory, described below). Consider the sentence: 'Hamburgers are food'. The relation between hamburgers and food is not one of constitution. In fact, objects and quantities of substance stand in several relations, all of which would have to be introduced as primitives in the model. Yet, let me remark that, insofar as these relations are irreducible to one another, this fact will simply have to be acknowledged by *any* kind of model: a new primitive will indeed have to be introduced each time one wants to represent a new relation.

Abstract MNs are treated in the same way: 'information' would 'denote the property of being a piece (that is, portion of) information' (Montague 1973a: 177). But, as mentioned in the third part of this paper, the notion of portion does not seem to apply to the abstract realm of, say, justice, nearness and chastity.

**ter Meulen** (1980, 1981) distinguishes sharply between what she calls *nominal* and *predicative* mass expressions. In sentences like 'Water is H<sub>2</sub>O', 'water' is a MN that behaves in syntactic and semantic respects like a proper name for an abstract entity, the substance 'water' —call such expressions *nominal* mass terms. In 'This ring is gold', 'gold' functions like

a predicate; it takes quantifiers and various modifiers and denotes a set of quantities of the substance —call such a term a *predicative* mass term.

More generally, a predicative mass term (like 'gold' in 'This ring is gold') is interpreted as a function on possible situations, which, in every given possible situation, picks out the set of quantities of gold. ter Meulen claims that 'a concept (the substance) is not the same as the set of all possible quantities that fall under the concept' (1981: 121). She takes the nominal mass term as denoting the *property* which is common to quantities of the substance in all possible situations. More precisely, a nominal mass term is interpreted as a function from possible situations to the function that interprets the corresponding predicative mass term, i.e. the nominal mass term has this function in its extension. In full: a nominal mass term is interpreted as a function from possible situations to a function from possible situations to sets of quantities of the substance. We see thereby that a nominal mass term functions as a second-order predicate. However, as remark Pelletier and Schubert (1989), why not just identify the substance with the *intension* of the predicative mass term, i.e. with the function on possible situations?

ter Meulen adheres to the hypothesis (mentioned in the second part) that MNs have homogeneous reference: quantities of a substance are homogeneous entities —i.e. any quantity of a substance consists of smaller quantities of that substance, and quantities can be fused together to form a larger quantity.

ter Meulen argues that MNs in subject position are not necessarily nominal mass terms. Indeed, consider 'Some gold shines' and 'All gold shines'. In these sentences, 'gold' functions not as a proper name for a substance, since perceptual characteristics cannot be predicated of a substance, which is an abstract entity. Instead, 'gold' functions as a predicate. 'Some/all gold' denotes the set consisting of all sets that contain some/all quantities of gold at a situation of reference.

An interesting feature of ter Meulen's model is that determiners and quantifiers are treated as basic lexical items that take nouns and form terms —they are translated as functions that take the sets denoted by the head noun as arguments and yield families of such sets.

Let me now turn to Link's model.

*Mass expressions interpreted as sets of portions of what they are true of*

**Link's** (1983) model of count and mass expressions is formulated in set-theoretic rather than mereological terms. He capitalizes on what seems the crucial property of mereologies in representing the interpretation of mass terms: their join semi-lattice structure, or *sup-lattice structure*, i.e. that the *sum* of any two parts of this structure is also part of the structure. Link's model is restricted to the interpretation of predicate expressions, since Link holds that 'nominal mass terms do not seem to have a proper logic' (p.306) and that their behavior is, in any case, independent of 'the lattice structure that governs the behavior of predicative mass terms and plural expressions' (ibid.). Yet, the consequence of such a position is clearly pointed out by Laycock (1972: 22): 'there is an absurdity in the "same" term's having two quite unrelated types of significance. [...] Without a reduction of one to the other [...] the existence of two types of occurrence must seem mysterious'.

Link (p.308) models the universe of discourse by way of a domain E of atomic individuals (those denoted by CNs) and a domain D of individual portions of matter which are not necessarily atomic (those portions of which MNs are true). Both E and D are taken to be Boolean algebras with a sup-lattice structure.

Given this, the extension {P} of a *mass noun* P is the semi-lattice generated by the set of portions of matter that are P. A *singular count noun* Q denotes a subset {Q} of E. The *plural count noun* formed from Q is taken to be true of exactly the non-atomic sums in the join semi-lattice generated by {Q}. I.e. it is true of all subsets of {Q} that have more than two elements. Link's interpretation of plural CNs is thus identical to the one I proposed in the second part.

A nice characteristic of Link's model is the interpretation of predicative MNs and plural CNs as denoting sup-lattices. Indeed this successfully captures the fact that both types of expressions refer cumulatively (in the weak sense). Singular predicative CNs are interpreted as denoting atomic individuals, which represents the alleged fact that, in a given situation of use, a CN specifies what is to count as an individual.

Before turning to the interpretation of MNs as mereological wholes, let us look at **Quine's** proposal, as he belongs to none of the three grand approaches identified in my third part. Quine (1960) analyses mass terms in predicate position in a different way than mass terms in subject position. 'Is water' is analyzed as 'is a bit of water'; it is true of any portion of the substance in question, excluding the parts that are too small to count (for instance, atoms of hydrogen would not be considered as 'bits of water'). On the other hand, in 'water is liquid', 'water' names the *scattered individual* which is all the water in the world. As noted in the second part, for Quine, a mass term like 'water' has the property that 'any sum of parts that are water is water' (p. 91).

Burge (1972: 266) remarks that Quine's account is incomplete as it cannot deal with sentences like 'John threw snow at Leslie'. It would be natural to assign to 'snow' here the status of a singular term, but it yields an incorrect interpretation since John did not throw the totality of snow in the world at Leslie.

Moreover, as Burge (1972: 266-267) and Pelletier (1974) pointed out, it does not account for the validity of syllogisms like the following "puddle syllogism": This puddle is water, water is wet, therefore this puddle is wet. The syllogism would be represented by Quine as: water(puddle), wet( water), therefore wet( puddle), which is invalid. This difficulty would be solved by specifying *sense postulates* for each mass term like 'water': For every x, water( x) if and only if x is a part of water. But Quine cannot do that since he holds to the hypothesis that mass terms have minimal parts, which makes this bi-conditional statement false from right to left.

### *Mereological approaches*

**Cartwright** (1975, reprinted in 1979) suggests that a nominal mass noun, like 'water', denotes a kind of (here, the substance water). The corresponding predicative mass term is true of quantities of the substance. A quantity can be a sub-quantity of another, and two quantities can be combined, or summed, to form a third quantity. Cartwright uses a mereological theory, Goodman's calculus of individuals, to represent quantities.

Two quantities of a substance may have the same amount, and this amount may be measured. The greatest part of Cartwright's paper is occupied with coming up with satisfying notions of amount and measure —I will not go into it since it would lead us too far afield. Every expression involving mass nouns is to be analyzed in terms of amounts of quantities of substance. For instance, 'x is some water' is represented as: there exists a number y which is the amount of water that the quantity of water x is (p.181). Let me remark that this translation is highly more complicated than the original. In particular, I see no need of the notion of amount to represent a sentence like 'x is some water'.

Cartwright claims that the basic unit of the measurement of the amount is dependent on the structural properties of the substance. Therefore, she faces the same difficulties as Moravcsik does. In fact, measurement of an amount of substance will fail, in general, to be transitive from one substance to another.

**Parsons'** (1968, reprinted in 1979) starting point is that in 'My ring is gold', 'gold' names a substance  $g$ . The sentence is to be represented as:  $r C g$ , where 'r' denotes the ring and 'C' stands for 'is constituted of'. This constitution-relation holds between the object  $r$  and the substance  $g$  just in case  $r$ 's matter is a quantity of  $g$ . In fact, in Parsons' model, three primitives are used, namely the notions of (ordinary) *object*, of *substance*, and of a bit of matter being *a quantity of* a substance.

Parsons acknowledges that his model applies best to concrete object nouns, and with difficulty to abstract MNs such as 'information' or 'speed': what could be a 'quantity of information' or a 'quantity of speed' when we use 'information' or 'speed' in ordinary discourse?

In order to be able to deal with the similarity between the sentences 'Water is widespread' and 'Muddy water is widespread', Parsons introduces a substance abstraction operator  $s$  that applies to formulas like  $[Mx \& xQw]$ . The formula inside the brackets represents 'muddy water' as being true of  $x$  if and only if  $x$  is muddy ( $Mx$ ) and  $x$  is a quantity of water ( $xQw$ ). The  $s$  operator yields a 'term that refers to that substance which has as quantities all and only things which the formula inside is true of' (p.147). We can thus form the following substances:  $s[Mx \& xQw]$  for the substance 'muddy water' and  $s[xQw]$  for the substance 'water'.

ter Meulen (1980: 57-60) has pointed the following problems with Parsons' analysis. Consider the sentence: 'Hamburgers are food'. The relation between hamburgers and food is not one of constitution. In fact, objects and quantities of substance stand in several relations, all of which would have to be introduced as primitives in the model. However, let me remark that, insofar as these relations are irreducible to one another, *any* kind of model will *have to* introduce a specific primitive in order to represent a given relation.

Another problem is that 'water' is a rigid designator, in that the noun designates the same substance in all possible situations. On the contrary, the extension of 'muddy water' varies from possible situation to possible situation, which is to say that 'muddy water' is not a rigid designator. Parsons is unable to distinguish between those MNs that are rigid designators and those that are not.

Finally, Parsons holds to the hypothesis that MNs have minimal parts and, moreover, that 'which 'parts' of  $x$  are quantities of  $x$  depends on  $x$ , and not just on some abstract notion of part' (Parsons 1968: 161, footnote 8). Therefore, the relation 'to be a quantity of' behaves either like Moravcsik's SP-part relation, or else the substances themselves have to be interpreted like Moravcsik's SP-wholes. As seen during the discussion of Moravcsik, the latter suggestion is incoherent; the former is simply to introduce various part-whole relations, one for each substance.



Yet other mereological theories have been proposed, by Roeper, Lonning, Simons and Ojeda. In the aspects that interest me, their models are similar to those already studied. Therefore I describe them quite quickly in what follows.

**Roeper's** (1983) interprets mass nouns in terms of *complete* Boolean algebras (i.e. *sup-lattice* Boolean algebras such that the *intersection* of any two parts is also a part of the algebra). Roeper distinguishes between nominal and predicative mass terms. A nominal mass term denotes a quantity, for instance, 'wine' denotes the total quantity of wine in the world. Quantities are individuals that may have parts. The structure which consists of a quantity together with all its parts, and the part-of relation, is a complete semi-lattice Boolean algebra. A predicative mass term denotes the set of quantities of which it is true. Roeper defines what he calls "mass predicates", as those predicates that refer distributively and cumulatively (p.256-257). Not all predicates of quantities of a substance are "mass predicates" (p.259).

Nominal MNs may be atomic or not (p.256) —i.e. Roeper adheres to the "linguistic wisdom" slogan. Singular CNs denote classes of atoms, which, under the inclusion relation, form an atomic Boolean algebra.

**Lonning** (1987) uses semi-lattice structures. He adheres to the hypothesis that MNs (seem to) refer homogeneously, 'that is both cumulatively and distributively' (p.8). More generally, Lonning identifies a class of mass expressions that refer homogeneously. MNs belong to that class, but also predicates like 'boiled' which are true of any part of what they are true.

To model the universe of discourse, he introduces a single Boolean algebra  $A$ . A mass NP like 'much water' denotes subsets of the algebra. Homogeneous expressions like 'boiled' denote elements in the algebra. A sentence like 'Much water boiled' is true if and only if the element denoted by 'boiled' is a member of the set denoted by 'much water'. Mass terms denote elements of the algebra, and determiners denote functions which to elements of the algebra assign subsets of it.

Although the model is a formal one, not a model of the world, one may think of the elements of the algebra as the quantities (or portions of matter) in the actual world. 'Water' refers to the totality of the world's water, 'boiled' to the totality of what boiled at the time interval involved and 'some water boiled' is true if and only if the quantity which is the intersection of these quantities is different from the empty quantity (p.13).

**Simons** (1987) interprets MNs as denoting masses, i.e. mereological individuals. He uses the axioms of traditional extensional mereology (p.150), but he interprets the relation between masses not as a 'part of' relation (which applies best to entities that have parts), but rather as a 'is some of' relation (p.157). For instance, rather than saying that the rice in this bowl is part of the food in this bowl, he states that the rice in this bowl is some of the food in this bowl. The 'is some of' relation appears as similar to the 'are some of' relation that exists between classes of individuals (e.g. dogs are some of the animals). Indeed, these relations can also be given a separate mereological interpretation (p.157). Simons introduces a *constitution* relation between individuals and the masses of which they are made (e.g. the wood constituting a bed). Given that MNs are interpreted as masses, which obey the axioms of traditional mereology, they have cumulative reference (the full system is given in pages 150 and 162 to 166). No assumption that MNs have minimal parts is made.

**Ojeda** (1993) proposes another mereological theory, which follows the same axioms as the traditional mereologies described by Simons (1987). The universe of discourse is described by a universe of elements. For an element *k* of the universe, its domain is the set of its elements/parts (in his mereology, to be an element is the same as to be a part). CNs are taken to denote *atomistic* domains, i.e. domains which have atoms as their smaller elements/parts (p.37). Therefore, CNs provide a principle of individuation for what they are true of (p.116). MNs denote domains that are *atomless*, e.g., 'wine' denotes the set of portions of wine, with the condition that a portion of wine has proper parts that are portions of wine (p.108). This is saying that, for Ojeda, MNs not only refer cumulatively but also refer distributively (p.122-123). Hence MNs provide no principle of individuation for what they are true of.

## Bibliography

The citation of Ludwig Wittgenstein opening this paper is taken from his *Philosophische Untersuchungen*, and that of John Macnamara from his paper *Cognitive basis of language learning in infants* (see references below).

When a text is mentioned as reprinted, pages references were made to the reprint.

- Allan, K. (1977). Classifiers. *Language*, 53, 285-311.
- Allan, K. (1980). Nouns and countability. *Language*, 56(3), 541-567.
- Bem, S. (1981). Gender schema theory: a cognitive account of sex typing. *Psychological review*, 88, 354-364.
- Bloom, P. (1990). Semantic structure and language development. *Psychology*, M.I.T.
- Bloom, P. (1994). Possible names: the role of syntax-semantics mappings in the acquisition of nominals. *Lingua*, 92, 297-329.
- Bloom, P. (1996). Controversies in language acquisition: Word learning and the part of speech. In *Perceptual and cognitive development* (pp. 151-184). Academic Press.
- Broch, H. 1945. *The death of Virgil*. New York: Pantheon Books Inc.
- Brown, R. (1973). *A first language: The early stages*. Cambridge, MA: Harvard University Press.
- Bunt, H. C. (1979). Ensembles and the formal semantic properties of mass terms. In J.F.Pelletier (Ed.), *Mass terms* (pp. 249-277). D.Reidel Publishing Company.
- Bunt, H. C. (1985). *Mass terms and model-theoretic semantics*. Cambridge: Cambridge University Press.
- Burge, T. (1972). Truth and mass terms. *Journal of philosophy*, 69, 263-282.
- Burge, T. (1975, reprinted 1979). Mass terms, count nouns and change. In J.F.Pelletier (Ed.), *Mass terms: some philosophical problems* (pp. 199-218).
- Carey, S. (1993). Speaking of objects as such. In G.Harman (Ed.), *Conceptions of the human mind*. NJ: Lawrence Erlbaum Associates.
- Cartwright, H. M. R. (1970). Quantities. *Philosophical review*, 79, 25-42.
- Cheng, C.-Y. (1973). Response to Moravcsik. In Hintikka et al. (Eds.), *Approaches to natural language* (pp. 286-288).
- Dickinson, D. K. (1988). Learning the names for materials: factors constraining and limiting hypotheses about word meaning. *Cognitive development*, 3, 15-35.
- Emonds, J. (1986). Les parties du discours en grammaire generative. In *Recherches linguistiques de Vincennes*.
- Gabbay, D., Moravcsik, M.E. (1979). Sameness and individuation. In J. F. Pelletier (Ed.), *Mass terms* (pp. 233-247). D.Reidel Publishing Company.
- Galmiche, M. (1986). Notes sur les noms de masse et le partitif. *Langue française*, 72, 40-53.
- Galmiche, M. (1987). A propos de la distinction massif/comptable. *Modèles linguistiques*, Vol. 8.
- Gathercole, V. C. (1983). The mass-count distinction: children's use of morphosyntactic vs. semantic approaches. *Papers and reports on child language development*, 22, 58-65.
- Gathercole, V. C. (1985). '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.
- Gathercole, V. C. (1986). Evaluating competing linguistic theories with child language data: the case of the mass-count distinction. *Linguistics and philosophy*, 9, 151-190.
- Geach, P. T. (1962, reprinted 1980). *Reference and generality*. Ithaca: Cornell University Press.
- Geach, P. T. (1972a). History of the corruptions of logic. In P.T.Geach, *Logic matters*. Berkeley: University of California.
- Geach, P. T. (1972b). What are referring expressions? In P.T.Geach, *Logic matters*. Berkeley: University of California.
- Geach, P. T. (1972c). Identity. In P.T.Geach, *Logic matters*. Berkeley: University of California.
- Gillon, B. S. (1992). Towards a common semantics for English count and mass nouns. *Linguistics and philosophy*, 15, 597-639.
- Gillon, B. S. (1994). On the semantic difference between mass nouns and count nouns. In 11th European conference on artificial intelligence. Amsterdam, The Netherlands.
- Gordon, P. (1982). Early encoding of the count/mass distinction: semantic or syntactic? *Papers and reports on child language development*, 71-78.
- Gordon, P. (1985). Evaluating the semantic categories hypothesis: The case of the count/mass distinction. *Cognition*, 20, 209-242.
- Gordon, P. (1988). Count/mass category acquisition: distributional distinctions in children's speech. *Journal of child language*, 15, 109-128.

- Greenberg, J. (1990). Numeral classifiers and substantial number: Problems in the genesis of a linguistic type. In J.Greenberg, *On language. Selected writings of Joseph H. Greenberg*. Stanford: Stanford University Press.
- Grevisse, M. (1993). *Le bon usage: grammaire française*. Paris: Duculet.
- Griffin, N. (1977). *Relative identity*. Oxford: Clarendon Press.
- Gross, M. (1986). *Grammaire transformationnelle du français*. Malfoff, France: Cantilene.
- Gupta, A. K. (1980). *The logic of common nouns*. New Haven: Yale University Press.
- Higginbotham, J. (1995). Mass and count quantifiers. In E.Bach, A.Kratzek & B.H.Partee (Eds.), *Quantification in natural languages* (pp. 383-419).
- Hintikka, J., Moravcsik, J. & Suppes, P. (Eds.). (1973). *Approaches to natural language*. Dordrecht: D.Reidel.
- Hugo, V. (1969). *Les contemplations*. Paris: Editions Garniers Freres.
- Huntley-Fenner, G.N., & Carey, S. (1995). Can infants represent the distinction between enumerable and continuously quantifiable entities? Submitted to *Child development*.
- Huntley-Fenner, G.N., Carey, S, Klatt, L. & Bromberg, H. (1996). Physical reasoning in infancy: The distinction between objects and nonsolid substances. Unpublished manuscript.
- Jespersen, O. (1924). *The philosophy of grammar*. London: G.Allen.
- Kleiber, G. (1990). L'article LE générique. La genericité sur le mode massif. Geneve: Librairie Droz.
- Langacker, R. (1991). Nouns and verbs. In R.Langacker, *Concept, image and symbol: the cognitive basis of grammar* Berlin: Mouton de Gruyter.
- LaPalme-Reyes, M., Macnamara, J., Reyes, G.E., Zolfaghari, H. (1994). Count nouns, mass nouns and their transformations: a unified category-theoretic semantics. Unpublished manuscript.
- LaPalme-Reyes, M., Macnamara, J., Reyes, G.E. (1994). Reference, kinds and predicates. In J. Macnamara & G.E.Reyes (Eds.), *The logical foundations of cognition* (pp. 91-145). Oxford University Press.
- Lawvere, F.W. & Schanuel, S.H. (1991). *Conceptual mathematics. A first introduction to categories*. Buffalo, NY: Buffalo Workshop Press.
- Laycock, H. (1972). Some questions of ontology. *Philosophical review*, 81, 3-42.
- Laycock, H. (1975, reprinted 1979). Theories of matter. In J. F. Pelletier (Ed.), *Mass terms* (pp. 89-120). D.Reidel Publishing Company.
- Levy, Y. (1988a). On the early learning of formal grammatical systems: evidence from studies of the acquisition of gender and countability. *Journal of child language*, 15, 179-187.
- Levy, Y. (1988b). The nature of early language: evidence from the development of Hebrew morphology. In Levy et al. (Eds.), *Categories and processes in language acquisition*.
- Levy, Y., Schlesinger, I. M. & Braine, M.D.S. (Eds.) 1988. *Categories and processes in natural language acquisition*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Link, G. (1981). The logical analysis of plurals and mass terms: A lattice-theoretical approach. In R. Bauerle, Schwartze, C. & von Stechow, A. (Eds.), *Meaning, use and interpretation of language* (pp. 302-323). Berlin: Mouton de Gruyter.
- Lonning, J. T. (1987). Mass terms and quantification. *Linguistics and philosophy*, 10, 1-52.
- Lyons, J. (1968a, reprinted 1991). Towards a 'notional' definition of the 'parts of speech'. In *Natural language and universal grammar*. Cambridge, England: Cambridge University Press.
- Lyons, J. (1968b). *Introduction to the theoretical linguistics*. Cambridge University Press.
- Lyons, J. (1970). *Linguistique générale. Introduction à la linguistique théorique*. Paris : Larousse.
- Lyons, J. (1981). *Semantics* (2nd ed.). Cambridge: Cambridge University Press.
- Macnamara, J. (1972). Cognitive basis of language learning in infants. *Psychological review*, 79(1), 1-13.
- Macnamara, J. (1982). *Names for things*. MIT Press.
- Macnamara, J. (1986a). *A border dispute: The place of logic in psychology*. MIT Press.
- Macnamara, J. (1986b). Principles and parameters: A response to Chomsky. *New ideas in psychology*, 4(2), 215-222.
- Macnamara, J. (1991). Linguistic relativity revisited. In R.L.Cooper & B.Spolsky (Eds.), *The influence of language on culture and thought*. Mouton de Gruyter.
- Macnamara, J. & Reyes, G.E. (1994). Foundational issues in the learning of proper names, count nouns and mass nouns. In J. Macnamara & G.E.Reyes (Eds.), *The logical foundations of cognition* MIT Press.
- Macnamara, J. & Reyes, G.E. (Eds.) (1994). *The logical foundations of cognition*. MIT Press.
- Maratsos, M. (1988). The acquisition of formal word classes. In I.M.Levy et al. (Eds.), *Categories and processes in language acquisition* (pp. 21-44).
- Martinet, A. (1979). *Grammaire fonctionnelle du français*. Paris: Didier.
- McCawley, J. (1975). Lexicography and the count-mass distinction. In *Proceedings of the first annual meeting of Berkeley linguistics society* (pp. 314-321).

- McPherson, L. M. P. (1991). "A little" goes a long way: Evidence for a perceptual basis of learning noun categories COUNT and MASS. *Journal of child language*, 18, 315-338.
- McPherson, L. M. P. (1995). Identifying verbs early in language learning: The roles of action and argument structure. *Psychology*, McGill.
- Mervis, C.B. & Johnson, K.E. (1991). Acquisition of the plural morpheme. *Developmental psychology*, 27(2), 222-235.
- Montague, R. (1973a). The proper treatment of mass terms in English. In Hintikka et al. (Eds.), *Approaches to natural language*.
- Montague, R. (1973b). Reply to Moravcsik. In Hintikka et al. (Eds.), *Approaches to natural language* (pp. 289-294).
- Morgan, J.L. (1986) *From simple input to complex grammar*. Cambridge, MA: MIT Press.
- Morgan, J.L., Meier, R.P. & Newport, E.L. (1987). Structural packaging in the input to language learning: Contributions of prosodic and morphological marking of phrases to the acquisition of language. *Cognitive psychology*, 19, 498-550.
- Morgan, J.L. & Newport, E.L. (1981). The role of constituent structure in the induction of an artificial language. *Journal of verbal learning and verbal behavior*, 20, 67-85.
- Mufwene, S. S. (1984). The count/mass distinction and the English lexicon. In *Parasession on lexical semantics* (pp. 200-221). Chicago linguistics society.
- Mulford, R. (1985). Comprehension of Icelandic pronoun gender: semantic versus formal factors. *Papers and reports on child language development*, 22, 83-91.
- Ojeda, A. (1993). *Linguistic individuals*. Stanford, CA: Stanford University.
- Parsons, T. (1970, reprinted 1979). An analysis of mass and amount terms. In J.F.Pelletier (Ed.), *Mass terms* (pp. 137-166).
- Pelletier, J. F. (Ed.). (1979). *Mass terms: some philosophical problems*. D.Reidel Publishing Company.
- Pelletier, J. F. (1979). Non-singular reference: some preliminaries. In J.F.Pelletier (Ed.), *Mass terms* (pp. 1-14). D.Reidel Publishing Company.
- Pelletier, J. F., Schubert, L.K. (1989). Mass expressions. In D.Gabbay & F.Guenther (Eds.), *Handbook of philosophical logic* (pp. 327-407). D.Reidel Publishing Company.
- Popova, M.F. (1973). Grammatical elements of language in the speech of preschool children. In C.A.Ferguson & D.I.Slobin (Eds.), *Studies of child language development* (pp. 269-280). New York: Holt, Rinehart and Winston.
- Quine, W. V. (1960, reprinted 1976). *Word and object*. Cambridge: MIT Press.
- Roeper, P. (1983). Semantics for mass terms with quantifiers. *Nous*, 17, 251-265.
- Roubaud, J. (1967). *Signe d'appartenance*. Paris: Gallimard.
- Rundle, B. (1979). *Grammar in philosophy*. Oxford: Clarendon press.
- Schlesinger, I. M. 1988. The origin of relational categories. In Levy et al. (Eds.), *Categories and processes in natural language acquisition* (pp. 121-178).
- Séguin, R. & Séguin, M.-C. (1975). A la pleine lune. In M.-C. Séguin & R. Séguin, *Récolte de rêves*. Editions de la Gigue Eternelle.
- Sharvy, R. (1978). Maybe English has no count nouns. *Studies in language*, 2, 345-365.
- Simons, P. (1982a). Number and manifolds. In B. Smith (Ed.), *Parts and moments* (pp. 160-198). Munich: Philosophia.
- Simons, P. (1982b). Plural reference and set theory. In B. Smith (Ed.), *Parts and moments* (pp. 198-260). Munich: Philosophia.
- Simons, P. (1987). *Parts: A study in ontology*. Oxford: Oxford University Press.
- Soja, N. N., Carey, S. & Spelke, E.S. (1991). Ontological categories guide young children's inductions of word meaning: object terms and substance terms. *Cognition*, 38, 179-211.
- Soja, N. N. (1992). Inferences about the meanings of nouns: the relationship between perception and syntax. *Cognitive development*, 7, 29-45.
- ter Meulen, A. (1980). Substance, quantities and individuals. *Linguistics*, Max Planck Institut fur Psycholinguistik.
- ter Meulen, A. (1981). An intensional logic for mass terms. *Philosophical studies*, 40, 105-125.
- Tucker, G.R., Lambert, W.E., Rigault, A. & Segalowitz, N. (1968). A psychological investigation of French speakers' skill with grammatical gender. *Journal of verbal learning and verbal behavior*, 7, 312-316.
- Tomasello, M. & Raquel, O. (1993). Twenty-three-month-old children have a grammatical category of noun. *Cognitive development*, 8, 451-464.
- Ware, R. X. (1975, reprinted 1979). Some bits and pieces. In J. F. Pelletier (Ed.), *Mass terms* (pp. 15-29). D.Reidel Publishing Company.

- Weinreich, U. (1966). Explorations in semantic theory. In *Current trends in linguistics* (vol.3, pp. 395-477). The Hague: Mouton de Gruyter.
- Wierzbicka, A. (1984). Apples are not "a kind of fruit": the semantics of human categorization. *American Ethnologist*, 11, 313-328.
- Wierzbicka, A. (1985). Oats and wheats: the fallacy of arbitrariness. In J.Haiman (Ed.), *Iconicity in syntax*. Amsterdam: J.Benjamin.
- Wittgenstein, L. (1958, reprinted 1968). *Philosophische Untersuchungen*. (English and German.) New York: Macmillan.