Learning the Categories 'Count Noun' and 'Mass Noun'

by

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Learning the Categories Count Noun and Mass Noun
Abstract

The categories count noun and mass noun are distinguished by syntactic properties that are most salient in connection with the quantifiers. It is argued that one semantic distinction underlies these syntactic differences: the presence or absence of a principle of individuation in the kind denoted by a noun. For some kinds, the presence or absence of a principle of individuation is readily inferred from perceptual information about their extensions: individuated in appearance (objects), or non-individuated (substances). A test was conducted of the hypothesis that children classify nouns as count or mass on the basis of an object/substance distinction. Two-year-old children were taught a word for objects or for a substance in a count or mass syntactic context. For the majority of children, the treatment of a word as a count noun or mass noun was based upon the object- or substance-like appearance of the stimulus presented. It was concluded that perceptual information is critical in establishing the categories count noun and mass noun.
M. A. Psychologie

Résumé

Les catégories "nom comptable" et "nom massif" se distinguent par des propriétés syntaxiques mises en évidence particulièrement par les quantificateurs. Nous proposons qu'une seule distinction sémantique est à la base de ces différences syntaxiques: c'est à dire la présence ou l'absence d'un principe d'individualisation du concept dénoté par un nom. Pour certains concepts, la présence ou l'absence d'un principe d'individualisation est inférée facilement à partir de l'information perceptive quant à leurs extensions: individualisés en apparence (les objets), ou non-individualisés (les substances). On a vérifié l'hypothèse selon laquelle la classification des noms comme comptable ou massif est fondée, chez les enfants, sur une distinction entre les objets et les substances. Des enfants de deux ans devaient apprendre un mot d'objet ou de substance dans un contexte syntaxique comptable ou massif. Pour la plupart des enfants, le traitement d'un mot comme nom comptable ou massif était basé sur l'apparence d'objet ou de substance du stimulus présenté. Il a été conclu que l'information perceptive est critique à l'établissement des catégories de nom comptable et nom massif.
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Introduction

English common nouns are generally divided into two categories: count nouns such as lawn and sun, and mass nouns such as grass and sunlight. The language marks count nouns as distinct from mass nouns in its syntax. Many authors have noted semantic differences between count and mass nouns as well, although the exact nature of these differences is the source of considerable debate. It is generally agreed, though, that for nouns for which the associated kinds have some physical extension, and in particular for nouns at the basic level (see Macnamara, 1986; Neisser, 1987; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976), there exists a rough correspondence between objects and count nouns on the one hand, and substances and mass nouns on the other.

The aim of this thesis is to provide evidence that the count/mass noun distinction is learned on the basis of an object/substance distinction. I will begin by describing what children must learn in order to arrive at adult competence in their use of count nouns and mass nouns.

The Nature of What is Learned

Syntactic Properties. The syntax of count nouns differs from that of mass nouns in several ways. Count nouns can appear in both singular and plural forms, whereas mass nouns cannot vary in number. Some determiner always appears with a singular count noun, but a mass noun can appear without a determiner. Furthermore, there are many expressions that are restricted to use with either count nouns or mass nouns. For
example, numerals may be used with count nouns but not with mass nouns. A list of some of the expressions that are used exclusively with one of these categories of noun appears in Table 1. Given the large number of such expressions, it would be advantageous to find some general principles underlying these restrictions; ideally, knowledge of such principles would make it possible to determine the grammaticality of noun phrases independently of specific co-occurrence rules. In order to find these underlying principles, it is necessary to examine the semantic properties of count nouns and mass nouns.

Semantic Properties. In describing the semantic properties of count and mass nouns, I will adopt a theory of meaning in which the interpretation of a noun is the kind to which it is used to refer (see Macnamara, 1982). Semantic properties are thus properties of a kind. Following Gupta (1980) and Macnamara (1986), I will assume that a kind designated by a noun consists of a set of principles: a principle of application that specifies the conditions for belonging to a kind, and a principle of identity that specifies how identity is to be traced. If a semantic difference exists between count nouns and mass nouns in general, then a comparison of the kinds to which count nouns and mass nouns refer should reveal some consistent difference in one (or both) of these principles.
## Table 1

Expressions That Are Restricted To Use With

**Count Nouns or Mass Nouns**

<table>
<thead>
<tr>
<th>Count Noun</th>
<th>Mass Noun</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Singular:</strong></td>
<td>(a) little (quantifier)</td>
</tr>
<tr>
<td>indefinite article (a)</td>
<td>less</td>
</tr>
<tr>
<td>another</td>
<td>much</td>
</tr>
<tr>
<td>each</td>
<td>an amount of</td>
</tr>
<tr>
<td>every</td>
<td>a portion of</td>
</tr>
<tr>
<td>either</td>
<td>a piece of</td>
</tr>
<tr>
<td>neither</td>
<td>a slice of</td>
</tr>
<tr>
<td>a whole</td>
<td>a chunk of</td>
</tr>
<tr>
<td><strong>Plural:</strong></td>
<td>a pinch of</td>
</tr>
<tr>
<td>(a) few</td>
<td>a dose of</td>
</tr>
<tr>
<td>fewer</td>
<td>a body of</td>
</tr>
<tr>
<td>both</td>
<td>a wad of</td>
</tr>
<tr>
<td>many</td>
<td>a gob of</td>
</tr>
<tr>
<td>several</td>
<td>a shot of</td>
</tr>
<tr>
<td>a (small/large) number of</td>
<td>a bit of</td>
</tr>
<tr>
<td>(a/the) majority of</td>
<td>a lump of</td>
</tr>
<tr>
<td>(a/the) minority of</td>
<td>a loaf of</td>
</tr>
<tr>
<td>a host of</td>
<td>a block of</td>
</tr>
<tr>
<td>a bunch of</td>
<td>a hunk of</td>
</tr>
<tr>
<td>a group of</td>
<td>a particle of</td>
</tr>
<tr>
<td>a set of</td>
<td>a grain of</td>
</tr>
<tr>
<td>a series of</td>
<td>a morsel of</td>
</tr>
<tr>
<td>a herd/flock/drove of</td>
<td>a drop of</td>
</tr>
<tr>
<td>a host of</td>
<td>the bulk of</td>
</tr>
<tr>
<td>a herd/flock/drood of</td>
<td>a litre of</td>
</tr>
<tr>
<td>a father/flock/ brood of</td>
<td>a metre of</td>
</tr>
<tr>
<td>a bevy/covey/brood of</td>
<td>an amount of</td>
</tr>
<tr>
<td>a swarm of</td>
<td>a smidgen of</td>
</tr>
<tr>
<td>a pack of</td>
<td>a trifle of</td>
</tr>
<tr>
<td>a crowd/mob of</td>
<td>a modicum of</td>
</tr>
<tr>
<td>a collection of</td>
<td>a great deal of</td>
</tr>
<tr>
<td><strong>Singular or Plural:</strong></td>
<td>an expanse of</td>
</tr>
<tr>
<td><strong>big</strong></td>
<td>a hint of</td>
</tr>
<tr>
<td><strong>small</strong></td>
<td>a trace of</td>
</tr>
<tr>
<td><strong>little</strong> (adjective)</td>
<td>a dash of</td>
</tr>
<tr>
<td><strong>round</strong></td>
<td>a tinge of</td>
</tr>
<tr>
<td><strong>square</strong></td>
<td>a soupcon of</td>
</tr>
<tr>
<td><strong>triangular</strong></td>
<td>a sip of</td>
</tr>
<tr>
<td><strong>spherical</strong></td>
<td>a taste of</td>
</tr>
<tr>
<td><strong>(many adjectives)</strong></td>
<td>a whiff of</td>
</tr>
<tr>
<td><strong>big</strong></td>
<td>a touch of</td>
</tr>
<tr>
<td><strong>small</strong></td>
<td></td>
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<tr>
<td><strong>little</strong> (adjective)</td>
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<td><strong>round</strong></td>
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<td><strong>triangular</strong></td>
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<tr>
<td><strong>spherical</strong></td>
<td></td>
</tr>
<tr>
<td><strong>(many adjectives)</strong></td>
<td></td>
</tr>
</tbody>
</table>
Many authors have noted that, among common nouns, count nouns are generally used to refer to kinds that encompass distinct objects, whereas the extensions of typical mass nouns consist of continuous masses of substance. There exist, however, many nouns that apply to neither objects nor substances (e.g., idea, way—beauty, and justice). What seems to distinguish all count nouns from all mass nouns is that the domain of any count noun is a set of individuals, whereas the domain of a mass noun, insofar as the conceptualisation of the domain under the mass noun is concerned, contains no individuals. The principle of application for a kind designated by a count noun must state what is to count as one individual of that kind, that is, it must be an individuating principle of application. For example, the principle of application for the kind person prohibits anyone from applying the noun person to just an arm, a leg, or to just the visible parts of a human body. It requires that the whole body, including the hair and the invisible internal parts, but not including the clothing, shoes, or jewellery, be counted as one individual. The principle of application for a mass noun such as water provides no means for individuation (Macnamara, 1986). The importance of individuation in differentiating count nouns and mass nouns is widely recognised (e.g., Gordon, 1988; McCawley, 1979; Mufwene, 1984).
The principle of identity for a kind designated by a count noun provides the means for tracing the identity of individuals that satisfy the principle of application for the kind. It is generally assumed that identity presupposes the existence of individuals; for $X$ to be the same $F$ as $Y$, $X$ and $Y$ must be individual members of the kind $F$ (and, in this case, identical members). Kinds designated by mass nouns provide no means of individuation, and yet it is possible to make statements of identity that involve mass nouns:

Heraclitus bathed in some water yesterday and bathed in the same water today.

The gold of which my ring is made is the same gold as the gold of which Aunt Suzie's ring was made.

(See Cartwright, 1965, 1970.) Several solutions to the problem of tracing identity for mass nouns have been offered, but none is satisfactory. Identity cannot be traced over sets of molecules or any elements of stuff, as some have suggested (e.g., Laycock, 1972), for it is not necessary that there should be any physical constituents that remain a part of a mass of stuff throughout its existence. Moreover, such an account of identity fails to explain human intuitions about the identity of a mass of stuff; molecules are not perceptible. Nor can a means for tracing identity be borrowed from some elided count noun (e.g., tub of water); no appropriate expression involving a count noun need remain constant for identity to obtain. The water in a jug can be poured into a glass without losing its
identity, and yet there is no elided expression (e.g., glass of water, jug of water) that applies to the water in every circumstance. In addition, the identity of a glass or jug must be traced differently than the identity of the water that it contains, so the principle of identity for the count noun is of no use in tracing the identity of the water. Furthermore, identity cannot be traced with vaguely defined count nouns such as portion, parcel, piece, or bit. One piece of toffee can easily be divided into two pieces without losing its identity, but two pieces cannot be identical to one piece (see Cook, 1975); it is the toffee that makes up the pieces that is identical. Cartwright (1970, 1975) attempts to trace identity over the quantity of stuff, but clearly this suggestion must fail. It is a matter for science, not for common sense, to determine what quantity, if any, remains constant as a single mass of stuff is transformed from one state to another. Furthermore, if by quantity Cartwright means something other than amount, as she claims to do, then she must mean something akin to portion, parcel, or piece; so the original problem remains.

The solution to this problem is to recognise that identity for a mass noun is traced for a mass of stuff that is conceptualised neither as an individual (in the usual sense of the word) nor as a set of individual elements. A mass of some kind of stuff usually results from separating some stuff from a larger mass of stuff (e.g., taking some
clay from a larger lump of clay); or by creating some stuff (e.g., porridge) that satisfies the principle of application for some kind (see McPherson, Macnamara, & Reyes, 1988). Sometimes a particular mass consists of the stuff that makes up an object (e.g., the gold in a particular ring). For liquid, granular, or gaseous substances, a separate mass of stuff is usually created by means of a container of some sort; for example, one might fill a bathtub with water, thereby creating a distinct mass of water with observable boundaries. (It is not necessary for boundaries to be observable, but it is easier to grasp the idea by studying such examples.) One can then refer to the water in the bathtub as the water, and can trace its identity both forward and backward in time. Prior to filling the bathtub with this water, this particular mass of water existed as what would result from filling a tub (or several buckets; the type of container is unimportant) in some possible situation; that possible situation coincides with an actual situation when the bathtub is filled. If the water is drained from the bathtub, one knows that the very same water that was in the bathtub is now somewhere in the sewer system. It can be referred to as a distinct mass because at one time it existed in a separated state. It needn't retain its cohesiveness or continuity to retain its identity. When the water mingleS with other water in the sewer system, it loses its cohesiveness, but intuition demands that we
acknowledge its continued existence. Similarly, if I measure out a cup of sugar and then spill the sugar on the floor, I can speak of the sugar as being the same as that which was in the cup in spite of its being spread out over the floor. I can even vacuum it up, with two different vacuum cleaners if I like. The identity of the sugar will remain. In summary, for identity to be traced under a mass noun, individuation must be accomplished through means that are not supplied by the mass noun. It is nevertheless the mass noun itself that provides the means for tracing identity.

Quantification. The foregoing discussion of the semantic properties of count nouns and mass nouns provides the framework necessary for understanding quantification for the two categories of noun. For count nouns, quantification is always over individuals. Counting presupposes the existence of individuals (and they must be of the same kind; see Frege, 1884/1980); numerals may not appear with mass nouns because mass nouns supply no principle of individuation, and their domains do not, therefore, consist of individuals. The expressions all and some range over a domain of individuals when used with count nouns (but not when used with mass nouns), and the expressions all (of) the Xs and some of the Xs denote particular sets or subsets of individuals. Quantifiers such as few and many relate to relative numbers of individuals. In contrast, quantification for mass nouns always involves continuous measures
(McPherson, Macnamara, & Reyes, 1988). *Much* and *little* refer to relative *amounts*, rather than numbers. *All* (of) the *X* and *some of the X* designate the totality or a proper part of some specified mass of stuff of the kind *X*. These comments on quantification highlight another aspect of the individuating/non-individuating distinction that characterises the semantic difference between count and mass nouns: Individuation implies discreteness, and requires discrete measures; a lack of individuation implies continuity, and necessitates the use of continuous measures. Learning the proper modes of quantification for count nouns and mass nouns requires that these two distinct intuitions of discreteness and continuity be linked to the characterisation of count nouns and mass nouns.

*Defining the Count/Mass Distinction*

Given that there exist both syntactic and semantic differences between the categories count noun and mass noun, it is important to determine which properties serve as defining ones. The defining properties are the ones that must be learned because criteria based on these properties will guide noun classification.

It is possible that the categories count noun and mass noun are defined syntactically, that is, in terms of the expressions with which they can co-occur and in terms of the appropriateness of pluralisation. If the categories are defined syntactically, then a count/mass distinction cannot
be said to exist until the syntactic differences between the two classes of noun are understood. The extreme version of this position appears in Gathercole (1983). She will not allow that the distinction has been fully grasped until children have mastered the use of every determiner and quantifier that differentiates count nouns and mass nouns. She argues that the distinction is not completely developed until around the age of 9 years when children use much and many appropriately. If this argument were accepted, it would be impossible to claim that the distinction is fully defined in most adults. Many highly educated people, including journalists speaking on national television, exhibit an incomplete grasp of the syntactic restrictions for count nouns and mass nouns; for example, many routinely use less instead of fewer (*less people, *less calories).

Gathercole (1986) suggests an adjunct to the definition of the mass/count distinction. She argues that, because some nouns appear in both count and mass contexts, one must think of the distinction not as an either/or one, but in terms of degrees of mass- and counthood. She favours a prototypical approach in which some nouns are "good" mass or count nouns and others are more marginal. The problem with this approach is that nouns are used in either/or fashion; that is, when a noun is used, it is used decisively as a count noun or as a mass noun. Furthermore, such use is not a matter of mere probability (as might be expected if a noun were "somewhat
mass" and "somewhat count"), but depends entirely on the conceptualisation of the domain pertaining to a word in a given instance of its use. In particular, its use in one or the other type of context depends on whether the domain of reference is construed as one of individuals or not. If the mass noun coffee is used as a count noun (e.g., three coffees), the sense of the word changes so that the kind referred to encompasses individual masses of coffee, perhaps in separate cups.

Gordon (1988) favours a syntactic definition of the count and mass noun categories, but is less strict about the criteria. He assumes that category membership can be defined on the basis of a small number of syntactic elements: a, another, numerals, and plurals. He stresses the importance of defining the categories in terms of interpreted syntax (Gordon, 1985, 1988). A noun cannot be assigned to one of the categories count noun or mass noun unless the quantificational implications of accompanying quantifiers, determiners, and other markers are grasped. In particular, he argues, it must be comprehended that quantification with count nouns is always over individuals, whereas quantification with mass nouns is not.

Macnamara (1982) argues that the distinction is fundamentally semantic: "Count nouns name things that have a characteristic form, and mass nouns do not" (p. 139). He believes that the distinction will be learned on the basis
of this perceptually given difference, and that the distinction will then serve to guide a child in learning the linguistic rules that relate to the use of count and mass nouns in general. Gordon (1985) equates this semantic distinction with one between objects and substances. Because Gordon believes that the distinction is a syntactic one in adults, he asserts that if acquisition is based on properties of referents, there must be a switch during development from one basis of representation to another. I believe that he is correct in rejecting an approach that necessitates such a switch, but I also believe that the basis of representation that should be rejected is not the semantic one, but the purely syntactic one. I will adopt the position that the categories count noun and mass noun are defined semantically throughout life.

If the distinction is semantic throughout life, it cannot be based on a distinction between words that denote objects and words that denote substances. An idea is not an object, but idea is a count noun. Justice is not a substance, but the word is used as a mass noun. It is therefore necessary to describe the distinction in some other terms.

I argued earlier that there is a consistent difference between the kinds to which count and mass nouns refer, namely that count but not mass nouns refer to kinds that have an individuating principle of application; as a result,
it is possible to view the count/mass noun distinction as one based, not on an object/substance distinction, but on an individuating/non-individuating distinction. This definition of the distinction is semantic because it has to do with the nature of the kinds to which words refer.

For the distinction to be realised in a speaker's mind, it is necessary for the individual to be able to form a conceptualisation of the nature of the kind to which a word refers that either includes a notion of individuation or does not. If the kind to which a noun refers is conceived of as one that individuates its extension, then the speaker can form noun phrases by selecting quantifiers, determiners, and other markers that imply quantification over individuals. If a kind is conceptualised as having an extension that is not individuated, then the quantifiers chosen will not be those that quantify over individuals. In this way, nouns can be used in appropriate syntactic contexts even though the distinction between the categories count noun and mass noun is not defined in terms of syntactic criteria.

Hypotheses About Learning the Distinction

Gordon (1985) favours a view of acquisition that is a compromise between Macnamara's (1982) position and a purely syntactic explanation that would have the child performing a "distributional analysis over uninterpreted symbols" (p. 210). Gordon argues that an analysis of syntax alone would be unlikely to yield two subcategories of noun that
correspond to count nouns and mass nouns. He estimates that, with no constraints on subcategorisation, a child would have to consider over eight and one half billion possible subcategorisations of noun (based on all possible combinations of single determiners with a plural or singular noun in a simple noun phrase). Gordon rejects this view in favour of an account of acquisition in which the semantic roles of some syntactic elements (e.g., a, another, and the plural marker -s) are learned first. The quantificational properties of these functors (i.e., whether they quantify over individuals or not) then lead the child to classify nouns into two syntactic categories: [+count] and [+mass]. But the question arises: How does the child learn that discrete quantification is implicit in the meaning of a, another, numerals, pluralisation, and so on in the first place? Is it not by assuming that the nouns that appear with these markers must be associated with kinds that have an individuating principle of application because of the nature of the assumed referent? In other words, is it not by noting that the extension of the accompanying noun consists of distinct entities (i.e., objects)? Similarly, how could children learn that much, little, and less do not quantify over individuals unless they noted that these words always appear with a noun for which the extension ranges over a domain of something other than individuals (i.e., masses of relatively homogeneous substance)? It seems necessary for
something akin to a count/mass distinction to be grasped before it is possible to learn the semantic force of determiners, quantifiers, and plural markers.

If it is accepted that the count/mass noun distinction is equivalent to a distinction between kinds that have or lack an individuating principle of application, then acquisition must be based on some evidence that the kind to which a word refers possesses or lacks such a principle. There must be some difference in the nature of the things to which common count nouns and mass nouns are normally applied that immediately suggests the relevance or irrelevance of the notion of individuation in the characterisation of the associated kinds. An object/substance distinction appears to be a good candidate, because objects present themselves perceptually as individuated, whereas substances do not. It is therefore likely that children will form conceptualisations that involve individuation when presented with objects, and the nouns applied to the objects will be attached to these conceptualisations. Nouns for substances will be associated with conceptualisations of kinds as lacking a principle of individuation.

A semantic definition based on individuation implies that the distinction can be learned as soon as the notion of individuation is understood. If our conceptual life can be guided by perception, such learning becomes possible as soon as the perceptual system is functioning in such a way that
separate objects are being picked out according to gestalt principles.¹

Given the above, it is possible to reformulate the semantic hypothesis of the acquisition of the count/mass distinction in the following way: If the count/mass distinction is a conceptual one (albeit one that has syntactic relevance when sentences are constructed), then the claim that children learn the distinction on the basis of an object/substance distinction is equivalent to the claim that it is easier to conceptualise objects as individuals than to conceptualise a quantity of substance as an individual or set of individuals.

This account of learning has implications for learning the syntactic elements that distinguish count nouns and mass nouns. Children should interpret any quantifiers, determiners, or other markers that appear with a noun as ones that imply quantification over individuals if and only if the noun denotes an object (or a plural noun denotes a collection of objects). If a noun denotes a substance, quantifiers that appear with it should be interpreted as ones that do not quantify over individuals, but that instead, "for example, indicate relative amounts.

¹ For sighted children, the visual system readily picks out individuals. For blind children, it is likely that individuation is accomplished through the tactile sense.
For nouns that do not designate objects or substances, the formation of a conceptualisation that includes or does not include the notion of individuation requires the ability to interpret count and mass markers correctly. As soon as one has learned that count markers such as a, another, and pluralisation imply quantification over individuals, one can use the appearance of these markers with a word as an indication to form a conceptualisation of the nature of the kind to which the word refers as one that includes a principle of individuation. Similarly, a noun that appears in syntactic contexts appropriate to a mass noun will be construed as one that refers to a kind whose principle of application does not include a principle of individuation. An understanding of the quantificational roles of various expressions permits classification of words into the semantically-defined categories count noun and mass noun on the basis of interpreted syntax alone.

Objects and Substances

Although we have an intuitive grasp of the difference between objects and substances, it is necessary to describe in some detail the possible criteria that one can apply in determining the object-like or substance-like nature of something. If criteria are to be relevant to the thesis of this paper, they must rest on perceptual and conceptual, as opposed to physical, distinctions.
Substances can be characterised as stuffs that are perceptually homogeneous, such as liquids and powders. Some stuffs consist of perceptually distinct parts, and different languages draw the line differently as to which of these stuffs will normally take mass nouns and which count nouns (Wierzbicka, 1985). For example, in Russian, the words for peas and beans are mass nouns. A collection of distinct entities is more likely to be perceived as substance-like if the individuals that make up the collection are virtually indistinguishable from one another and small enough to make differentiation difficult (Markman, 1987; Wierzbicka, 1985).

Another way to characterise substances is that they maintain identity through arbitrary division (Wierzbicka, 1985). Carey (1982) expresses this property by invoking the "universal grinder" test: those things that maintain identity when put through the grinder are described with mass nouns. Physical objects described by count nouns do not pass this test. A man remains a man if you cut off a hand, though his hand is not a man; but if you divide his body in such a way as to kill him, neither part is a man. For this reason, there are separate words for dead bodies (corpse; remains). Similarly, a table without legs is no longer a

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2 The notion of a "universal grinder" comes from Pelletier (1975). Pelletier argues that any count noun can be converted into a mass noun by changing one's conception of the extension of a kind so that it encompasses ground-up objects rather than objects in intact form.
table (it is a table-top). Wierzbicka (1985) and Akiyama and Wilcox (1988) use the criterion that whenever a loss of function accompanies a loss of integrity, a count noun is required.

Another criterion for mass "stuffs" is that they have no characteristic size or shape (Brown, 1958; Macnamara, 1982). Gases, liquids, and granular substances take the shape of containers in which they are placed. Malleable solids such as clay and dough take whatever shape results when external forces are applied (e.g., kneading). Rigid solids such as wood and steel can be formed into any shape, and will maintain that shape indefinitely, but no shape is characteristic of them. When substances do take on a characteristic form, as, for example, when they are placed in a glass or bowl, they can be referred to with count nouns (e.g., two whiskies).

One final criterion is that substances tend to coalesce when placed together (Macnamara, 1982); two cups of milk can be poured into a jug to form a larger quantity of milk. This property of substances is the converse of their maintenance of identity through arbitrary division.

Empirical Evidence

If children are to learn the categories count noun and mass noun on the basis of the ontological categories object and substance, it is necessary that they have intuitions of the object-like or substance-like nature of stimuli. Smith,
Carey and Wiser (1985) provide evidence that children have such intuitions at least by age four. They tested 32 children ranging in age from 4 to 9 years. They used Carey's (1982) "universal grinder" test to determine whether the children could distinguish between objects and the stuff of which they are made. They showed the children an object (e.g., a paper cup) and then cut up the object in the children's presence (or presented pieces of another object of the same kind). The children were then asked to decide whether the resulting pile of pieces was still the object, and whether it was still the substance out of which the object was made (e.g., "Is it still a cup?" and "Is it still paper?"). Very few errors were made, which indicates that the children possessed a notion of substance that allowed for maintenance of identity through arbitrary division, and a notion of object that depended on maintenance of form or function.

Soja (1987) provides evidence that intuitions of object and substance exist very early, at least by the age of two. She showed that young children make a distinction between kinds with objects in their extension and kinds with substances in their extension, and that this distinction is based on the object- or substance-like appearance of stimuli. In one condition, she presented two-year-old children with an unfamiliar object (e.g., an apple corer, a plumbing fixture, or a honey dipper). The children were
taught a word for the object, and were then asked to indicate which of the following stimuli could be described by the same noun: (i) an object of the same kind but made from a different substance, or (ii) a quantity of substance of the same kind as the substance out of which the original object stimulus was made. Children were significantly more likely to choose the stimulus that matched the original stimulus in object type rather than substance type. For half of the children, nonsense words were taught using count-noun syntax (e.g., another blicket, this is a blicket); for the other half, syntax was neutral with respect to count/mass status. The availability of syntactic count-noun cues did not increase the frequency with which the matching object (versus the matching substance) was chosen. In a second condition, the first stimulus was a quantity of an unfamiliar non-solid substance (e.g., hair-setting gel, hand cream mixed with gravel, or sawdust). It was presented in one of two possible configurations: a single pile or glob, or a few piles or globs. Children were taught a word for the substance, some hearing the word in mass-noun syntactic contexts (e.g., some blicket, this is blicket), and some hearing it in neutral contexts. Two further stimuli were presented; one matched the original in substance type but not in configuration, and the other matched it in configuration but not in substance type. Children tended to choose the quantity of substance of the same kind rather
than the alternative substance in a configuration that matched the original presentation. As in the first condition, children were unaffected by syntax. All of these results obtained in each of three experiments. In total, 84 children between the ages of 1;10 and 2;9 were tested. These findings suggest that young children can distinguish two types of kinds that correspond to the ontological categories of object and substance. This study does not, however, provide a direct test of the hypothesis that the count/mass distinction is learned on the basis of an ontological distinction between objects and substances. The nature of the tasks was such that it was not possible to determine whether a word had been assigned to any particular linguistic category. Children were not required to interpret or produce any expression that contained syntactic elements restricted to use with count nouns or mass nouns. Furthermore, the possibility cannot be ruled out that their interpretation of a nonsense word was as an adjective such as blue or cylindrical. The substances had different colours, consistencies, and textures, and the objects had distinct shapes; without a linguistic task where responses can vary on the basis of category-specific syntax, the children's interpretations cannot be inferred.

If children learn the distinction between count and mass nouns on the basis of an object/substance distinction, it should be possible to demonstrate that they are aware of
the correspondence between objects and count nouns, and of that between substances and mass nouns. Evidence for an awareness of this correspondence comes from a study done by Brown (1957). He tested 16 subjects aged 3 to 5 years. He showed his subjects a picture of a pair of hands kneading some red confetti-like material in a shallow container. Semantically, the action should correspond to a verb, the substance to a mass noun, and the container to a count noun. The subjects were then shown three pictures. In each picture, one of the three features in the first picture (the action, the substance, or the container) was reproduced in isolation. Three other sets of pictures were also presented, each featuring an action, a substance, and an object. The children were taught a word while presented with the first picture in a set. The word was marked syntactically as a verb, a mass noun, or a count noun. Each child was then asked to point to one of the three remaining pictures (in which features were isolated) to indicate the referent of the word. Of the 16 children, 10 chose the picture of the action in the verb condition, 11 chose the picture of the object in the count-noun condition; and 12 chose the picture of the substance in the mass-noun condition. The proportions of subjects making these choices all differed significantly from chance. The results of this study indicate that young children are sensitive to the correspondence between objects
and count nouns on the one hand, and between substances and mass nouns on the other.

Akiyama and Wilcox (1988) provide further evidence of children's understanding of the interrelations among noun type, ontological category, and syntactic context. They used Carey's (1982) "universal grinder" test to determine the conditions under which children aged 3 to 8 will judge a label to remain appropriate after a labelled object/substance is broken up into pieces. Children were shown photographs of an object or substance before and after transformation, and asked if the transformed item was still entitled to the descriptor used with the untransformed item. There were three major findings in this study. The first was that for familiar objects such as a piece of chalk and a crayon the count or mass status of their descriptors (chalk, crayon) was of primary importance in determining whether the descriptors were seen to remain appropriate after transformation of the object/substance. Discrete objects were perceived to lose their identity after transformation when described by a count noun, but not when described by a mass noun. For example, a piece of glass remains glass when broken up into pieces, but a mirror does not remain a mirror. This finding may reflect the force of syntactic cues in eliciting a conceptualisation that includes or excludes the notion of individuation. Although limited syntactic cues as to the status of the noun as count or mass were available
in the experimental procedure itself, children may have classified the nouns as count or mass prior to the experiment as a result of hearing them used in certain kinds of syntactic contexts by their parents and other speakers. Alternatively, children may have grasped the substance-like nature of the mass-noun items presented because, although they typically take some enduring form (owing to their status as solids), no particular form is characteristic of them. Support for this interpretation of the results comes from item differences; children judged chalk (a mass noun) to lose identity after transformation, presumably because their experience led them to believe that chalk always occurs in a characteristic form (i.e., sticks). A sponge (used as a count noun in this study; sponge can also be used as a mass noun) was perceived to maintain identity when cut into pieces; this perception may reflect the varying shapes of sponges, and also the modification in shape of any given sponge when squeezed. The items that were perceived to maintain identity through transformation were those that enter the world of experience in varying forms: Paper exists in sheets of many different shapes and sizes; glass can take the form of a window or of a drinking glass; rubber can appear in the form of a tire or a ball; wood is found in tables, walls, trees, and pencils.

Akiyama and Wilcox's (1988) second major finding was that for food items, the appropriateness of the label was
always maintained through transformation. This result fits well with the fact that most words for food items can be used as either count or mass nouns depending on whether an item is served whole or mashed/chopped. Furthermore, the properties of the food item that are relevant to people remain constant through transformations of the food. Many of the children commented that the word still applied because one could still eat the item in its transformed state. This finding shows the importance of human purposes in determining how a word can be used. Because children were asked about the identity of items with syntax appropriate to a count or mass noun (e.g., "Do you think this is still an onion?"), it also shows that children can ignore syntactic information about the status of a noun.

The last major finding was that for unfamiliar items, children showed a tendency to use perceptual and conceptual information (object-looking items versus food items) rather than linguistic information (count or mass syntax) in judgements of the appropriateness of the descriptor after transformation of the item. This finding suggests that when there is limited experience of a noun in various syntactic contexts, perceptual and conceptual information is used in decisions about the substance-like nature of that to which the noun is applied. When some training was given to provide the children with more syntactic cues as to the status of each noun, only a weak effect of syntax was obtained, and
the distinction between objects and food items still accounted for most of the variation in responses. Taken together, the findings of this study indicate that children are aware of the relations among syntactic elements, ontological status, and noun type.

Two researchers, Peter Gordon and Virginia Gathercole, have conducted studies designed to test the hypothesis that children learn the count/mass noun distinction on the basis of an object/substance distinction. I will examine their research in some detail because they claim to have provided evidence against the thesis I seek to maintain.

Gordon ran three experiments along these lines. In the first, Gordon (1982, 1985) collected data from 40 subjects ranging in age from 3;5 to 5;5 (M = 4;3). He taught the children nonsense words for objects or substances, using syntax appropriate to either a mass noun or a count noun. In one condition syntactic and semantic cues were in conflict (e.g., an object described with mass-noun syntax), and in the other they were in accord. He tested for count or mass classification of a noun by pointing to a group of additional objects or quantities of substance of the same kind and asking the children to complete a sentence with the word ("... over there we have more, what?"). The presence or absence of the plural -s in the children's responses was taken to indicate count or mass noun assignment. Three subjects pluralised all of the words and 10 subjects
pluralised none of them, and so their data were not used in the analyses. Where syntax and semantics were in conflict, the remaining children tended to rely upon syntax in classifying nouns. Reliance upon syntax was more common among older subjects, although no statistical comparison of responses for younger and older subjects was reported. When syntax and semantics were in accord, most subjects classified the noun appropriately. The younger subjects were significantly more inconsistent in their classification of the word in the conflict condition than in the accord condition, which suggests that the children were torn between attractive alternatives.

In order to evaluate these results, it is necessary to take a closer look at the tasks used. One problem is the nature of the stimuli. When words applied to objects occurred in count-noun contexts, the stimulus was a single object. On the other hand, when nouns were applied to objects in a mass-noun context, the objects were presented to the subject in a group. Gordon shows in his second experiment (discussed below) that presenting objects as part of a collection produces a bias towards classifying a noun as mass. This effect is not unexpected; kinds whose members are collections of objects do not fit the prototype for count nouns. Furthermore, his "substances" consisted of test-tubes filled with coloured liquid. In spite of efforts on the part of the experimenters to draw attention to the
stuff inside the test-tube, the possibility cannot be ruled out that the children took the kind referred to by the noun as having an extension consisting of bodies of liquid individuated by a tube (versus the liquid in general). The problem may have been exacerbated by the fact that each tube contained a differently coloured liquid, and the children were told, "This is a red garn, this is a blue garn ... ."

In the real world, substances typically (although not always) have a characteristic colour. It is likely, then, that in so novel a situation, the children would be led into relying upon syntax (which might necessitate a readjustment of their hypotheses regarding the referent of a word).

In a second experiment, Gordon (1985) attempted to isolate semantic and syntactic cues in his presentation of stimuli to 39 subjects aged 3;0 to 5;1 (M = 4;5). An effort was made to isolate syntactic cues by using the phrase a X in describing one bean in the count condition, or some X in describing a beaker filled with beans in the mass condition. Gordon expected that children would not know whether to treat a bean or a group of beans as a substance or object(s). I would expect that one bean in isolation would be conceived of as an individual unless the child was very familiar with that particular type of bean; given that the beans were dyed in various colours, it is unlikely that the children sensed any familiarity with them, and so would not realise that such objects normally occur in large mass-like
groups. Gordon himself provided evidence that he had failed to isolate syntactic cues in this experiment. When he presented one bean versus several beans with neutral syntax, the presence of several beans tended to bias the children towards a mass noun hypothesis. So it appears that in this condition, children had available to them both syntactic and semantic cues as to the type of noun. An attempt was made to isolate semantic cues by using an object or test-tubes filled with liquid, and by using syntax that was neutral with respect to the count or mass status of the noun (the X). Neither type of cue (syntactic or semantic) proved to be more influential as regards noun classification, and both produced responses appropriate to the nature of the cue. Gordon concluded that, "the count/mass distinction is essentially, but not exclusively syntactic" (p. 221). There was a slight though nonsignificant tendency for responses to be compatible with the cue more frequently in the "syntactic" condition, but, as I argued above, it appears that the children also had the benefit of a semantic cue in this condition; their improved performance is therefore not surprising. In a comparison of age groups, it was found that only the older subjects made use of the semantic cues. This finding may reflect the confusing nature of the stimuli. It may also reflect a greater awareness by older children that words for individuated bodies of liquid (such as drink and cupful) are rare; older children may therefore be more
likely to conclude that the liquid itself must be relevant, and hence the noun must be mass. Gordon reports that when only syntactic cues were available, no difference existed between the two age groups in the pattern of classification. It is difficult to interpret this result, though, because four of Gordon's subjects mysteriously switched from the older to the younger group between the semantic and syntactic cue conditions. A large number of subjects in both conditions showed a response bias, either by pluralising all nouns or none of them. Responses biases in this experiment and in the first one may reflect confusion, and perhaps also uneasiness engendered by a training procedure in which failures to pluralise were corrected and children were asked to repeat the word. This training may also have had the effect of prompting children to pay greater attention to syntax than they would normally do.

In the third experiment, Gordon (1985) collected data from 40 subjects ranging in age from 1;11 (only one subject was under 2 years of age) to 5;9. Gordon argued that non-prototypical mass and count nouns in the English language should be frequently misclassified. He tested the children's use of mass superordinates (furniture, silverware, and jewellery), count superordinates (toy, pet, and flower), and food terms with mass or count status. He predicted that children would have trouble with the mass superordinates because they denote classes of objects, and, he claimed, one
would therefore expect them to be count nouns. This is dubious reasoning, as the referentially based semantic hypothesis predicts that distinct objects of a particular kind will be linked to count nouns, but not that classes of objects belonging to different kinds (e.g., chairs and tables) will be associated with count-noun status. Gordon also predicted that errors would occur with considerable frequency for food terms because food items can be converted into substance-like mush (e.g., chopped onions, mashed potatoes). He tested subjects by taking them on a tour of a miniature shopping centre. As they "came to" each store, they were asked what was sold there. So, for example, as they "passed" the "furniture store," they were asked what one gets in a furniture store. If they responded with the plural form of the noun with which the store was labelled, they were assumed to have classified the noun as count. In the "food store," they were asked what was sold in each section (e.g., the fruit section) and in each box (e.g., the celery box). Gordon argued that errors should occur for all but count superordinates, because these words denote classes of objects. In fact, more errors were made with count superordinates than with mass superordinates. Most of the data for superordinates came from the older children, as the younger ones rarely used such terms (only 30 percent of their data could be used). On the whole, few errors were made. The single exception is of some interest. For count
food terms, the two-year-olds in his sample had an error rate of 30 percent. This finding may reflect the fact that young children are typically presented with food in a mashed or cut-up state (and hear the mass version of a noun applied to it), in spite of the fact that the food was presented as groups of objects in this experiment.

In another study by Gordon (1981), 48 children between the ages of 3;3 and 5;10 were asked to judge the correctness of sentences produced by puppets. When sentences included English mass nouns, they were applied either to substances presented in some "continuous" form (e.g., a pot of soup), or in discrete units (e.g., cans of soup). Gordon found that the younger subjects (mean age 3;10) were more likely to judge the plural use of the noun as correct when the substance was individuated into discrete units (e.g., cans) than when it was presented as a continuous mass (e.g., in a big pot). Older children (mean age 4;9) were unwilling to accept the plural form of the mass nouns. Gordon argues that children initially use a semantic rule that the plural form of a noun is used when it is applied to more than one discrete object, regardless of noun category. It is possible that, instead, children seeing several cans of soup interpreted soups as meaning several kinds of soup; because neither the sentences children were asked to judge nor detailed descriptions of the stimuli are given in the report of the study, it is impossible to determine whether this
interpretation of the data is viable. Another possibility is that the children did not know that the nouns presented are ones that are used almost exclusively as mass nouns. Children are accustomed to hearing both count and mass versions of the same nouns (e.g., food terms; all the examples given of mass nouns used in this study were food terms); children might be more liberal in their willingness to allow a plural form of a noun because they are more willing to allow a noun to take both count and mass form. The tendency to judge a pluralised noun as correct may reflect a failure to calibrate possibilities for count or mass usage with other members of the speech community rather than an initial belief that both mass and count nouns can be pluralised. If that is so, then the tendency to pluralise nouns when they apply to several discrete entities is a reflection of the adoption of count-noun status for those nouns; the results therefore support the hypothesis that the count/mass noun distinction is initially based on semantic properties that are inferred from perceptual evidence.

Gathercole (1985a) examined the effect of object or substance status on noun classification by studying the effect of the non-prototypicality of a noun on the ability of children to correct syntactic errors in sentences containing the quantifiers *much* and *many*. Her subjects were 79 children aged 3;6 to 9;0. She found no difference in the percentage of correct judgements for prototypical and non-
prototypical nouns. Most judgements for both types of noun were incorrect in the younger children. She found that children were unable to detect errors involving the use of much with count nouns (singular and plural) and the use of many with mass nouns (singular or plural) with an accuracy rate over 50 percent until the age of 5;0 (the accuracy rate at the youngest age, 3;6, was 43.8 percent). This finding would seem to indicate that these two quantifiers are learned rather late; it is, however, difficult to determine whether children's judgements of the correctness of sentences are governed by their understanding of correct use in the language or by their ability to discern the intended meanings of sentences. It may be that children attend to the message and ignore the medium, with the result that an utterance such as "too much boys" is regarded as correct because of its comprehensibility in spite of its being ungrammatical. Be that as it may, if the correct understanding of much and many is learned rather late, then a task that depends on this knowledge is not useful in studying how the count/mass noun distinction is learned. It should be noted that Gathercole was interested in the learning of the count/mass distinction only insofar as it applies to the quantifiers much and many.

Gathercole (1985b) obtained some evidence that the prototypicality of a noun with respect to its count or mass status can affect the interpretation of more. She carried
out an experiment with 56 children between the ages of 2;6 and 6;0. Gathercole used count nouns (e.g., pencils and bows) and mass nouns (e.g., chalk and ribbon) that are normally used to denote discrete objects. The count nouns used were thus prototypical ones, whereas the mass nouns were not. Children were presented with two sets of objects for each noun. In one set, the number of items was greater, and in the other set, the mass of all the objects combined was greater. Children were asked to point to the set with more X, where X was either a count noun or a mass noun. If a noun is classified as count, more should be interpreted as a larger number of. One should therefore choose the set with the largest cardinality. Mass status for a noun should lead to an interpretation of more as equivalent to a larger amount of, and one should choose the set with the largest mass. Correct responses were far less frequent with the mass nouns: Accuracy was 68.1 percent for count nouns, but only 34.4 percent for mass nouns. Performance for mass nouns did not change significantly with age, although there was some decrement, but accuracy improved significantly with age for count nouns. Gathercole does not herself attribute this pattern of results to an effect of the prototypicality of the nouns used. She argues that the age trend for count nouns shows an increased tendency with age to interpret more in terms or relative number versus relative mass. This conclusion was supported by data from another of her
experiments, but fails to explain the relatively low accuracy rate for the non-prototypical mass nouns. She also found lower accuracy for prototypical mass nouns (clay and sand) as compared to prototypical count nouns (ball and candle), but the difference in accuracy (68.2 percent for mass nouns versus 84.3 percent for count nouns) was less striking than the difference in accuracy found in comparing non-prototypical mass nouns and prototypical count nouns.

For a test of the hypothesis that the count/mass noun distinction is learned on the basis of an object/substance distinction to be adequate, it must be conducted on children who have not yet achieved sufficient linguistic sophistication to rely upon syntax in distinguishing between count nouns and mass nouns. It is necessary to test children who are just beginning to show evidence of understanding that there are two types of noun that correspond to the categories count noun and mass noun. One must therefore address the question of when the distinction is learned.

Evidence for the existence of a count/mass distinction at an early age comes from Gordon's (1988) analysis of records of naturally occurring speech in two children. The children used count-noun syntax (a, another, numerals, and pluralisation) far more frequently with count nouns than with mass nouns from a very early age (from the first use of mass nouns at 1;11 for one subject, and from the beginning of sampling at 2;3 for the other subject). There was no
evidence that this differential usage was attributable to rote learning of noun phrases. It should be noted that at these early ages, most nouns appeared in the absence of determiners, quantifiers, and pluralisation ("telegraphic" speech). It should also be noted that the instances of using syntax appropriate to count nouns involved a small set of quantifiers, determiners, and other markers (i.e., a, another, numerals, and pluralisation). The correct use of many, each, and every does not occur until much later, close to age 5;0 (Gathercole, 1985a; Gordon, 1981). Because all of the quantifiers, determiners, and other markers used by young children are restricted to use with count nouns, it was impossible for Gordon to look for errors involving the application to count nouns of quantifiers that are restricted to use with mass nouns. Nevertheless, these findings give some indication of the minimum age at which children demonstrate knowledge of a distinction between the two categories of noun. Possession of such knowledge may come earlier. A reasonable estimate of the upper bound for the age at which the distinction is formed is 2;0.

Gordon (1988) also looked at the ages at which the two children learned the obligatory determiner rule for singular count nouns (i.e., the rule that any singular count noun must be preceded by some determiner). He found that this rule was learned relatively late (around 2;2 or 2;7 by one subject and between 2;9 and 3;1 by the other). It may be
that this rule is learned rather late because it has little
to do with semantics, whether construed as referentially
based or as dependent upon the notion of individuation.

It appears that a distinction between count nouns and
mass nouns is learned sometime before the age of two. In the
experiments of Gordon and Gathercole, the youngest subjects
were typically over the age of three (although there were
small numbers of subjects between two and three in two
experiments). It is therefore apparent that an adequate test
of the hypothesis that the distinction is acquired on the
basis of an ontological distinction between objects and
substances has not been conducted.

Rationale and Overview of Study

It is well known that the nature of early speech is
"telegraphic"; children tend to omit determiners and other
syntactic elements that might provide evidence about the
categories to which words are assigned. As a result, evidence for the count/mass distinction in young children
can only be obtained from studies where comprehension,
rather than production, is assessed. It is necessary to use
a task in which children will behave differently depending
upon their interpretation of an unfamiliar noun as count or
mass.

An experiment was designed to determine whether young
children are more sensitive to semantic or syntactic cues in
interpreting a noun as count or mass. In particular, the
effect of hearing object- or substance-like stimuli labelled was pitted against the effect of hearing the label in a syntactic context appropriate to a count noun or mass noun. In the experimental conditions, a nonsense word was applied to unfamiliar objects in a mass-noun context or to an unfamiliar substance in a count-noun context.

Noun classification was assessed by observing behaviour that was contingent on the interpretation of a noun phrase. The design of the experiment took advantage of an ambiguity in English. The phrase a little has two possible interpretations when placed before a noun: as consisting of an article marking a count noun and the adjective little (i.e., as equivalent to a small), or as constituting a single quantifier indicating a relatively small amount of whatever is signified by the accompanying mass noun. The experiment was designed so that it was possible to determine which interpretation a child made upon hearing this expression; it could thus be determined whether the noun had been interpreted as a count noun or mass noun.

Method

Subjects

The subjects for the study were 48 children, 24 girls and 24 boys. Mean age was 2;10 (SD = 0;5) with a range in ages extending from 1;9 to 3;10. The subjects were recruited through day-care centres and play groups in several areas of Montreal, and came from a variety of socioeconomic
backgrounds. The majority of subjects had English as a first language. Eight of the subjects (16.7 percent) were raised in a bilingual environment with extensive exposure to English.

An additional 43 subjects were excluded from the study. Of these subjects, 34 were dropped because they did not possess the knowledge required for the experiment to be a fair test of the hypothesis; this lack of requisite knowledge was ascertained through the administration of a post-test (see later in Method section). The other 9 subjects were excluded because their data were uninterpretable (see Results section for details). Data for these subjects are included in analyses of post-test performance (see Results section, "Post-Test").

Materials

The materials used for the object condition were small yellow pom-poms onto which are attached eyes, a mouth, and three appendages. The objects are of two sizes: 15 mm and 30 mm in diameter. The two sizes were mixed together. The substance used was a mixture of two sizes of tapioca pearls, 2.5 mm or 5 mm in diameter. These stimuli are pictured in Figure 1. It should be noted that the substance consists of perceptually similar but separate entities (tapioca pearls) that could conceivably be treated as individuals. Although most collections of small indistinguishable individuals are designated by mass nouns (e.g., cereal, rice, oatmeal), some
Stimuli Used in the Object and Substance Conditions
are designated by count nouns (e.g., beans, lentils, pebbles). For such substances, syntactic cues are necessary for correct classification as count or mass. In learning a language, one presumably learns the syntactic rules for using mass nouns with unambiguous substances such as water or milk for which no individuation is available to perception (one cannot see a water molecule). The presence or absence of count and mass markers then aids in determining the count or mass status of a noun applied to a collection of small individuals. If a listener is unable to make good use of such markers, the tapioca pearls are likely to be viewed as a substance because of their perceptual similarity and relatively small size. It was expected that the pom-poms would be treated as individuals even though they are small and not unlike, for example, pieces of popcorn (a mass noun). The addition of facial features to the pom-poms should have led to a conceptualisation of them as replicas of some sort of unfamiliar living creature, thereby increasing the likelihood that they would be treated as individuals.

Additional materials were used in creating a pretext for the task. These included a small puppet, a set of wooden "walls," several miniature chairs, miniature flowers, styrofoam in which to "plant" the flowers, green flakes used for making a "lawn," sand, a miniature sandbox, and a small box in which the target objects/substance could be placed.
Objects and substances resided in plastic bins, each of which contained a plastic scoop. Finally, three drawings were used as an aid in telling a story.

Design and Procedure

The child was introduced to a small puppet named Count Massey, who greeted the child. It was then pointed out that Count Massey was frowning, and the child was told that Count Massey was very sad. The experimenter then told a story that explained the puppet's sadness. The child was shown a picture of the Count in happier times, standing next to his beautiful house. A second picture showed an evil troll who lived in a dark hole under a bridge. It was explained that the troll was very jealous of Count Massey because of his beautiful house, and that the troll had constructed a wicked plan. In the final picture, the troll is running away after having set fire to Count Massey's house, which is blazing in the distance. The child was told that the house burned to the ground, and that Count Massey now had no place to live. The child was then asked to assist the experimenter in building a new house for the Count.

The experimenter put up some "walls" and asked the child to help her in putting some things in the "house." The child was shown the contents of a bin while the experimenter described the contents and scooped up a small number/amount of the objects/substance. The child was then asked to give
the experimenter one of the objects or some of the substance.

The first, third, fifth, seventh, and ninth item was one of the following: chairs, flowers, grass, or sand. The order of presentation for these objects/substances varied. Object and substance were always alternated. Because one of these items was presented twice, half of the children withdrew objects (a chair or a flower) three times and scooped up some stuff (grass or sand) twice, whereas the other half of the subjects withdrew quantities of substance three times and objects twice. This difference in the preponderance of objects or substances as part of the context of the task was distributed equally across conditions. In describing the objects and substances to the child, syntactic constructions were appropriate for the type of noun used. For example, the experimenter would say, "Look what we have in here. Do you know what these are? These are chairs. Let's put a chair in the house. Could you please give me a chair?"

The second, fourth, sixth, eighth, and tenth item was the yellow pom-pom creatures for half of the subjects ("object condition"), and the tapioca pearls for the other half ("substance condition"). These items were always described with the nonsense word voks. This nonsense word was chosen because it is ambiguous as to whether it is a
plural of vok or, alternatively, what could be written as vox (on a par with box).

For half of the subjects in the object condition and for half in the substance condition, the syntactic context was appropriate for count nouns. For the other half, the syntax was appropriate to mass nouns. Thus, for half of the subjects, syntactic and semantic cues were incongruent (objects discussed with mass syntax or a substance discussed with count syntax), and for the other half, they were congruent. Whenever syntactic and semantic cues steered the child in opposing directions, it was possible to see which type of information guided classification of the noun as count or mass.

To determine which type of cue, syntactic or semantic, guided the child's interpretation of the word as a count noun or mass noun, the child was asked to give the experimenter a little vok(s). If the child interpreted the word as a count noun, then a little should be interpreted as synonymous with a small. If, on the other hand, the child interpreted the word as a mass noun, a little should be taken to mean a small quantity. If the child picked out one of the smaller sized creatures/tapioca pearls, then it was assumed that the word had been interpreted as a count noun. If the child scooped up a small quantity of the creatures or tapioca pearls, it was assumed that the interpretation of the word was as a mass noun.
The syntactic contexts for the five trials are presented below. For portions of the context that differed between the two syntax conditions, the count and mass noun versions are given in square brackets, separated by a slash:

1. Look what we have in here. Do you know what [these are/this is]? [These are/This is] vocals. Can you say [vok/voks]? (Child repeats.) Have you ever seen [so many/so much] vocals? [There are/There is] a lot of vocals in here, [aren't there/isn't there]? Could you please give me a little [vok/voks]?

2. I don't think we put enough vocals in there. I think we need [another vocal/some more vocals] in there. You can't have too [many/much] vocals. Let's put [another one/some more] in there, okay? Could you give me a little [vok/voks]?

3. Oh, Count Massey has something to say. What is it, Count Massey? (Count Massey says: "{Child's name}, I want [another vocal/some more vocals].") Oh, he says he wants [another vocal/some more vocals]. Let's give him [another one/some more], okay? Could you give me a little [vok/voks]?

4. Since Count Massey likes the vocals so well, why don't we give him [another vocal/some more vocals], okay? Could you give me a little [vok/voks]?
5. I think we still need [another\vok/some more voks] in there. Let's put [another vok/some more voks] in there, okay? You can't have too [many/much] voks. Could you give me a little [vok/voks]?

In these contexts, the syntactic elements that distinguish count and mass nouns are: (i) the singular/plural contrast (vok versus voks) available in the count-noun context; (ii) the plural form of the verb to be in the count-noun context; (iii) the failure to drop the -s on voks in the mass-noun context; (iv) consistent use of the singular form of to be in the mass-noun context; (v) the expression another (one) in the count-noun context; (vi) the quantifier many in the count-noun context; and (vii) the quantifier much in the mass-noun context.

To recapitulate, the four conditions were: Objects/Count Syntax (Condition I), Objects/Mass Syntax (Condition II), Substance/Count Syntax (Condition III), and Substance/Mass Syntax (Condition IV). Conditions II and III are the incongruity conditions, and Conditions I and IV are the congruity conditions. Gender of subjects was distributed equally across these four conditions.

Post-Test

A post-test was conducted to determine whether the child knew both senses of the word little. This knowledge was essential to the task because it was necessary for the child to be in a position to choose between the two possible
senses of the word. The child was shown four buttons, two small and two large, and asked to pick a little button. The child was then shown four different buttons, two small and two large, and asked to pick a big button. The experimenter then placed two tall cylindrical transparent plastic containers in front of the child; one was filled to a height of 20 cm with a substance (pearl barley or cous-cous) and the other was filled to a height of 2 cm with the same substance. The child was told that one of the containers had a little barley/cous-cous inside, and was asked to point to that one. The experimenter then brought out two other containers in which a small or large quantity of the other substance (pearl barley or cous-cous) had been placed. She told the child that one of them contained a lot of barley/cous-cous, and asked the child to point to the appropriate container. The big and lot of tests were included to ensure that the children were not choosing randomly. Children who were unable to perform all of these tasks were excluded from the data analyses. The post-test data for all subjects provide information about the age at which the adjectives big and little and the quantifiers a lot of and a little are understood.

It is likely that children who know both senses of little have some sophistication with syntax, perhaps enough to enable them to use the interpretations of syntactic cues to their advantage. It follows that if most subjects favour
perceptual information over syntactic cues in interpreting the noun as count or mass, strong support will have been obtained for the hypothesis that the count/mass distinction is acquired on the basis of an object/substance distinction.

Results

Primary Task

Ninety-one subjects were tested, 34 of whom were excluded because they did not pass the post-test. A further 9 subjects were excluded because on the majority of trials (three or more), when asked to withdraw a little vowel(s), they chose one big item, rendering their data uninterpretable. Analyses were conducted on the remaining 48 subjects, 12 in each group. There was no significant difference in age across groups. The children were divided into three age groups, 16 subjects in each, with mean ages of 2;4 (SD = 0;3), 2;10 (SD = 0;1), and 3;3 (SD = 0;3).

14.6 percent (7) of the subjects chose one big item on one trial, and 8.3 percent (4) responded this way on two trials. There was no significant difference across conditions in the mean number of trials on which one big item was chosen, nor were there any effects of age group or gender. There was an effect of context (i.e., the preponderance of objects or substances among additional items presented as part of the background for the task; F[1] = 5.15, p < .05): children were more likely to choose a single big item when the context was dominated by objects.
It is not clear whether subjects choosing a big item were not paying attention or were simply unwilling to conform exactly to the experimenter's wishes. The latter possibility is likely, as there is no obvious reason to want only little items in the house; additionally, two subjects said, "big one" or "big vok(s)" as they picked up a larger item. It should be noted that the larger items were much easier to pick up, and children who did withdraw a smaller "vok" had to go to some trouble in order to do so. In any case, because no clear interpretation of such responses was possible, it was decided to ignore trials on which one big item was chosen.

The dependent variable for the main analyses was the proportion of useable trials on which the child behaved in accordance with the syntactic cue. It was predicted that this proportion would drop when there was incongruity between the syntactic and semantic cues.

There was very little variability within conditions, and existing variability was greater in the two incongruity conditions. The distributions for the four conditions are neither normal nor of equal variance (Bartlett-Box $F = 12.42, p < .0001$). Although normality and homogeneity of variance are assumptions of the ANOVA model, it was decided that analyses of variance were appropriate nonetheless because ANOVA is extremely robust under violations of the normality assumption, and because the probability of type I
error is close to the nominal probability \( \alpha \) when sample sizes are equal, as they were in this experiment.

In an ANOVA with semantic cue, syntactic cue, gender, age group, and context as factors, it was found that gender, age group, and context were not involved in any significant \((\alpha = .05)\) interactions or main effects. In order to get a clearer picture of the effects of the semantic and syntactic cues, the analysis was repeated with just these factors. The predicted interaction between the semantic and syntactic cues obtained \((F[1] = 60.46, p < .0001)\). This interaction can be explained by a marked deviation from responses in accordance with syntax when the semantic and syntactic cues were incongruent. There were no significant main effects of semantic cue or syntactic cue. The mean scores for each group are presented in Table 2.

### Table 2

Mean Proportion of Trials on Which Responses Were in Accordance With Syntactic Cues

<table>
<thead>
<tr>
<th></th>
<th>Objects</th>
<th>Substance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count Syntax</td>
<td>.97</td>
<td>.25</td>
</tr>
<tr>
<td>Mass Syntax</td>
<td>.29</td>
<td>.97</td>
</tr>
</tbody>
</table>
The majority of subjects (85.4 percent) responded consistently by choosing one small item or by scooping out a small amount/number of the substance/objects. There were no effects of condition, age, gender, or context on consistency (defined as the percentage of trials on which the dominant response was given). There was a significant interaction between semantic cue and context \( (F[1] = 9.83, p < .01) \). This interaction reflects some loss of consistency when there was a mismatch between the semantic cue and the type of item presented before the first trial. In a separate test, the decrement in consistency associated with a mismatch between semantic cue and type of item presented prior to the first trial was significant \( (t[46] = 2.77, p < .01) \). All of the children who responded with some inconsistency were those for whom such a mismatch existed in the experimental situation. Most of the inconsistent responses occurred on the first trial. Of the subjects in the object condition who were presented with a substance (grass or sand) just prior to the first trial, 42 percent scooped up a small number of objects on that trial regardless of syntax condition. After one presentation of objects (chairs or flowers), they realised that it did not make sense to use the scoop for all items, as it was much easier to pick up a chair or flower with one's hand; these subjects chose one pom-pom creature on subsequent trials. This pattern of responding accounts for 71.4 percent of the
inconsistency in responding among subjects in this study, and reflects uncertainty on the part of the children as to what responses were acceptable to the experimenter. There were only two subjects whose inconsistency in responding could not be accounted for in this way.

Because most subjects responded consistently in one manner or the other, and because most of the inconsistency that existed is attributable to temporary confusion about acceptable responses, the subjects can be classified profitably into two categories: those that chose one small item on most trials, and those that scooped up a small amount/number on the majority of trials. These two types of response tendency are equivalent to an adjectival and quantifier interpretation of little, and to an interpretation of the noun as count or mass. The response tendencies of subjects in each of the four conditions are shown in Table 3. It can be seen that response tendencies were identical for all subjects in each of the two conditions in which semantic and syntactic cues were congruent. All subjects in the substance/mass syntax condition interpreted little as a quantifier. All subjects in the objects/count syntax condition interpreted little as an adjective. For the two conditions in which semantic and syntactic cues were incongruent (substance/count syntax, objects/mass syntax), responses were classified according to compatibility with an interpretation based on semantic or
Table 3
Number of Subjects in Each Condition
Choosing One Small Item or a Small Amount
On the Majority of Trials

<table>
<thead>
<tr>
<th>Objects</th>
<th>Small Item</th>
<th>Small Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count Syntax</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Mass Syntax</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Substance</th>
<th>Small Item</th>
<th>Small Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>

syntactic cues. Seventy-five percent of the subjects responded on the basis of semantic cues.

It appears that the majority of children in this study used perceptual information about the presence or absence of obviously distinct individuals to assign a word to the count or mass subcategory of noun. It was expected that this tendency would show up most clearly in the younger children, because some of them were in the age range at which, according to Gordon (1988), a count/mass distinction emerges. When semantic and syntactic cues were incongruent, the use of syntactic cues in categorisation was, in fact, rare among the youngest children in the sample. In an ANOVA with age group as the independent variable and the
proportion of trials on which behaviour was in accordance with the syntactic cue as the dependent variable, a planned contrast between the youngest group and the two older groups revealed that the mean proportion of trials on which children were guided by syntax was significantly lower in the youngest group (t[16] = 2.47, p < .05; separate variance estimates were used because of unequal variances; Bartlett-Box F = 6.49, p < .01). The mean score was .06 (SD = .10) for the youngest children, .35 (SD = .49) for the middle group, and .40 (SD = .50) for the oldest children (F[2, 21] = 1.66, p > .10). Although chronological age is not a very good indicator of the stage of development or linguistic sophistication, this analysis of age trend lends some support to the claim that perceptual cues are critical at an early stage and become less important in category assignment as linguistic knowledge increases.

Post-Test

Neither gender nor condition affected performance on any of the four tasks in the post-test (little, big, a little, a lot of). The lack of any effect of condition suggests that no aspect of the primary task contributed to the children's understanding of the four expressions.

Data collected in the post-test give some indication of the approximate ages at which children learn the adjectives little and big and the quantifying expressions a little and a lot of. The 91 subjects were divided into three age
groups: under 28.68 months (n = 30; minimum = 16.39 months), between 28.68 and 34.86 months (n = 31), and over 34.86 months (n = 30; maximum = 45.69 months). In $\chi^2$ tests (Age Group X Correct/Incorrect Response), it was found that there was no significant change with age in the percentage of subjects who knew the sense of *big*, but there was a significant increase with age in the percentage exhibiting an understanding of *little*, *a little*, and *a lot of*. Percentages of subjects giving correct responses in each age group and significance levels for $\chi^2$ tests are presented in Table 4.

Table 4

Percentage of Subjects in Three Age Groups Exhibiting an Understanding of Four Expressions

<table>
<thead>
<tr>
<th>Expression</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Little</strong></td>
<td>50.0</td>
<td>87.1</td>
<td>100.0</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td><strong>Big</strong></td>
<td>83.3</td>
<td>96.8</td>
<td>96.7</td>
<td>&gt;.05</td>
</tr>
<tr>
<td><strong>A little</strong></td>
<td>56.7</td>
<td>87.1</td>
<td>83.3</td>
<td>&lt;.02</td>
</tr>
<tr>
<td><strong>A lot of</strong></td>
<td>60.0</td>
<td>77.4</td>
<td>90.0</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

*a Low = 16.39 to 28.68 months; Medium = 28.68 to 34.86 months; High = 34.86 to 45.69 months.*
Discussion

The majority of children tested in this study showed evidence of using perceptual information about the object- or substance-like nature of stimuli in responding to a word applied to the stimuli as a count noun or mass noun. Nevertheless, one quarter of the subjects were swayed by syntactic cues in determining the count or mass status of the noun. This relatively high proportion undoubtedly reflects the linguistic sophistication of the subjects, a sophistication that was required for performance of the task. It is, unfortunately, difficult to devise a task that would allow one to see what kind of bias exists in very young children (e.g., 17 or 18 months old). Nevertheless, the data from this study and also from Gordon (1985) are suggestive of an age trend; if it was possible to invent an adequate test of the hypothesis for very young children, it is likely that an even stronger reliance upon perceptual information would be observed.

The evidence provided in this thesis supports the hypothesis that children learn the count/mass noun distinction on the basis of an object/substance distinction. The distinction between the two categories of noun cannot be defined in this way, but must instead be defined as an individuating/non-individuating distinction. This latter distinction will capture the difference between all count nouns and all mass nouns. It can be viewed as a recognition
that some kinds have a principle of individuation and some kinds do not.

It is likely that children learn the semantic roles of quantifiers, determiners, and plural markers by observing their co-occurrence with nouns that have been classified as count or mass on the basis of perceptual cues. If count nouns are understood as having a domain of reference that consists of individuals (some of which are physical objects), then it follows that any quantifier that appears with a count noun must quantify over individuals. When the plural version of a regular count noun is applied to a collection of objects of the same kind, a child should be able to learn the meaning of the plural -s by contrasting this situation to one (present or past) in which the singular form of the noun was applied to a single object. If mass kinds are understood to be ones that lack any means of individuation because their extensions are usually masses of substance, then quantifiers that appear with mass nouns will be assumed to relate to continuous (versus discrete) measures. Research is needed to test these hypotheses.

The account of learning offered in this thesis rests on the assumption that there exist two ontological intuitions, one relating to individuals (discrete entities) and one relating to the stuff of which individuals can be made (see Laycock, 1972). An understanding of the ontological category of object requires an intuition of discreteness. Stuff must
be treated as continuous, and so there must exist an intuition of a continuum. It is necessary for these intuitions to be sufficiently salient in the mind for categorical distinctions to be drawn along these lines.

It is likely that these intuitions come pretheoretically from perception. In vision, percepts formed according to gestalt principles present us with a world of individuals, but the contours, surface textures, and colours of individual forms are roughly continuous in nature. Tactual information also leads to the perception of the world as made up of individuals with continuous contours and surfaces. In auditory perception, distinct gestalts are formed, and these separate streams of sound appear to have continuity across an interval of time. Individuation and continuity are interrelated; the appearance of continuity has been found to play a role in the construction of gestalts. In vision, one of the gestalt principles is "good continuation." Its counterpart in audition is the "trajectory principle" which dictates that signals that are in positions along the trajectory (direction) of previous signals for some parameter (e.g., frequency) are captured into the same auditory stream (Tougas & Bregman, 1985).

The principles that yield an intuition of continuity are not well understood, but it is well known that the visual system "fills in" discontinuous areas of input to create the appearance of continuity (e.g., to compensate for
scotomas, including the natural blind spot). The auditory system also creates the perception of continuity for discontinuous inputs, as long as the boundaries of the discontinuities do not meet criteria for auditory "edges" (e.g., Bregman, 1978; Bregman & Dannenbring, 1977; Dannenbring, 1976; Warren, 1984; Warren, Obusek, & Ackroff, 1972).

Identity is related to continuity in that being the same individual usually implies continuity over time and space. In perception, it is possible that continuity is defined in terms of identity. The texture or colour of a surface at point A may appear continuous with that at point B just in case the visual system works out that the two points belong to the same form (i.e., an area defined by clear boundaries). An auditory signal at time A may appear continuous with one at time B if and only if the auditory system determines that the two signals belong to the same auditory stream. There may thus be a relation between continuity and identity that is analogous to the relation between discreteness and individuation.

If perceptual intuitions can feed into linguistic ones, then the process of learning a language is greatly simplified. Therein lies the rationale behind the hypothesis that the categories count noun and mass noun are learned on the basis of perceptually salient information about the presence of objects or substances. Studies similar to the
one described in this thesis are needed to determine whether other kinds of perceptual and conceptual information are used in learning the categories verb, adjective, and so on. The results of Brown's (1957) study, in which children demonstrated an understanding of the relation between an action and a verb, indicate that such a possibility is likely for the category verb. Children might assume that adjectives denote sensible properties of individuals or masses, and it is probable that the adjectival status of a word is not considered unless an appropriate noun is known (see Macnamara, 1982). Research into the hypotheses that children form about the possible meanings of suspected adjectives might yield information about biases that come from the perceptual system, and in so doing provide data relevant to a theory of perception.
Bibliography


