The Use of Mass Nouns to Quantify Over Individuals

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Abstract

Theories of the mass-count distinction in linguistics, philosophy and psychology commonly argue that count nouns are distinguished from mass nouns by their reference to, and quantification over, individuals (e.g., Bloom, 1999; Wisniewski, Imai & Casey, 1996). We present experimental evidence that both children and adults interpret some mass nouns as quantifying over individuals, and suggest a model of the mass-count distinction that includes these cases.

Introduction

In many languages, a syntactic distinction exists between count nouns and mass nouns. For example, in English, only count nouns can appear as both singular and plural. Also, count nouns can be modified by the indefinite article, terms like *many* or *few*, or by cardinal or quasi-cardinal numerals *(e.g., two, three, several)*, while only mass nouns can be modified by *much* or *less* (see Gillon, 1992 for details).

The use of particular terms as mass or count is highly flexible (see Bunt, 1985; Gillon, 1992; Jackendoff, 1991; Quine, 1960; Ware, 1979). Common examples include *hamburger, difference, apple, carrot, meaning, water, orange, banana, chicken, deer, fish, duck, steak, coffee, tea, hope*, etc. (see Barner & Bale, 2002; Gillon, 1992; Quine, 1960; Ware, 1979). A number of devices contribute to this flexible use. For example, most words that are typically used as mass nouns can also appear as count nouns when referring to types of things (e.g., *many French cheeses use raw milk*). Also, partitive constructions (e.g., *an inch of cigarette; a piece of cake*), and distinctions between things and the food they yield (e.g., *my pet duck*; *my duck a l'orange*) often yield mass-count flexibility.

In general, the use of a term in one category or the other has predictable consequences for interpretation. For example, the use of a term as a singular count noun entails that the thing being referred to is an *individual* of some type or another (Bloom, 1999; Bunt, 1985; Gillon, 1992; Gordon, 1985; Jackendoff, 1991; Link, 1983, 1998). Thus, according to Bunt (1985), count nouns, but not mass nouns, provide a "default dimension and unit of measurement, that of counting individuals." (p. 137). Discrete physical objects (e.g., *cats*), portions of substances (e.g., *two coffees*), actions (e.g., *several jumps*), and abstract entities (e.g., *hopes and dreams*), are all individuals that can be thought of as being discrete and bounded, and which are subject to being counted. This entailment persists even in cases where particular lexico-semantic knowledge is absent. Talk of *three blickets*, while not terribly informative, does nevertheless imply that three individual things, whatever they may be, are being referred to. Such examples suggest that speakers might "conceptualize the referents of count nouns as distinct, countable, individuated things and those of mass nouns as non-distinct, uncountable, unindividuated things" (Wisniewski, Imai, & Casey, 1996, p. 271).

This semantic distinction has been argued to play a critical role in the child's initial construction of the syntactic categories mass and count (e.g., Gordon, 1985; Bloom, 1999). For example, Bloom argues that young children determine the syntactic categories of these words using the rules in (1) (from Bloom, 1999).

(1) individual → count noun
non-individual → mass noun

Thus, upon hearing a word used to refer to an individual thing (e.g., a dog), the child could infer that it was a count noun. Similarly, reference to a non-individual (e.g., some milk) could be taken as evidence of a mass noun. Using such rules, Bloom (1999) notes that children could capitalize on their ability to represent and enumerate not only physical objects (e.g., Shipley & Shepperson, 1990), but also such abstract entities like actions (Wynn, 1996) and sounds (Starkey, Spelke, & Gelman, 1990), and collections (see Bloom & Keleman, 1995; Wynn, Bloom, & Chiang, 2002). Later in development these same syntax-semantics correspondences could allow the child to use linguistic context to close in on the meanings of novel nouns (as in Brown, 1957).

While a host of linguists, philosophers, and psychologists have embraced reference to individuals as the key distinction between count nouns and mass nouns (e.g., Bloom, 1999; Bunt, 1985; Link, 1998; Wisniewski et al., 1996), others have objected that various exceptions exist. For example, Gillon (1992) notes that many mass nouns in English have individuals in their extensions, including *furniture, hair, spaghetti, silverware, jewelry, clothing, traffic, infantry,* and *footwear* (see also Chierchia, 1998;

Quine, 1960), and that counting such things poses no particular problem. At least extensionally, these Object-Mass terms do not appear to differ from co-referential count nouns such as *furnishings, hairs, noodles,* and *utensils*. In each case, it seems that the mass noun in question has individuals in its extension, and refers to them as such.

In response to such objections, several researchers have suggested that, although words like *furniture* have individuals in their extensions, they do not in fact quantify over them as such, but refer to them in a non-individuated fashion (Bloom, 1990; Wierzbicka, 1988; Wiesniewski et al, 1996). Thus, Wiesniewski et al. (1996) note that: "on a particular occasion, we may conceptualize a swan, several ducks, and a heron on a lake as an unindividuated group called *waterfowl*, and not think of them individually as birds." (p. 295) By this view, objects such as furniture can be construed in multiple fashions, sometimes as individuals, and sometimes as an unindividuated mass, or group. Construal of things, and not their ontological classification, determines whether words are classified as mass or count. Thus, while mass nouns may not care about what they have in their extensions, they may care about how such extensions are construed. Use of mass nouns to name individual things may cause these things to be construed as non-individuals. Likewise, words used to name individual things in the world might be interpreted as mass nouns when the things are construed as non-individuals.

While this solution preserves the semantic purity of the categories mass and count, it raises the question of how the child learns to construe these objects in the same manner as the adults around her. What could enable the English-speaking child to see *the furniture* as an unindividuated mass while the young French speaker comes to view *les meubles* as distinct individuals? Given the subtlety of the distinction, we might expect that children would frequently misclassify Object-Mass terms as count nouns. But few such errors are made (Gordon, 1985). By the time these words appear, children are able to use syntactic cues to determine the grammatical category of the word and thus could presumably correct any semantic misconstruals (see Gordon, 1985; and Soja, 1992 for evidence of early sensitivity to mass-count syntax). [1]

Wisniewski and colleagues (1996) explored the hypothesis that we construe referents of mass and count superordinates differently. Adult subjects judged that members of mass superordinates (e.g., *tables, chairs* for furniture) co-occur more often than members of count superordinate terms (e.g., *lions, tigers for the superordinate animal*), and that people are more likely to interact with multiple mass superordinate referents at one time. In a separate experiment subjects made speeded category membership judgments of basic-level concepts belonging to either mass or count superordinate categories. When asked to judge whether a single noun belonged to a superordinate category, subjects were faster for count superordinates than for mass nouns (e.g., *ferns are plants* vs. *chairs are furniture*). But when test sentences involved more than one subordinate term (e.g., *a pig and a cow are livestock* vs. *a lion and a tiger are animals*) performance was faster for mass superordinates. Based on such results, Wisniewski et al. argued that mass superordinates encode "knowledge about an unindividuated group of objects united by spatial, temporal, and functional contiguity." (p. 292)

However, there is equally strong evidence suggesting that Object-Mass terms quantify over individuals. For example, Gillon, Kehayia and Taylor (1999) performed a lexical decision task comparing mass nouns like *furniture* to those like *water* and *mud*. Subjects were shown a determiner prime, such as *these, much,* or *many* and then asked to decide if the following string was a word. Interestingly, while subjects' responses were faster for words like *water* when the preceding determiner was grammatically congruent (e.g., *some, much*) and slower when it was incongruent (e.g., *many, three*), responses for words like *furniture* showed the opposite pattern. Gillon and colleagues argue that Object-Mass nouns were primed by determiners for plural count nouns because these terms, like plural count nouns, denote quantities of individual things.

While each of these studies is suggestive, they fail to resolve the question of whether Object-Mass nouns quantify over individuals. Wisniewski's judgment tasks do not directly test the quantificational properties of superordinates. Reference to multiple objects does not preclude quantification over individuals, as demonstrated by plural count nouns (e.g., *chairs*) nor does spatio-temporal co-occurrence (e.g., *Siamese twins* and *ducklings*). The relation between the priming results and quantification is equally murky. Object-Mass nouns could be primed by plural determiners because they quantify over individuals. However priming could also reflect their status as superordinates, their relationship with subordinate plural count nouns, or the nature of their extensions rather than their construals.

The present study examined how adults and young children interpret the quantification of mass nouns like *furniture*. Perhaps the most transparent measure of grammatical quantification is quantity judgment behavior. For example, we can verify that the count noun *cat* quantifies over whole, individual creatures by asking whether one overfed 15 pound cat is more cats than three 2-pound cats. The fact that three cats, whatever their size, are always more cats than one cat, indicates that the term *cat* quantifies over individuals when used as a count noun.

[1] This early sensitivity to syntactic cues is not problematic for Bloom's particular version of semantic bootstrapping (1999). If semantic and syntactic categories are truly equivalent, rather than merely correlated, then the linking rules are bidirectional and syntactic and semantic evidence should be equally diagnostic. On this account we might expect that children would be able to use determiners to classify (and construe) novel nouns as soon as they identify their selectional restrictions.

Likewise, the fact that one giant 15 pound chunk of fudge is more fudge than three 2 pound chunks of fudge indicates that the term *fudge* does not quantify over individuals. Applying this logic, the present study assessed the quantification judgments of adults and children for common Count nouns referring to objects, for Substance-Mass nouns referring to substances, and for Object-Mass nouns (e.g., *furniture*), to determine whether some mass nouns quantify over individuals. The first experiment examined adults' quantity judgments for the three types of noun by asking subjects to indicate which of two characters had more stuff (e.g., furniture, cups, mustard). Of interest was whether judgments regarding Object-Mass nouns were based on number of individuals, like Count nouns, or on continuous extent, like Substance-Mass nouns.

Experiment 1a

If all mass nouns represent unindividuated groups of objects, subjects should not quantify over individuals when interpreting Object-Mass nouns, but should always judge one large object to be more than the three small ones, when the large object occupies more space than the three small objects combined. In contrast, if Object-Mass words do quantify over individuals, subjects should base quantification judgments on number. In either case, it was expected that subjects would quantify over continuous extent when tested on Substance-Mass nouns such as *ketchup* and *toothpaste*, and over individuals when given Count nouns such as *plate* and *candle*.

Method

Subjects

The subjects were 16 Harvard University undergraduates, including 8 males and 8 females, who participated as part of a course requirement.

Procedures and Stimuli

Subjects were presented with two characters and were asked to point at or choose which of the two had more of some substance or thing on each trial. Three categories of word were used: (1) Count nouns that refer to physical objects (e.g., *shoe, plate, cup, candles*); (2) Substance-Mass nouns that refer to substances (e.g., *mustard, ketchup, peanut butter, toothpaste*); and (3) Object-Mass nouns that refer to discrete physical objects (e.g., *furniture, jewelry, silverware, mail*). For trials involving discrete physical objects (i.e., Count and Object-Mass noun trials) one character was shown with one large object, while the other was shown with three smaller objects of the same kind. In each case, the large object exceeded the volume and had greater overall surface contour than the three small objects. For example, on *furniture* trials, one character had one large chair that comprised more overall stuff than the other character's three tiny chairs combined. For trials involving substances (i.e. Substance-Mass trials), one character was shown with a large portion of the substance (e.g., ketchup), while the other character had three smaller portions that amounted to less overall stuff.

The complete list of test words are shown in Table 1. Extra words are provided in the Object-Mass category, in anticipation of Experiment 1b, which tests the judgments of young children. For adults, the Object-Mass words were selected at random from the list. This difference in method motivated our separate analysis of data for children and adults.

All test questions had the same general format: "*who has more x, Cowboy Brown or Captain Blue*?", where the variable "x" was replaced by words from one of the three categories of test words. Each subject was provided two familiarization trials, where continuous variables such as volume were confounded with number. For example, in one trial one character was shown with three napkins and the other with one of the same size, and the subject was asked to point at the character with more napkins. In the other trial, one character was shown with one large piece of crumpled paper, and the other with tiny piece of paper.

Table 1. Count, Substance-Mass and Object-Mass nouns used in test stimuli sentences

Count	Substance-Mass	Object-Mass	
Shoe	Ketchup	Clothing	Mail
Plate	Mustard	Furniture	Jewelry
Cup	Peanut Butter	Fruit	Company
Candle	Toothpaste	Silverware	

Side of presentation was counterbalanced to ensure that the set of three objects/portions appeared equally often on each side and with each character for each type of noun. Subjects were encouraged respond by pointing at and naming the chosen character.

Results and Discussion

For the analysis of quantity judgments, the dependent measure was the number of judgments based on number of individual objects or portions (versus the number of responses based on a continuous extent).

A 2 × 2 × 3 ANOVA was performed with gender (male vs. female) and order of presentation (order 1 vs. order 2) as between factors, and with word category (count vs. substance mass vs. object mass) as a within-subjects factor. Figure 1 shows the mean percentage of judgments based on number of individuals, for each category of word. There was a significant effect of word category, with individual judgments more frequent in the Count and Object-Mass conditions than in the substance mass condition (100% and 97% vs. 0%; $F(2, 24) = 1215.02$, $p < .000$). There were no effects of gender or order of presentation.

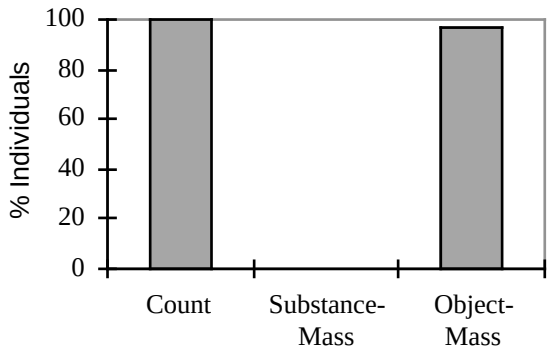

Figure 1. Adults' quantity judgments, as a percentage of judgments based on number of individuals

Adult quantity judgments were based almost exclusively on number of individuals for both the Count and Object-Mass conditions, but never for the Substance-Mass condition. Thus, adult subjects interpreted the question "who has more *x*" as pertaining to the number of individuals only for the count and Object-mass conditions. This pattern of judgments fails to support the hypothesis that Object-Mass nouns like *furniture* cause adults to construe referents as unindividuated.

Experiment 1b

The second experiment employed the same method, to examine the quantification judgments of four-year-old children. Experiment 1a clearly demonstrates that adults quantify Object-Mass nouns over individuals, undermining the semantic characterization of the mass-count distinction. But many authors have argued that semantic-syntactic correspondences are particularly potent early in development (Pinker, 1984; Macnamara, 1982). Children may begin with semantically homogenous syntactic categories, which become more diverse as the child accommodates this scheme to wider range of concepts or encounters clear counterexamples.

If young children rigidly equate count nouns with individuals and mass nouns with non-individuals, then their performance on this task should be radically different from that of the adults. Any mass noun, regardless of its extension, cannot quantify over individuals. Since children this age correctly use mass noun syntax with Object-Mass terms (Gordon, 1985), we would expect them to interpret even the Object-Mass as quantifying over continuous extent. These intuitions might change later in life, with the development of numerical and world knowledge.

Method

Subjects

The subjects were 6 English-speaking children from the greater Boston area, aged 4;0 to 4;6. This age group was selected based on an informal analysis of the entire English language CHILDES database (MacWhinney, 2000), which revealed the very low frequency of target words in child speech before 4 years of age. A total of 4 girls and 2 boys were tested.

Procedures and Stimuli

The procedures and stimuli used were identical to those used in Experiment 1a, except that Object-Mass words were selected on the basis of a pretest to ensure that children knew the extension of the term. For each word, children were shown a page with a target picture and three distractors and asked to point to the picture that matched the word ("Can you find the luggage?"). Children were tested on the first four words they correctly responded to.

Results and Discussion

Analyses for Experiment 1b were identical to those used for Experiment 1a. Figure 2 shows the mean percentage of judgments that were based on number of individuals (rather than continuous extent) for each category of word.

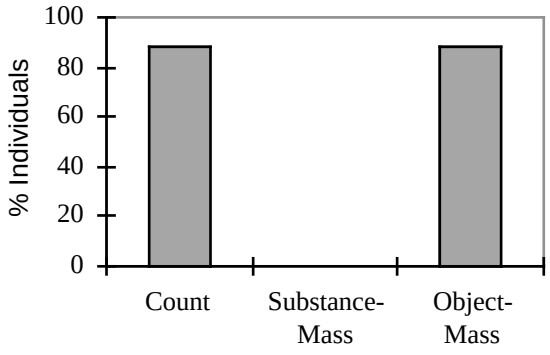

Figure 2. Children's quantity judgments, as a percentage of judgments based on number of individuals

These data suggest that, as with adults, children's quantity judgments are based almost exclusively on number of individuals for both the Count and Object-Mass conditions but not for the Substance-Mass condition. Although only six children had been tested at this time, there was a significant effect of word category, with judgments based on number being more frequent in the Count and Object-Mass conditions than in the Substance-Mass condition (88% and 88% vs. 0%; $F(2, 4) = 31.148$, $p < .004$). There were no effects of gender or order of presentation.

General Discussion

The results of this study demonstrate that adult and child quantity judgments are based almost exclusively on number of individuals for Object-Mass nouns, but not for the Substance-Mass nouns. Thus, subjects interpreted the

question "who has more *x*" as pertaining to the number of individuals both the Count and Object-Mass conditions. This pattern of judgments suggests that children and adults interpret certain mass nouns as quantifying over individuals, and fails to support the hypothesis that Object-Mass nouns like *furniture* cause adults to construe referents as unindividuated. If the quantificational content of Object-Mass terms were truly unindividuated, subjects should not have accessed and employed information regarding number to perform judgments of quantity.

This result raises the question of whether a systematic account of mass-count semantics is possible. To date, most proposals of the mass-count distinction, like Bloom (1999) and Wiesniewski et al. (1996), have proposed a uniform representation for the semantics of mass nouns. While some researchers have proposed, like Wisniewski et al., that no mass nouns quantify over individuals, others have taken the opposite view, claiming that cases such as *furniture* are evidence that all mass nouns must as some level refer to individuals (see Chierchia, 1998).

However, a third possibility exists, if we accept that there's a distinction between quantificational entailments of syntax, and entailments of particular lexical items. For example, based on the common observation that use of terms as count nouns creates an entailment of reference to individuals, we might propose that this entailment is generated by the syntax itself, and is unrelated to the semantics of particular lexical items. Thus, for most lexical items, the entailment of reference to individuals is created by use in a count noun context. Use in a mass context creates no entailment. That is, mass syntax is *underspecified* with regards to reference to individuals (Gillon, 1992). For other items, such as *furniture* or *jewelry*, features regarding individuation are stored in the lexicon, and combine with underspecified mass syntax to create entailments about reference to individuals.

An example of how this might work is provided by Jackendoff (1991). In his discussion of the mass-count distinction, Jackendoff suggests that all nouns have lexico-conceptual feature relating to *internal structure* (+/- i) and *boundedness* (+/- b). Here, the feature +i "entails a medium comprising a multiplicity of distinguishable individuals" (p. 19) and characterizes the semantics of bare plurals and Object-Mass nouns like *furniture*. The feature +b corresponds to the boundaries entailed by an expression, and applies in cases where number is explicitly specified (e.g., *a cat; three dogs*), but not for bare plurals or Object-Mass nouns, where number is left open. According to Jackendoff, linguistic expressions come about their features in two ways. First, all nouns are specified lexically for either +/-b and +/-i. Second, features can be added by functions, or rules, that correspond to inflectional morphology such as the plural morpheme –s, or to larger phrases, involving partitive constructions like "a piece of bread". Thus, for example, the representation of *a dog* would be [+b, -i DOG], while *dogs* would be [-b, +i (+b, -i DOG)], where the embedded set of features corresponds to a single individual, and the second set to an unspecified multiplicity of individuals. While such specifications would need to be added by rules for words like *dog* (i.e. to get *a dog* and *some dogs*), words like *furniture* could come lexically equipped with the specification (-b, +i), as could terms like *rice* (see Jackendoff, 1991).

Given the correct description of where features such as +/-b and +/-i originate, we believe that such a model can account for mass-count semantics and distribution in language use. While Jackendoff notes the featural specifications for singular count nouns, he does not indicate what features a bare root might have. We would like to suggest that the functions proposed by Jackendoff remove the need for lexical specification of features related to the mass-count distinction, and that almost all such features may be introduced in the syntax (see Barner & Bale, 2002, for discussion of lexical underspecification and adding of features in the syntax). For example, since count syntax uniformly creates an entailment that reference is to individuals, we propose that these features are added in the syntax with corresponding morphology such as the indefinite article "a", or the plural morpheme "-s". Where feature combinations like [+b, -i] are clearly not contributed by the syntax (e.g., as is the case for mass noun constructions), yet are evidenced by quantification judgments, the features must be thought of as being marked lexically.

Using this type of scheme, several interesting predictions can be made. First, the fact that both plural count nouns and Object-Mass nouns cannot be pluralized, while Substance-Mass nouns often can be (e.g., *two waters; two coffees*), suggests that the featural combination of [-b, +i] blocks pluralization in the syntax (as in Jackendoff, 1991).[2] Also, the combination of [-b, +i] appears to block reference to substances. Although talk of "dog all over the road" conjures images of a horrible accident, talk of chairs or furniture all over the road do not. *Furniture* and other Object-Mass nouns, it seems, are unlike many other mass nouns in not allowing reference to substances. Thus, while we can use mass-count syntax to shift construals for terms like *apple* (e.g., allowing either reference to the individual or the stuff between one's teeth), terms like *furniture* can never be used to refer to substances, and seem to allow *only* reference to individuals. Similarly, while many mass nouns can be converted to count nouns to refer to portions (e.g., *two coffees, two soups*), portions of *furniture, jewelry, infantry* and *traffic* cannot be named using count nouns. Their lexical features appear to be fixed, allowing reference to individual portions only through phrases (e.g., *a piece of*

[2] Pluralization to refer to types seems possible (e.g., "Acme Furniture: Supplying fine furnitures for over 35 years"). However, this does not involve pluralization of terms with the features [-b, +i], but must affect a singular count noun [+b, -i], which must be accessible to all type interpretations of NPs.

furniture).

This view of mass-count semantics is consistent with one version of the semantic bootstrapping hypothesis, where bootstrapping is seen as a process of using semantics to discover syntactic constructions, rather than specifications of individual lexical items (see Barner & Bale, 2002). By using correspondences between syntax and semantics, children could find count and mass contexts, and then learn the phonological values associated with each context (e.g., for the plural morpheme, or for quantifiers such as *each* and *all*, etc.). Having acquired the fundamental syntactic distinction between mass and count, the child could then use morphological evidence to isolate Object-Mass words and mark them lexically. For example, the use of words with semantic features resembling a plural count noun yet lacking a plural morpheme (e.g. *furniture*), could signal the child to mark the features lexically, since attributing them to syntactic features would not be an option (due to the lack of count noun morphology to which features could be mapped). In this way, both distributional and semantic features of words could be used to identify syntactic constructions and lexically mark exceptional items as Object-Mass nouns.

According to this study of mass-count semantics, some mass terms, like *water*, do not quantify over individuals, and others, like *furniture* do. Both adults and children in our study used Object-Mass nouns like *furniture, jewelry* and *clothing* to quantify over individuals. These results suggest that quantificational entailments are generated not only by the syntax, but also in some cases by individual lexical items. This, in turn, supports a model of grammar in which features relating to mass-count semantics are added both in the syntax and in the lexicon, and a model of acquisition where syntax-semantics correspondences interact with distributional analysis to specify mass-count semantics.

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