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Evaluating the semantic categories hypothesis: The case of the count/mass distinction

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Abstract

It is often claimed that grammatical categories are initially acquired via their semantic properties. In the case of the count/mass distinction, semantic correlations should predispose the child to acquire the count/mass subcategories as a distinction between names for objects vs. substances. This proposal is tested in three experiments. The first two experiments with 3- to 5-year-olds employ a word-learning paradigm in which semantic and syntactic cues are either in conflict, in accord or in isolation. Results demonstrate that syntactic cues are clearly the most effective and predominate over semantic cues as a basis for subcategorization. The third experiment with 2- to 5-year-olds demonstrates that children do not miscategorize nouns whose semantic properties are either inappropriate or indeterminate. Thus, for example, they do not tend to miscategorize a term such as "furniture" which is a mass noun yet denotes a class of objects. These results suggest that the count/mass distinction is not acquired via an object/substance distinction although semantic properties of quantification are probably important for the acquisition process.

Introduction

In the field of language acquisition there is a widely held belief that the child's early grammar is more semantically grounded than that of the adult. Early rules and categories are claimed to be derivative of pre-formed conceptual categories, only later to be replaced by more formally defined representa-

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tions. A typical example of such a view is the claim that the child's early syntactic categories are defined over referential rather than formal properties. As Macnamara (1982) states:

> ... children arrange their words in semantic, not syntactic, categories. The principle categories [are] words for objects, words for attributes of objects, and words for actions. (p. 105).

This claim is interesting in that it postulates a representational format that is qualitatively different from that of the adult. That is, the set of primitives over which the categorial definitions are written have to do not with grammatical roles, but with properties of reference, viz. what kinds of things are denoted by a particular class of words. It is clear that semantic definitions of the above kind for syntactic categories are unworkable in adult grammars since they do not capture the correct categorizations of words falling outside of such semantic descriptions. Rather, the adult's categories must be defined in terms of the role they play in the grammar. Therefore, if the child's categories do start out semantically in this sense, this implies a stage in development when there is a "shift" from semantically defined categories to a more formally based system.

This claim, which I shall call the "Semantic Categories Hypothesis", is much stronger than a more general claim that syntactic development is complemented by semantic development. An alternative to the semantic categories hypothesis does not necessarily require that the child acquire syntax in the absence of semantics. That is, one need not postulate that category development takes place purely in terms of some distributional analysis over uninterpreted symbols. Not only is such an account unlikely to work, but it also fails to explain how the child ends up actually learning the correct semantic functions of the syntactic component (e.g., general properties of logical form such as quantifier scope, binding relations, constituent dependencies). What is controversial is the claim that the child looks to his real-world knowledge in order to induce the definition of his categories.

Macnamara's above quote clearly identifies the sense in which categories are claimed to be semantic for children. "Object", "action" and "attribute" are referentially defined classes. Such terms are crucially distinguished from linguistically defined (semantic) functions such as: modifier, argument or predicate. These semantic functions of syntactic categories would presumably be required in any workable account of what children need to acquire in language acquisition. Furthermore, they are not functions that are discarded in development, unlike the proposed referentially based category definitions that Macnamara and others propose. In the present paper, I shall examine

the question of whether the count/mass distinction is initially acquired as a semantic distinction defined referentially.

The count/mass distinction can be characterized in terms of both quantificational and distributional differences between noun-types. Count nouns such as *table*, *shirt*, *car* are discretely quantified as individuals and pluralities (e.g., *a car*, *two shirts*, *many tables*). Mass nouns, on the other hand, do not denote individuals when quantified (e.g., *some water*, *much sand*). As a consequence, mass nouns may not be pluralized, counted or individuated (cf. **two waters*, **a sand*). In terms of distributional differences, only count nouns may be pluralized and modified by *a*, *another*, *several*, *few*, *both*, *each*, *every*, *either* and numerals. Only mass nouns may be modified by *much* and *little* (used as a quantifier).

These characterizations in terms of quantification and distribution are pretty much coextensive. That is, count noun distributional properties such as determiner type and plural are precisely the things that invoke individuated quantification. Individuation, in this sense, is not a referential property of the class of count nouns. It is a semantic function of the syntax of the language. A semantic definition for the count/mass distinction in terms of referential properties would involve what kinds of things count nouns and mass nouns denote. In general, count nouns tend to be names of objects whereas mass nouns tend to name substances (within the class of concrete nouns). Thus one finds a good correlation between discreteness of perceptual form and discreteness in the mode of quantification (i.e., names for discrete objects tend to be individuated count nouns). Consequently, Macnamara (1982) suggests that the relevant criterion for determining count nouns is that they name: "... things that have characteristic form" (i.e., concrete objects) and: "... when substances are named that usually coalesce when placed together, the name is a mass noun" (p. 139).

Macnamara thus proposes that the child bases her count/mass distinction on something like an object/substance distinction. I take this to be a qualitatively similar claim to the proposal that nouns and verbs are initially acquired in terms of semantic classes such as object and action. Furthermore, I assume that such definitions would be discarded in development. The alternative "syntactic" account would propose that categories are defined in terms of grammatical roles which include their proper quantificational functions. The difference here is crucial in deciding whether the basis of representation is fundamentally different for the child and adult.

Before proceeding it is necessary to demonstrate that the object/substance characterization is not, in fact, coextensive with the notion of individuation. For example, *furniture* names a class of objects and, on the basis of referential properties, should be a count noun. However, it may not be individuated

when quantified (e.g., **a furniture*) and is thus a mass noun. Thus, whether or not a noun is individuated depends not on what it denotes, but on whether the language allows it. Therefore, individuation appears essentially to be a matter of linguistic convention rather than semantic entailment. This may differ from language to language. For example, in French, *meuble* (= *furniture*) is indeed a count noun. Other languages may not even have a count/mass distinction, thus allowing pretty much any noun to be individuated (e.g., Hopi—see Greenberg, 1972). Also, for a large number of nouns, the object/substance distinction is simply irrelevant and the child could not use it as a means of determining subcategorization. For example, abstract nouns such as *example* and *advice* must be subcategorized as count and mass respectively.

While adult categories (in English) do not appear top be referentially defined, the reasons for suggesting that children's categories are semantically based are well motivated. The language learner is faced with the problem of taking unlabeled strings of words and deciding which of them are nouns, which are verbs and so on. Yet he has no *a priori* knowledge of which distributional properties each of the categories will have. If the child were endowed with certain innate assumptions that names for objects will be nouns, names for actions will be verbs and so on (Grimshaw, 1982; Macnamara, 1982; Pinker, 1979, 1982), this semantic strategy could be used to fix an initial set of candidate categories.

Opposing such a position, Maratsos and Chalkley (1981) propose that categories are induced on the basis of correlations of common privileges of occurrence of sets of words.[1] In this model, open-class (content) words in input utterances are encoded in terms of argument–relation schemas along with the relevant closed-class vocabulary (functors) specified. These represent the relevant contexts that are used to define categories. Unfortunately, the model does not specify how the open/closed class distinction is identified, nor how the child assigns words as either arguments or relations. Furthermore, a number of people have criticized the model on other grounds. For example, Pinker (1982) makes the observation that, without further specification, there are too many possible ways of construing the "context" of a privileged occurrence as a basis for defining categories. These and other criticisms suggest that the Maratsos and Chalkley model, as it stands, is inadequate to account for category acquisition.

[1]Maratsos and Chalkley (1981) do allow that categories might start out semantic in the very earliest stages (see also Maratsos, 1981). However, if this position is allowed, then there is essentially no difference between the various accounts. I shall therefore be employing the more exclusive claim that there is no initial stage of semantic categories.

In examining the count/mass distinction the issues are somewhat different. If we assume that major categories are acquired prior to their subcategories, then the child is not dealing with an unlabeled string when he hears an utterance. Rather, the string will be categorized in some fashion. That is, the child will be able to label words in terms of the major categories (or at least some of them), but not in terms of their subcategories. Unlike the case of the major categories, there cannot be an argument that subcategories are unlearnable without first assuming a semantic correspondence. This is simply because of the empirical fact that children do acquire subcategories where there is no possibility of semantic support for the induction. For example, in gender acquisition where the semantic correspondence to natural gender is almost arbitrary, it is consistently found that children never use natural gender as a basis for assigning nouns to their subcategories (Karmiloff-Smith, 1979; Levy, 1983b; MacWhinney, 1978).[2] The question does not appear to be whether it is possible in principle to form subcategories independent of semantic support, but whether children actually do so when semantic support is available. The count/mass distinction provides an ideal test case for this question.

The two accounts to be contrasted will be referred to as the "semantic account" and the "syntactic account". Neither is purely semantic nor purely syntactic. The semantic account must assume that the categories play some syntactic role in sentence formation, otherwise there would be no justification for claiming the child had categories at all. Similarly, on a syntactic account, one must assume that (at some point) the child learns the proper quantificational properties contingent on a noun's subcategorization. The difference is that the semantic account assumes that the child defines her categories in terms of an object/substance distinction whereas the syntactic account assumes a definition in terms of linguistic functions. "Define" here, is used to characterize the essential core of the representation for the child. Brown (1957) has demonstrated that 3- to 5-year-olds do appear to know that a nonsense word heard in a count noun context (e.g., "a sib") should denote an object, whereas "some sib" (mass noun) should denote a substance. However, adults also appear to know this, but one would not want to say that the adult's representation is in terms of an object/substance distinction (examples such as *furniture* clearly militate against any such position).

Brown's results suggest that the count/mass distinction is different from,

[2]Mulford (in press) has studied gender acquisition in Icelandic and found that natural gender is used. However, her task involved use of pronouns, not nouns (see also Karmiloff-Smith, 1979 on pronouns). Pronouns clearly must be coordinated with natural gender, since they are required in purely exophoric cases where it is necessary to appropriately use *he/him* or *she/her* to refer to some person. This is a quite separate case from gender subcategorization of nouns where no such demands are involved.

say, gender. Children do seem to be sensitive to referential properties in the count/mass cases. A way of characterizing this difference might be to say that, for gender, the categories are *exclusively* syntactic/phonological. This means that children cannot use semantic properties as a basis for category assignment. However, it is possible that a category could be *essentially* syntactic, but not *exclusively* so. This means that, while the child might be able to use properties of referents as a basis for assigning new nouns to their subcategories, these would never predominate over syntactic cues.

In deciding whether a category is defined essentially in terms of semantic or syntactic properties, it is necessary to determine what cues the child will use in assigning a new noun to its subcategory. In particular, it is necessary to determine which cues will predominate when semantic and syntactic cues are in conflict with each other. In the first experiment children were tested in a situation in which new nouns (nonsense words) were presented syntactically as count nouns (e.g., "This is a garn") but semantically denoted mass-like substances. Similarly, mass noun syntax was paired with semantic referents that were objects. If subjects were to subcategorize on the basis of semantic cues, then this would suggest that the representation is indeed in terms of something like an object/substance distinction. However, if syntactic cues predominated then this would suggest that the essential basis of the representation is in terms of linguistic properties and hence, qualitatively similar to that of an adult.

Experiment 1

Method

Subjects

A total of 44 subjects were initially tested. Four were excluded (see Results section), thus leaving a total of 40. Ages ranged from 3;5 to 5;5, mean age 4;3. There were 17 males and 23 females. Subjects were mostly from middle-class backgrounds, all were native speakers of English.

Materials

Fifteen pairs of index cards were used for training. One of the pair contained a line drawing of a nonsense object and the other contained a picture of two of the objects. Nonsense words assigned as names for these objects included: *Tib*, *Brine*, *Pon*, *Shap*, *Gren*, *Sib*, *Dap*, *Carb*, *Lobe*, *Vell*, *Durn*, *Prote*, *Lop*,

Kip, *Thorp*. On the main items, four object and four substance stimulus sets were used. The objects were chosen to be things that the child would not know the regular names of, and in many instances they were painted in unusual colors. These included: electrical components, file clips, fuses and wall plugs. The substance stimuli were unusual-looking liquids presented in sets of four test-tubes. Names for the main items included: *Brode*, *Cabe*, *Grote*, *Garn*, *Fant*, *Turp*, *Cheem* and *Latt*. The control condition included pennies (about twenty-five) and water in four test-tubes. A small toy robot (Mickey-the-Martian) was also used.

Procedure

The aim of the present experiment was to examine whether semantic or syntactic cues would predominate in children's assignment of new nouns to either the count or mass subcategories. The method consisted of teaching names of objects and substances to children using nonsense words (or low frequency words). The linguistic context in which the word was embedded contained determiner-noun sequences indicating either count or mass noun subcategorization. This constituted the syntactic cue. Whether the stimuli were objects or substances constituted the semantic cue.

There were two main test conditions which are termed: *Conflict* and *Accord*. In the conflict condition, the child was given semantic and syntactic cues that differed in whether they indicated count or mass noun subcategorization. For example, subjects would be shown some unusual objects such as electrical components, and would be told:

> This is some garn, can you say garn? [S repeats]. Have you ever seen any garn before? This is some (green) garn, and this is (blue) garn ...

On other items, subjects would be shown a test-tube full of liquid (substance) and would be told:

> This is a garn, can you say garn? [S repeats]. Have you ever seen a garn before? Well this is a (red) garn and here's another (red) garn ...

Thus, in the former case, semantic cues indicated count noun subcategorization while syntactic cues indicated mass noun subcategorization, and vice versa for the latter case. In the *Accord* condition, the pairing of stimuli with linguistic contexts was made congruent. That is, objects were referred to as: "a garn" and substances as: "some garn". For each of the conflict and accord conditions, there were two trials with object-type stimuli and two with substance-type stimuli.

In order to test for how the child had subcategorized the new noun, she was required to perform a sentence completion in the manner of Berko (1958). The experimenter would continue:

> ... So, here we have a/some garn, over there we have more ... what? [Said as the Experimenter pointed to a group of additional objects or substances of the same kind.]

The form of the child's completion allowed for an assessment of how she had subcategorized the noun. If she said "more ... garn", this would indicate mass noun subcategorization. On the other hand, a plural completion of the form: "more ... garns" would indicate count noun subcategorization. Previous experiments (Gordon, 1982b) have demonstrated that the use of *more* and the plural is an effective indicator of noun subcategorization in production tasks. In introducing the noun to the child, the plural form was never used by the experimenter.

The conflict condition described above tests for the two competing predictions. On the semantic account, children should pluralize for names of objects, but not for names of substances. On the syntactic account, the exact opposite prediction arises. Substance names should be pluralized, but not object names, since the syntactic cues indicate such subcategorizations. The accord condition does not differentiate between the two accounts. However, if the results show a preference for either semantic or syntactic cues in category assignment, then it is of interest to determine whether the alternative cue is totally ineffective or partially effective. If there were no effect of the secondary cue, then there should be no difference between the results for the conflict and accord conditions. If there was an effect, then there should be more consistent responding in the accord condition than in the conflict condition.

A number of points need to be made about the presentation of stimuli. First, it was necessary to present substance stimuli in a form in which pluralization would be pragmatically appropriate. One would not expect children to use plurals if there were not a plural referent being denoted. Therefore, the substances were presented in test-tubes. To circumvent possible misinterpretations, it was made clear to the child that it was, in fact, the liquid and not the tube that was being named during the test. For example, the liquid was shaken around, the experimenter pointed inside the tube and used the locution: "*In here* we have a garn". While presentation in this form made the stimuli discrete, the relevant characteristic of being a substance was maintained.

The second point concerns the number of object stimuli presented to sub-

jects. In the accord condition, *a garn* was used to refer to a single object. However, in the conflict condition, *some garn* was used to refer to a group of objects (about three or four). The reason for this difference is that in comparable situations in which a real word such as *furniture* would be used, *some furniture* would normally be used to denote a set of objects rather than, for example, a single chair. It might be objected that this difference in number could be a confounding factor in the experimental design. However, the separate effects of numerical differences are examined in experiment 2 which will provide a control for such objections.

In initial pilot studies employing this design, it was found that many subjects never pluralized the nonsense words. To attempt to elevate the level of pluralization, it was decided to use a training procedure prior to testing on the main items. Subjects were introduced to a toy robot called "Mickey-the-Martian" and were told that he had brought some pictures of things from Mars. These were line drawings, on index cards, of various nonsense objects. The child was first shown a drawing of a single object and was told its name (e.g., "This is a sib") and was asked to say the name. He was then shown a card with two of the objects and was told: "Here we have two ... What?" If the child did not produce a plural form (*sibs*), he was given it and asked to repeat. Once the subject had produce three consecutive plurals unassisted, he was moved onto the main items. If, after fifteen training items, the criterion was not met, the subject was dropped from the experiment.

One further condition was added to the design. This was a control condition to ensure that pluralization was an effective indicator of subcategorization for the subject. A real count noun (*penny*) and a mass noun (*water*) along with their referents were presented in the same manner as the main items. For example, the water was presented in test-tubes. The child did the same kind of sentence completion as in the main items. Any child who failed to pluralize appropriately (i.e., pluralizing *water*, or not pluralizing *penny*) was eliminated from the experiment, since the measures for evaluating subcategorization would be ineffective.

To summarize, the conditions were as follows: (1) Training; (2) Real Word Control; (3) Conflict Condition; (4) Accord Condition. The conflict condition was to determine whether children assign nouns to their subcategories on the basis of semantic cues (object vs. substance) or syntactic cues (e.g., *a X* vs. *some X*). A comparison of the accord and conflict conditions allows for an evaluation of whether secondary cues are ineffective or partially effective.

Results

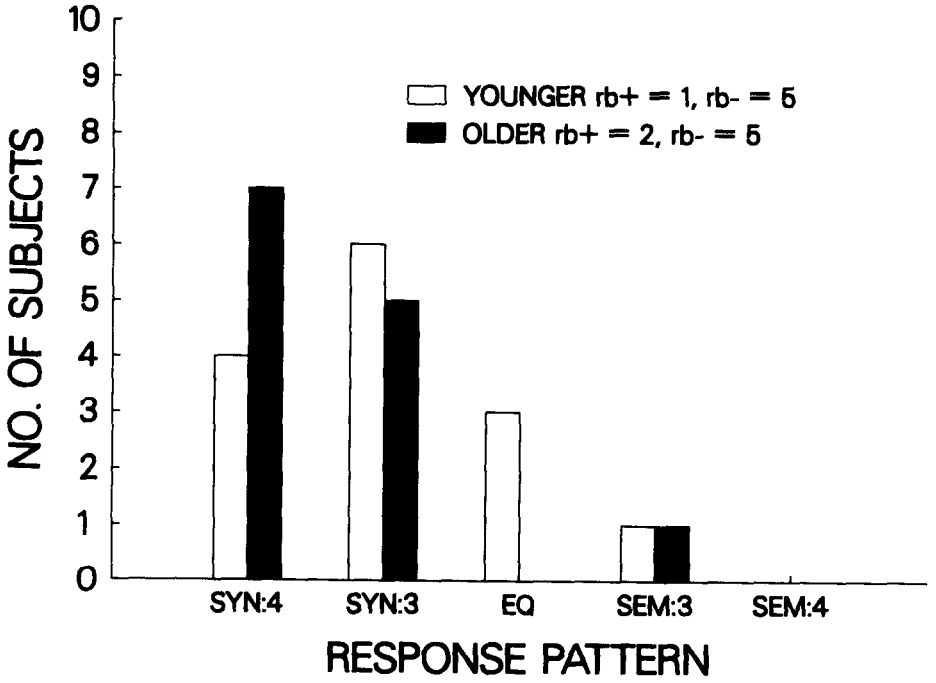
Of the 44 subjects originally tested, 3 were disqualified for failing the training phase, and 1 for pluralizing *water* in the control condition. The fact that only one subject failed this control confirms that having the referent of a mass noun in test-tubes does not persuade the child to pluralize (see also Gordon, 1982b, chapter II). Therefore, the method of using plurals did appear to be a reliable indicator of subcategorization. The final population of 40 subjects was divided into two groups of 20 by age. The younger group ranged in age from 3;5 to 4;1 (mean age: 3;9) and consisted of 11 males and 9 females. The older group ranged from 4;2 to 5;5 (mean age: 4;9) and consisted of 6 males and 14 females.

Conflict Condition

It will be recalled that the main conditions (conflict and accord) each had four items: two objects and two substances. The response patterns for the four items in the conflict condition were categorized as to whether they indicated subcategorization on a syntactic or semantic basis. Patterns where all four responses indicated a syntactic basis for category assignment were coded as SYN:4. Here, subjects pluralized for *a garn* but not for *some garn*. Three such responses were coded: SYN:3. Conversely, the equivalents for semantic response patterns are SEM:4 and SEM:3 respectively. Subjects in these categories pluralized object names, but not substance names. Since SYN:2 = SEM:2 this pattern is termed "equivocal" or EQ. Coded separately are patterns where subjects produced the same response for all four items. Four plurals were coded as RB+ (Response Bias: + plural); four non-plurals were coded as RB− (Response bias: − plural).

Results for the conflict condition are shown in Figure 1. Although there were a large number of response biases, the results are strikingly clear for subjects that consistently attended to either semantic or syntactic cues. Only two subjects approached a semantic pattern (SEM:3) and none gave the full semantic pattern (SEM:4). Syntactic patterns (SYN:4 and SYN:3) on the other hand were predominant among the consistent responders ($n = 22$). This result was highly significant ($\chi^2 = 4.28$, $p < .001$). While the older subjects were slightly more polarized toward the syntactic patterns with no EQ patterns, in both groups the majority of subjects used syntactic rather than semantic cues as a basis for category assignment (Younger: $\chi^2 = 7.46$, $p = .03$; Older: $\chi^2 = 14.7$, $p < .001$). Clearly the results for this, condition support the position that category assignment for children is based on syntactic not semantic cues when the two are in conflict.

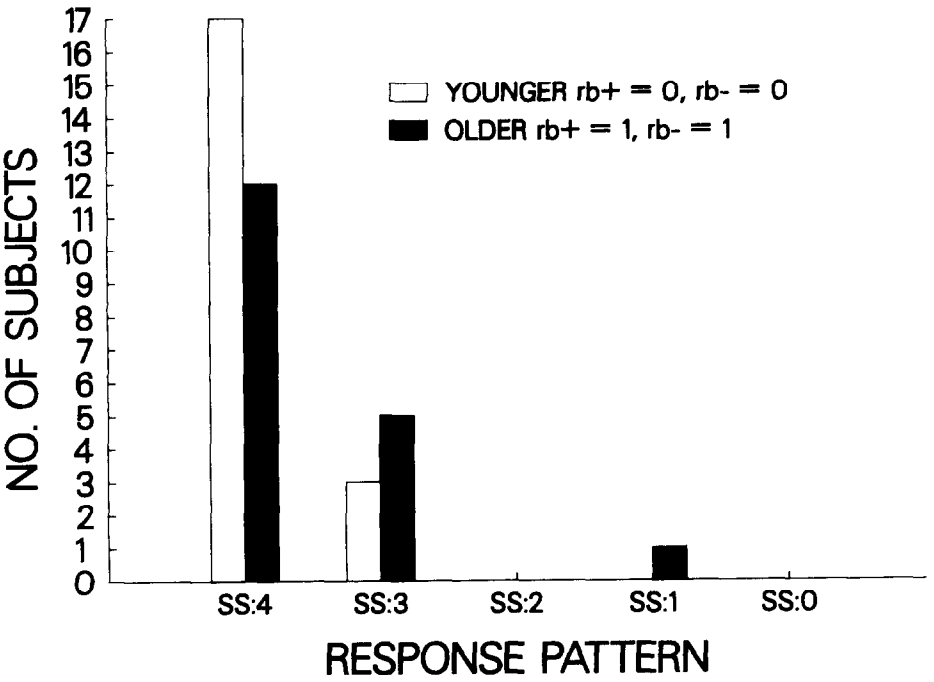
Figure 1. *Categorization patterns obtained for semantic and syntactic cues in conflict (experiment 1).*



Accord vs. Conflict

The purpose of comparing results in the accord and conflict conditions is to determine whether the ineffective semantic cue is totally superfluous, or if it has some secondary role in category assignment. Results for the accord condition are shown in Figure 2. Response patterns are coded SS:4 ... SS:0 according to the number of responses in the direction predicted by both semantic and syntactic cues. Comparing this figure with Figure 1 for the conflict condition, it can be seen that responses here were certainly more consistent. Thirty-seven of the 40 subjects produced SS:4 or SS:3 patterns with fewer response biases (2 vs. 13). The response biases and equivocal patterns in the conflict condition thus appear to be a consequence of the fact that semantic and syntactic cues were in conflict. In other words, the conflicting cues did cause some children to fail to respond consistently on the basis of one set of cues. Separating this effect for the two age groups, it was found

Figure 2. *Categorization patterns obtained for semantic and syntactic cues in accord (experiment 1).*



that the decrement was only significant for the younger group (Younger: $p < .01$; Older: $p < .2$, McNemar test).

Discussion

The main result for this experiment has shown that when children are able to consistently respond on the basis of either semantic or syntactic cues, they overwhelmingly categorize on the basis of the syntactic context. That is, the type of determiner is a much more effective cue to categorization than the semantic properties of the referent. However, this does not mean that there was no effect of the semantic cue. Subjects were much more consistent in their responses when there was no conflict between cues. This result appears to support Brown's (1957) finding that children do know the correspondence between referential properties and subcategorization. However, since those

referential properties never predominated in category assignment in the conflict condition, they do not appear to be the essential basis for the representation. In the previously introduced terminology, it could be proposed that the count/mass distinction is *essentially* syntactic but not *exclusively* syntactic. In other words, this is not the same as the case of gender acquisition. However, neither is it a case of the child having a different kind of representation from the adult in essential respects. These results do not support the claim that what the child has represented for the count/mass categories is some kind of object/substance distinction. What they do suggest is that most children use syntactic cues as a basis for category assignment. However, when discreteness of perceptual form conflicts with discreteness in quantification, this leads to a certain amount of inconsistency in responding.

In this experiment, the semantic and syntactic cues were always presented together. In order to support the present conclusions, it would be useful to examine children's ability to assign nouns to count/mass subcategories on the basis of a single cue. This would give a cleaner indication of the comparative effectiveness of each of the cues. The prediction here is that syntactic cues presented alone should be a more effective basis for category assignment than semantic cues alone. However, since it has been suggested that semantic cues have a secondary role in category assignment, then the child should also be able to use them in determining subcategorization. If the semantic hypothesis is maintained, not only should semantic cues alone be used, but they should be far superior to syntactic ones. These predictions will be tested in the next experiment.

A further issue to be examined concerns the effects of quantity differences. It will be recalled that in the accord condition, *a garn* denoted a single object. In the conflict condition, *some garn* denoted a group of objects. Notice that simply having this difference in number gives the child a partial cue to subcategorization. Consider if one were to use a neutral determiner that gives no cue to subcategorization such as *the* (cf. *the car*, *the water*). If *the garn* were used to refer to a group of objects, then the noun could not be a count noun since, in its singular form, a count noun must usually denote an individual. However, in the case of a mass noun, *the furniture* would tend to denote more than one object. It is possible, that subjects could have been basing their subcategorizations on these simple quantitative differences. If so, then subcategorization would not be "syntactic" in the sense of being contingent on the selectional properties of determiners. Therefore, the next experiment will examine to what extent children are able to subcategorize purely on the basis of numerical cues.

Experiment 2

Introduction

The present experiment has two aims. The first is to compare the effectiveness of semantic and syntactic cues in isolation, second to examine whether children are able to subcategorize nouns given no semantic or syntactic cues, but only quantitative differences in stimuli.

Isolated syntactic and semantic cues

In order to provide an isolated cue for subcategorization, it is necessary to neutralize the alternative cue. For syntactic cues, this is fairly straightforward: one can simply employ a determiner that does not exclusively select for either count nouns or mass nouns. For example, *the garn* provides no cue as to whether *garn* should be count or mass.

To neutralize the semantic cue requires a referent that is somewhat indeterminate with respect to whether it should be considered an object or substance. The most common class of such entities is food. That is, while most food items start off as discrete wholes (e.g., beans, rice, carrots), in their functional use they become ground up into non-discrete entities. Consequently, there is considerable variance in count/mass assignment among food names that appears to have little to do with perceptual appearance (consider the following count vs. mass pairs: *carrots* vs. *celery*, *beans* vs. *rice*, *onions* vs. *lettuce*). It was decided to use beans as the referent for the nonsense term in neutralizing semantic cues. Although *bean* is a count noun, there are many similar food items such as rice and corn whose names are mass nouns. The beans themselves were dyed in unusual colors, were given nonsense names and subjects were told that they were "Martian food".

The predictions that follow from the findings of experiment 1 are clear. If it is the case that the count/mass distinction is essentially syntactic for young children, then while semantic cues alone should be a possible basis for subcategorization, their effectiveness should be less than for syntactic cues in isolation. Alternatively, if children's categories are in fact semantic, then the semantic cues should be more effective.

Isolation of quantitative cues

The second problem addressed in this experiment concerns the effects of having singular vs. plural referents. Quantity was isolated as a cue to subcategorization by neutralizing both the semantic cue (i.e., by using bean

referents) and the syntactic cue (i.e., by using *the* as determiner). Thus, there were two conditions: One in which *the garn* denoted a single bean (count noun), and the other in which a collection of beans was denoted (mass noun). To show that this is not a critical factor in children's subcategorization, quantity cues in isolation should not be as effective as syntactic cues alone.

Method

Subjects

There were initially 45 subjects, none of whom had participated in experiment 1. Six were not included in the final analysis thus leaving 39 subjects ranging in age from 3;0 to 5;11 (mean age 4;5). Twenty-two were female, 18 were male; all were native speakers of English, mostly from middle-class families. For comparisons with experiment 1, it should be noted that while the number of subjects was almost the same, the age range was extended slightly. Mean age was more or less comparable (4;5 vs. 4;3).

Materials

Materials included three sets of substances each in four test-tubes, and three sets of object stimuli. These were the same as in experiment 1. In addition, there were six quantities of California beans dyed in various colors. These were stored in transparent plastic beakers. The nonsense figures, water, pennies and the robot from experiment 1 were also used.

Procedure

Training was identical to experiment 1 using index cards and the robot. There were three main conditions: *Semantics Alone*, *Syntax Alone* and *Quantity Differences*. The relevant semantic, syntactic and numerical cues are summarized in Table 1. In each of the main conditions there were four items. Two of these had potential cues for count subcategorization and two for mass. In most respects presentation was identical to experiment 1. Children were shown the stimulus, were told its name using the appropriate linguistic context, and were required to do a sentence completion ("Over here we have more ... What?"). Presence or absence of the plural indicated count or mass subcategorization respectively.

However, it was necessary to make a slight change in the procedure because the definite article was being used in some cases. It would be pragmat-

Table 1. *Stimuli and linguistic contexts used in syntax, semantics and quantity conditions in experiment 2*

	Condition	Stimulus	Linguistic context
Syntax	Count:	bean ($n = 1$)	a X
	Mass:	beans ($n > 1$)	some X
Semantics	Count:	object ($n = 1$)	the X
	Mass:	substance	the X
Quantity	Count:	bean ($n = 1$)	the X
	Mass:	beans ($n > 1$)	the X

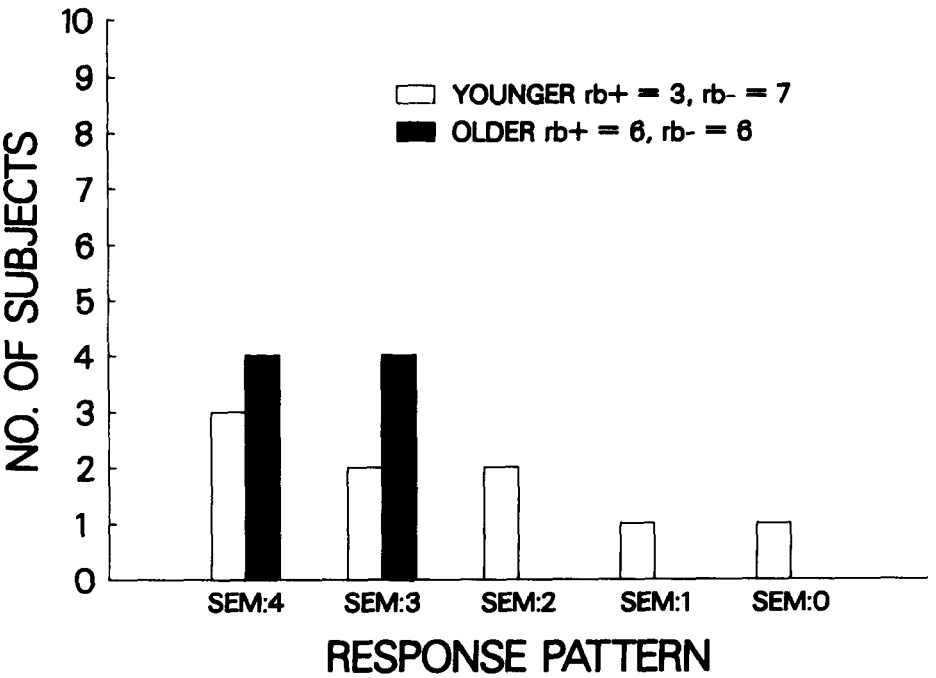
ically inappropriate to refer to a presented object as *the garn* if there had been no previous mention of it or if it was not being contrasted with something else. Subjects were therefore presented with two different items at once. This provided a contrastive sense for the definite article. Thus, they were shown either two objects or two substances and were told: "This is the garn, and this is the turp"—pointing to each of the items in turn. The experimenter then ran the rest of the test on each of the items: "... so this is the garn, can you say garn? Well over there we have more ... What?" This was followed by the same procedure with *turp*.

As in the last experiment, water in test-tubes and pennies were used as controls. This time however, their names were modified by *the* (i.e., *the water/the penny*) rather than *a* and *some*. For half the subjects, main test items using object/substance stimuli were presented first, and those using beans were presented last. For the other half, this order was reversed. Within these partitions, order of presentation was randomized in four predetermined sequences. Groups of subjects assigned to the various orders were balanced for age and sex. Training and control conditions again preceded the main items.

Results

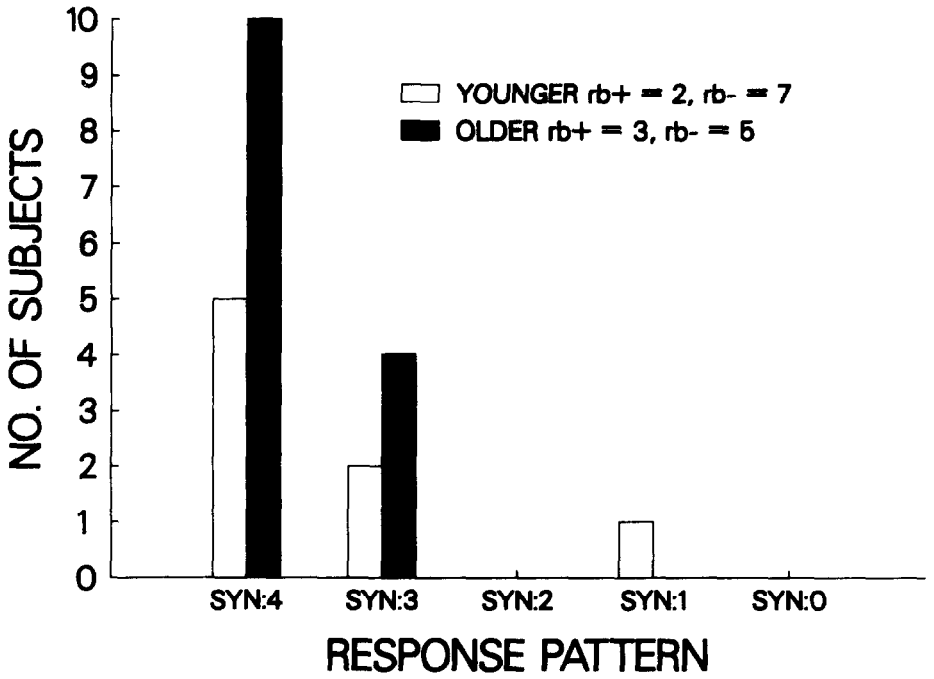
A total of 5 subjects were disqualified on the basis of failing to reach criterion on the training phase. Another subject was eliminated for pluralizing *water* in the control condition. Otherwise, a total of 39 subjects were retained. For purposes of age-trend analysis, subjects were divided into two groups. The younger group contained 19 subjects ranging from 3;0 to 4;5. The older group of 20 ranged from 4;6 to 5;11.

Figure 3. *Categorization patterns obtained with semantic cues alone (experiment 2).*



In addressing the first question, results for the Semantics Alone and Syntax Alone conditions are shown in Figures 3 and 4 respectively. Response patterns are coded in the same manner as experiment 1: SEM:4 ... SEM:0 for the semantics conditions and SYN:4 ... SYN:0 for the syntax condition. Bars on the left indicate consistent responding on the basis of the relevant cues. Those on the right indicate patterns inconsistent with the relevant cues. As predicted, subjects were able to employ semantic cues as a basis for category assignment. The pattern in Figure 3 shows a significant bias toward SEM:4 and SEM:3 patterns ($\chi^2 = 12.1$, $p < .005$). In the syntactic condition, the trend in Figure 4 also showed a significant bias favoring syntactic patterns ($\chi^2 = 33.8$, $p < .001$). Comparing the two graphs, it seems that the syntactic condition produced more patterns consistent with the relevant cues and that there was more polarization toward fully syntactic patterns (SYN:4) than to fully semantic patterns (SEM:4). The difference between the distributions did not quite reach significance (McNemar, $p = .07$). However, a closer inspection of Figure 3 shows that it was only the older subjects who were able

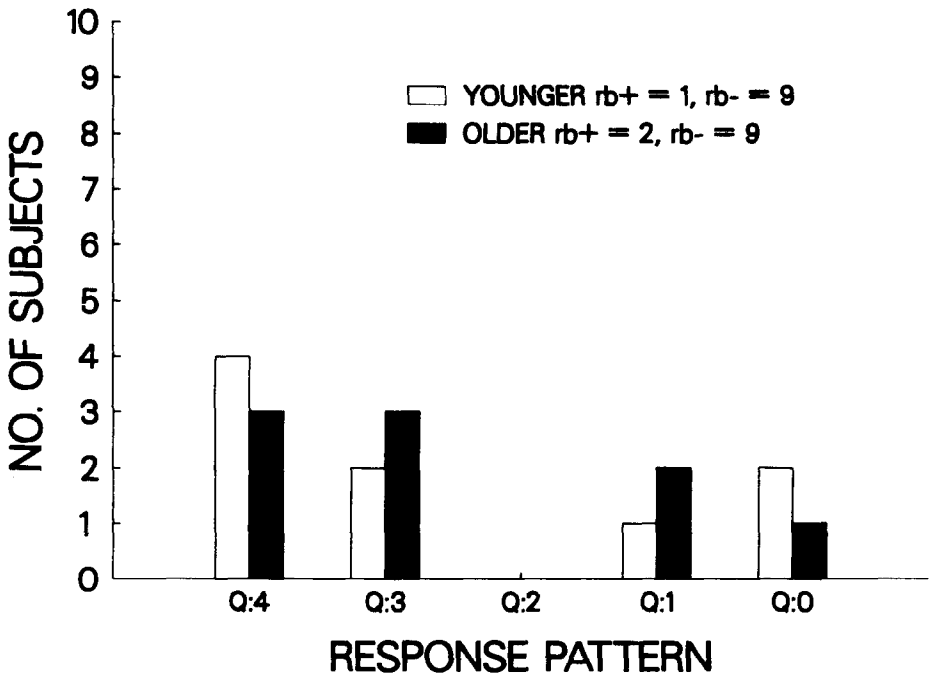
Figure 4. *Categorization patterns obtained with syntactic cues alone (experiment 2).*



to use the semantic cues as a basis for category assignment, whereas the younger subjects appear quite random. Binomial analyses of these results bear this out (younger: $p = .124$, older: $p = .0026$). On the other hand, syntactic cues were used by both older and younger subjects for category assignment (younger: $p < .001$, older: $p < .0001$).

The second question was addressed to the issue of whether children could use differences in quantity as the only cue for subcategorization. The relevant data for the quantity condition are shown in Figure 5. Again, there was a significant bias favoring responses based on quantity cues ($\chi^2 = 9.77$, $p < .01$). While this result suggests that children are indeed sensitive to the fact that differences in quantity can signal noun subcategorization, the distributions are much less clear-cut than those for semantics or syntax. For example, there are a substantial number of patterns in opposition to those predicted (Q:1 and Q:0). Since there is no reason to expect such patterns, they suggest that there was a fair amount of responding in this condition. Comparing these data with those for syntactic cues, it was found that subjects produced many

Figure 5. *Categorization patterns obtained from differences in quantities (experiment 2).*



more response patterns consistent with syntactic cues (Figure 4) than with quantity cues (Figure 3) (McNemar, $p < .05$). This suggests that children do indeed use selectional properties of determiners as a basis for category assignment and not simply numerosity. This is hardly surprising given the rather tenuous nature of quantitative differences as a cue to subcategorization.

Discussion

The results of this experiment generally support the claim that the count/mass distinction is essentially, but not exclusively syntactic. While some children are able to use semantic cues as a basis for subcategorization, such cues appear to be less effective than syntactic cues such as determiner type. It is quite significant that only the older subjects as a group showed significant ability to subcategorize using semantic cues alone. This clearly speaks against

the claim that children start out semantic and shift to a syntactic basis. If anything, the opposite conclusion seems more warranted. That is, in the early stages, only syntactic cues appear to be effective in category assignment. However, it should be remembered from experiment 1, that a combination of the two cues is, nevertheless most effective for both younger and older children. The quite bad performance of the younger subjects with semantic cues is quite surprising, given the enhancing effect in the accord condition of the previous experiment. It would appear that the semantic cues are only truly effective in a parasitic sense of relying on a syntactic base.

Finally, it would appear that syntactic subcategorization clearly is a function of the selectional properties of determiners specifying count vs. mass. The results from this and the previous experiment do not simply reflect an artifact of the differences in the number of stimuli used.

The experiments so far have led to fairly clear conclusions about the nature of category assignment in these children. From the present evidence it appears that the nature of the child's representation is not of a semantic nature. That is, the representation of the count/mass distinction appears to be qualitatively similar to adults. It is based not on the semantic notions of object and substance but on syntactic properties relating to role that count nouns and mass nouns play in syntactic construction.

Let us consider some possible objections. First, the tests that were used involved teaching children large numbers of nonsense words. Such tasks could not be a true simulation of the word learning situation. Second, one often finds that responses made by children using nonsense forms often do not reflect their genuine productive ability with real words (cf. Berko 1958; Levy 1983a). While these criticism are valid, I think they are defensible. There certainly is an air of artificiality in the test situation. However, to some extent, word learning for the child must resemble hearing nonsense words, although perhaps not as many at the same time. It may well be more "ecologically valid" to test each child with just one item in a more natural situation. However, this would make it impossible to obtain a pattern of responses indicating the nature of the individual child's representation. The second criticism is, in many ways less relevant. If differences are found between productive use of nonsense words and real words, that difference invariably shows a less mature use of nonsense words. For example children tend to be delayed in producing inflected forms on nonsense words when compared to real words.

In the present experiments however, lack of competence was not at issue. Children behaved as if they had adult-like (i.e., formally based) representations. If anything, the present results probably underestimate the degree to which children are like adults with respect to the nature of their categories.

Another point to be made is that the training procedure was specifically included to ensure that subjects were up to par in their production of plurals on nonsense forms. That is, no child continued in the experiment unless he had produced nonsense word plurals on three consecutive training items. Evidence for the effectiveness of this training can be seen in the very consistent manner in which children pluralized in the *Accord* condition of experiment 1 (see Figure 2).

There is a third, more serious problem. The youngest children in these experiments were 3;5 for experiment 1 and 3;0 for experiment 2. It may be the case that the shift from a semantic to a syntactic basis has already occurred by this age, and that the semantically based representation occurs prior to 3 years of age. On any account, one cannot extrapolate from the present findings downwards to a younger age range. Thus, the interpretation of these results must be restricted to the age range studied (3 to 5 years). The reason that younger children were not tested is that the task is basically too difficult for 2-year-olds. Therefore, a further study was designed in order to test much younger children. At the same time, it is possible to deal with residual objections to the use of nonsense words as a basis for assessing real language categories. In the next experiment children as young as 2-years-old were assessed on the basis of how they subcategorized real words whose semantic properties were either inappropriate or indeterminate with respect to the semantic correspondence between count/mass and object/substance.

Experiment 3

Introduction

In the conflict condition of the first experiment children were taught nouns that were "inappropriately" subcategorized according to semantic criteria. Thus, when *some garn* denoted a set of objects, this was in many ways comparable to the situation in which one would talk of *some furniture*, since *furniture* similarly denotes a class of objects rather than substances. What happens when the child, in real life actually has to subcategorize nouns such as *furniture*? The prediction on the semantic categories hypothesis is clear. *Furniture*, *silverware*, *jewelry* and other "inappropriately" subcategorized nouns, should be miscategorized as count nouns. Before testing this prediction, it was first ascertained whether subjects had such nouns in their vocabulary, since none of them are of high frequency. This was done using a picture verification task. The same measure of pluralization was used to determine subcategorization assignment.

Four kinds of nouns were examined in this experiment. These included:

(1) Mass Superordinates: *furniture*, *jewelry*, *silverware*. These should be miscategorized as count nouns on the semantic hypothesis since they denote classes of objects.

(2) Count Superordinates: *toy*, *pet*, *flower*. These should be categorized correctly since they also name discrete objects.

(3) Mass Food Terms: *fruit*, *lettuce*, *rice*, *celery*.

(4) Count Food Terms: *vegetables*, *onions*, *beans*, *carrots*.

In the case of (3) and (4), the nouns are food terms which, as mentioned previously, tend to be somewhat indeterminate with respect to semantic properties. That is, there is a certain ambiguity as to whether they should be considered objects or substances due to the fact that they tend to be transformed from one to the other in their functional use. Depending on how the child construes food (i.e., as objects or substances), one should again find some proportion of erroneous subcategorizations.

On the alternative hypothesis whereby noun subcategorization is on the basis of syntactic properties, the only barrier to perfect subcategorization for any of these noun classes is if the child has not heard the noun used in a defining linguistic context. Given that such problems should be equally likely to arise amongst the four classes of nouns, no differences are predicted in the frequency of miscategorization errors.

Method

Subjects

Subjects included 40 children aged: 1;11 to 5;9. There were 10 subjects at each of the ages: 2, 3, 4 and 5 (one subject who was 1;11 was included with the 2-year-olds). All were native speakers of English, most were from middle class families. None had participated in experiments 1 or 2.

Materials

Materials included a series of small stores about 5 × 7 × 4 inches. These included: Furniture, Silverware, Jewelry, Toy, Flower and Pet stores. A larger food store had a removable front with detailed counters, shelves and boxes of food inside. The boxes of food contained small toy food made from clay. The food included: carrots, celery, onions, lettuce, beans and rice.

Also, one counter contained miniature fruit. A series of index cards with pictures of machines on them, was used for training sessions. The machines included: coffee, juice, lemonade, milk, gumball, cookie, sandwich and peanut machines. A small Paddington Bear was used as the subject of the story. For the pre-test, a series of eight picture cards was used. These were each divided into quadrants with one target picture and three distractors. The target pictures were of the nouns to be tested in the main items.

Procedure

In the present task, subjects were required to respond with nouns that might be unfamiliar to them. In order to determine whether a child knew the nouns to be tested, a pre-test was administered about a week in advance of the main test. In this task, the child was shown a set of cards, each with four pictures on them and was asked to point to the picture of the relevant noun (e.g., *furniture*, *celery*). This was done for all nouns in the main items. The child was credited with knowledge of the word if he chose the correct picture. If a wrong choice was made, his data for that item were not included in the analysis.

From the results of the previous experiments, children appear to be able to use syntactic cues for assigning nonsense words to their subcategories. Since this was designed not to be a word-learning task, it was important not to provide the child with any such cues. Therefore it was necessary to devise a context in which the child received no determiner, inflectional or quantity cues. This was done by using noun compounds such as *furniture store*, *toy store*. As the test noun is not the head of the compound in this construction (see Williams 1981), it is not modified by the determiner, receives no inflection, and does not determine the quantitative properties of the referent.

The context for testing the main items involved a story with a toy Paddington Bear. Subjects were told that Paddington had to go to the food store to get some food. A series of small stores was lined up in front of the subjects with the food store at the end, thus requiring that Paddington pass all of the other stores on the way. As he passed each store, the subject was told:

> E: ... next he came to a (furniture/toy) store. Do you know what you get in a (furniture/toy) store?
> ANS: (Furniture/Toys)

Thus the task was extremely simple. All that the child had to do was to provide a one-word answer. The form of the noun could either be singular (mass) or plural (count). A miscategorization error consisted of either

pluralizing a mass noun (e.g., "furnitures"), or not pluralizing a count noun (e.g., "... what do you get in a toy store?"–"Toy"). There were six stores whose names were the superordinates to be tested (*furniture*, *silverware*, *jewelry* [mass]; *toy*, *pet*, *flower* [count]). The seventh store was the food store whose front lifted away, revealing various food items. On "entering" the food store, the child was shown the fruit section and the vegetable section and was asked for each of these:

> What do they have in the *fruit/vegetable* section? (ANS: *fruit/vegetables*).

Next the subject was shown a series of boxes containing the relevant food items to be tested (e.g., carrots, celery). For each of the food items, the subject was tested in a similar manner, substituting *box* as the appropriate head noun of the compound (e.g., "What's in the celery box?").

Before receiving the main test items, subjects were given a training session with pictures of various machines (see Materials section). The names of the machines included four count nouns (*gumball*, *cookie*, *sandwich*, *peanut*) and four mass nouns (*coffee*, *juice*, *lemonade*, *milk*). The subject was shown the picture of the machine and was told:

> E: this is a (gumball/lemonade) machine. What do you get in a (gumball/lemonade) machine? [ANS: Gumballs/lemonade].

Subjects were given all eight of the training items prior to testing on the main items in order to get them familiarized with the general procedure. If there was any hesitancy or irrelevant responding, the subject was encouraged to provide an appropriate response and feedback was given if necessary.

To summarize, there were four sections to the experiment: Pre-test, Training, Stores and Food. If a child failed on a particular item in the pre-test, the item was still included in the main test, but the data for the unknown word were not included in the analysis. Conditions were always presented in the above order, but within each condition, items were presented in one of four predetermined random sequences. On the main items, count/mass subcategorization was indicated by the presence or absence of a plural on the noun.

Results and discussion

As a preliminary, the data from this experiment will be presented in terms of how they are distributed with respect to: (a) Correct Responses (pluralizing

Table 2. *Distribution of responses in experiment 3*

	Fail pre-test	Pass pre-test		
Age (years)		Correct	Error	NR/IR
2	0.28	0.37	0.05	0.29
3	0.06	0.76	0.03	0.15
4	0	0.91	0.08	0.01
5	0	0.94	0.05	0.01

count nouns but not mass nouns); (b) Miscategorization Errors (pluralizing mass nouns or not pluralizing count nouns); (c) Non-Responses/Irrelevant Responses (NR/IR); and (d) Failures on the Pre-Test. This is to give the reader an indication of what proportion of the data were usable and to what extent errors were being made. One general difference between the predictions here is that the semantic account should predict a large proportion of miscategorization errors since only the Count Superordinates (*toy*, *flower*, *pet*) provide the child with appropriate, unambiguous semantic information.

The distribution of the data for the four age groups is shown in Table 2. For 2-year-olds and, to some extent 3-year-olds, a large amount of data is lost to failures on the pre-test or the NR/IR category (57% for 2-year-olds, 21% for 3-year-olds). It is simply very difficult to test children of this age. However, within each age group, there were 140 possible responses. Therefore, even with the 2-year-olds there were a total of 59 usable responses. For 4- and 5-year-olds, the responses were much easier to obtain, and thus there were very few discards.

Errors were in fact, very few and far between rising to only 8% for the 4-year-olds. When the error rate is adjusted for discarded responses, the level reaches only 12% for 2-year-olds and 4% for 3-year-olds. However, it is important to determine how these errors are distributed among the four noun types: Mass-Superordinates, Count-Superordinates, Mass-Food Terms and Count-Food Terms.

Error rates for the four noun-types are given in Table 3. The error rate for each of the conditions was calculated as the number of errors divided by the number of non-discarded responses (i.e., errors + correct responses). Discarded items included: non-responses (NR), irrelevant responses (IR) and those items where children failed to choose the correct picture on the pretest.

Table 3. *Error rates for superordinates and food names in experiment 3. (Absolute values in parentheses)*

	Superordinates		Food names	
Age (yrs)	Mass	Count	Mass	Count
2	0	0.06 (1)	0	0.30 (6)
3	0	0	0.06 (2)	0.06 (2)
4	0.14 (4)	0.10 (3)	0.02 (1)	0.07 (3)
5	0	0	0.10 (4)	0.02 (1)
Total	0.07 (4)	0.04 (4)	0.05 (7)	0.09 (12)

Mass-Superordinates

On the semantic hypothesis, these nouns should have the largest proportion of miscategorization errors because the semantic properties should indicate count noun subcategorization. That is, one should find large numbers of errors in which children responded by saying **furnitures* rather than *furniture*. The data in Table 3 fail to support this prediction. In fact, only 4-year-olds made such errors. Even then, they also made an equivalent number of errors on the Count-Superordinates, where none are predicted. Of the 2-year-olds, one child did say **a furniture* suggesting that he might have miscategorized *furniture* as a count noun. However, on closer inspection, it was clear that the use of *a* did not indicate count noun subcategorization for him. It will be recalled that on the training items, children were asked what one gets from lemonade machines, candy machines and so on. His responses on the training items included such constructions as: "a juice", "a lemonade" and "a milk". In fact, nearly all of his nouns in the test were preceded by "a". Since *juice*, *lemonade* and *milk* name prototypical substances, it is clear that this subject was not using a semantic strategy and the error on *furniture* should not be interpreted in terms of miscategorization.[3]

The only possible support for the semantic hypothesis with respect to Mass-Superordinates is in regard to the number of discards in this category. In fact, for the 2-year-olds, some 70% of the items were discarded in this condition, mostly due to failures on the pre-test. This compares with 56% for the Count-Superordinates. Why should Mass-Superordinates lead to so many discards?

[3]Since use of *a* was uninformative for this subject, it was decided not to count responses of the form *a* as indicating count subcategorization in the other two cases where it was used. Instead, they were categorized as NR/IR.

There does not appear to be a natural prediction on either hypothesis that would lead to this result. Although one could hypothesize that mass superordinates are harder to learn, the question is, what makes them harder? If it is the fact that they are subcategorized inappropriately, then this would suggest that the child does pay attention to syntax, sees the conflict and somehow decides not to learn that word.

While such a state of affairs is possible, there is an alternative account. The Mass-Superordinates used were of lower frequency than the Count-Superordinates, and 2-year-olds may simply be less likely to know them. This is suggested by the fact that, for the Mass-Superordinates that were discarded, 83% were discarded because the child failed to identify the appropriate refer ent in the pre-test. For the Count-Superordinates, on the other hand, the figure was only 47% and the majority of discards were due to NR/IR responses. Thus there was a much larger proportion of discards due to pre-test failures for the lower frequency mass nouns. To test the possibility that frequency is the important variable, a Spearman Rank Correlation Coefficient was calculated on attrition rate (failure on pre-test + NR/IR) and Frequency (calculated from Kucera and Francis 1967) for each of the Count- and Mass-Superordinates. The resulting correlation coefficient was extremely high ($r = .94$, $p = .01$). This is particularly strong evidence for a frequency explanation because *furniture* was of relatively high frequency, and consequently was less prone to attrition than *silverware* or *jewelry*. Thus, it did not appear to be the case that the fact of being inappropriately subcategorized, in itself, caused attrition.

Food terms

For food terms, the error rates were again very low (see Table 3). The only rate of any significance occurred for the 2-year-olds on the count nouns (*vegetables, carrots, onions, beans*). Even on these items, the subjects were 70% correct. Comparing the error rate for the count and mass food terms, there was a significant difference across all subjects (Wilcoxon, $T = 20$, $p < .05$, 2-tail), although the difference was not significant when only the younger, 2- and 3-year-olds were considered (Wilcoxon, $T = 3$, $p > .05$). The error rate for count food terms was also not significantly greater than for count-superordinates (Wilcoxon, $T = 3$, $p > .05$)—a difference one would predict on the semantic categories hypothesis. It is also of interest that on the training stimuli, for the 2-year-olds there was a very similar pattern of errors: 29% for count nouns, and 0% for mass nouns.

Why were the 2-year-old's errors for the food terms, the superordinates and the training items all on count nouns? Taking the food terms alone, it

could be argued that errors on at least some of them are predicted on the semantic account. However, it is not at all clear why the count nouns should be singled out. It may be that, for some reason, children construe carrots, beans, and onions as substances rather than objects. However, the state in which they were presented as stimuli, did not lend itself to such an interpretation. That is, they were presented as discrete objects, not as ground up substances. Therefore, the semantic account would more naturally predict that the greatest number of errors would be on the mass nouns. Furthermore, such an account would not explain the fact there was an across-the-board uniformity in the fact that only count nouns received erroneous responses among 2-year-olds.

There is a much more mundane explanation. Two-year-olds are not completely perfect at pluralizing. The count nouns required use of the plural for a correct response. It seems quite likely that purely morphological errors of omission can be invoked to explain the fact that count nouns caused more errors than mass nouns. While it is puzzling that there were fewer errors on the Count-Superordinates than on the count noun food terms, the difference was not significant. Such an account provides a clear explanation for the fact that only count nouns caused errors.

The one difference in error rates found, thus appears to have a logical explanation in terms of morphological problems. None of the results for this experiment show any convincing evidence to support the claim that children represent their count/mass categories in terms of an object/substance distinction. These conclusions are very clear for the 3- to 5-year-olds, and, moderately supportive for the 2-year-olds. Some caution is warranted in interpreting the data for 2-year-olds since a significant number of items were discarded. However, the number of data points actually used was quite respectable. Given these provisos, the present experiment appears to lend support to the conclusions of the previous experiments. The use of real words versus nonsense words does not seem to be an issue. As young as it is possible to test children on such a task, the results appear to point in the same direction: count/mass categories are not represented in terms of an object/substance distinction.

General discussion

In the three experiments reported here, it has been consistently found that there is no support for the claim that children represent the count/mass distinction in terms of a distinction between objects and substances. To be sure, the semantic properties do appear to be significant, and children appear to

know that there is a correlation between semantic type and syntactic category. However, the extent to which the semantics plays a role, appears to be quite modest. I have characterized the representation as being *essentially* syntactic. That is, the core of the categories has to do with their role in sentence construction and quantification—just as it is in the adult grammar. Children do not appear to hold that the essence of the count/mass distinction has to do with what kinds of things are denoted. However, the categories are not *exclusively* syntactic. Semantic correlates are perceived, unlike the case of gender. However, they do not appear to be crucial in the process of assigning new nouns to their subcategories (experiment 1), they cannot be used as the sole basis for category assignment by younger subjects (experiment 2) and they do not appear to cause children to miscategorize nouns that possess inappropriate semantic properties (experiment 3).

These experimental findings are corroborated by longitudinal analyses of free speech data from two children aged 1;9–3;6 and 2;3–3;5 (Gordon 1982b).[4] In these studies it was again found that there was no support for predictions based on the hypothesis that children's count/mass categories are acquired as an object/substance distinction. There was no consistent evidence of miscategorization errors for nouns that were inappropriate or indeterminate with respect to semantic properties. In fact, the only significant finding across subjects was that count nouns that did not denote prototypical objects (e.g., food names, abstract nouns) were used more frequently in linguistic contexts strictly requiring count nouns (e.g., *a X*, *another X* etc.). Again, such results speak strongly against the semantic categories hypothesis.

Thus, the results of both experimental and naturalistic investigations appear to agree in failing to provide any support for the semantic categories hypothesis. One problem remains however. The youngest children it was possible to test were 2-year-olds, and the youngest age at which transcripts were taken for the longitudinal data was at 1;9. While this is certainly within the age-range that many researchers would have proposed for a semantically-based representation, it could still be argued that it is too old. No one, to my knowledge, has ever been specific about when they think there is a shift from semantically based to syntactically based representations (except with regard to claims concerning grammatical relations—see Marantz, 1982). However, many have cited results from studies of 2-year-olds in support of their claims. It is conceivable though, that the time period during which the count/mass distinction is semantically based is simply below the age of the children in the present studies.

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[4]These data were originally collected by Wick Miller and Susan Ervin-Tripp and were kindly made available by the latter (see Miller and Ervin, 1964 for details of the corpora).

The problem now becomes whether the claims of the semantic categories hypothesis are at all testable. For example, below about 2 years of age, children are simply not using much syntax that would indicate whether a noun is count or mass. It would thus be impossible to use production data as a basis for assessing noun subcategorization. However, Katz, Baker and Macnamara (1974) have shown that girls as young as 17 months are able to use the presence or absence of a determiner in their input as a basis for categorizing a nonsense word as either a proper or common noun (see Macnamara, 1982, Gelman and Taylor, 1984 for replication and extensions). Thus, measures of comprehension may show a more advanced analysis when compared to production. At this point, I shall have to leave open the possibility that there is a period when the count/mass distinction is based on an object/substance distinction, but that this period only lasts for a short time. Given the present results, I find this quite unlikely. There is no evidence from these or other studies that there ever is such a period. Furthermore, the fact that it was only the older children in experiment 2 who were able to use semantic cues for category assignment, suggests that the ability to subcategorize semantically is a characteristic of advanced rather than early development.

In considering the question of semantic categories more generally, it might be suggested that the Katz *et al.* (1974) study, mentioned previously, shows an early semantic basis for the proper/common distinction. The subjects of these studies were shown either a doll or a box, and were told that it was either "a sib" (common noun) or "sib" (proper noun). A second doll/box was also on hand, and, after a short play session, the child was asked to get "a sib" or "sib". In the case of the proper noun naming a doll, subjects were more likely to choose the same doll. However, when a common noun was used for the doll, either doll was likely to be chosen. In the case of the box, subjects chose either box in both conditions. There was no preference to choose the same box in the proper noun condition.

Do these experiments show that children initially represent the proper/common distinction in terms of something like a person/non-person distinction? The crucial point here is that the box did not receive a proper noun interpretation whereas the doll did. However, notice that the linguistic context (no determiner) does not serve to uniquely identify the noun as a proper name. For example, it could be a mass noun (cf. "this is cardboard"). Furthermore, given that a 17-month-old child probably has not completely analyzed her language, it may not be at all clear what subcategories are allowed without determiners (this is certainly suggested by their production data—see Gordon, 1982b). What, in fact, is a proper noun? It is a noun that denotes a *unique* individual. Thus, besides naming animate beings, proper nouns can also name places (Boston), automobile manufacturers (Ford),

computer languages (LISP) and security blankets. The semantics of proper nouns has to do with *quantification*, not with persons or non-persons. In other words, the situation is parallel to the case of the count/mass distinction. The Katz *et al.* study does not indicate that the child is in any way different from the adult in this respect. In fact, in a pilot study, Susan Gelman and Majorie Taylor (personal communication) found that adults also did not treat boxes as having proper names, and produced similar results to children in this respect.

It has been repeatedly stressed in this paper that I am not addressing the question of whether semantics, in general, is important to category acquisition. Rather, the point of the studies is to examine whether the categories are referentially defined for the child (in terms of object, substance or whatever). In essence, the question is: Does the child make *false* assumptions about the semantic nature of categories? This is quite distinct from the question that asks: Do children *correctly* interpret the semantic function of a category? In the former case, the child has a qualitatively distinct representational format from the adult. In the latter case, the formats arer qualitatively identical. As I have suggested, semantic interpretation of a syntactic function is quite warranted in the case of a child who has syntactically-based categories. In fact, it would be extremely odd if the child learned the count/mass distinction but did not learn the role of the distinction with respect to quantification. Such a vacuous acquisition model could not account for how the child actually ends up knowing the semantic functions of the syntactic categories.

There may even be reason to believe that learning quantificational distinctions is crucial to acquiring the count/mass distinction. Consider the case of the Maratsos and Chalkley (1981) model. In this model, subcategorization would require the child to simply correlate occurrences of different nouns in different linguistic contexts and consequently induce the appropriate subcategories. As they note, not every noun appears in every relevant context in the child's input. For example, the child may never have heard anyone say: *another table*. In the Maratsos and Chalkley model the child would generalize use of *table* on the basis of having previously heard some expression such as *a table*, and also having heard both: *a car* and *another car*. Thus, generalization on the basis of category membership would allow for *another table* to enter as a grammatical expression. But consider the following case: If the child had heard *the car* and *the water*, what would stop him from generalizing on this basis and thus coming up with: **another water*?

The problem is, how does the child know how to cut the categorical cake such that only the right contexts allow for generalization? How does he know that generalization based on use of *a* is appropriate, but not on the use of

the? Furthermore, how does he know how many categories he is supposed to end up with? To get an idea of the extent of this problem, consider the possible NP contexts in which a noun may occur in English. Taking a list of simple NPs with single determiners and [± plural] one can arrive at about 33 contexts (see Gordon 1982b). With just these, an unconstrained learner would have to consider $\sum_{n=1}^{33} \binom{n}{33}$—over eight and a half billion (billion = 10^9)—possible subcategorizations. While there would probably not be an equal chance that all of these would be derived, it would be hard to guarantee that all children ended up selecting the same ones.

Thus, a semantically uninterpreted distributional analysis probably would run into problems. One solution is the traditional patch that assumes that categories are initially acquired by equating them with conceptual types such as object and substance. This claim receives little or no support from the present findings, although such a stage could occur at an earlier age. An alternative is to suggest that the appropriate quantificational distinctions provide the necessary cutting point for dividing the categories. The contexts that differentiate count and mass nouns in early child speech are those that transparently reflect individuation (e.g., *a*, *another*, numerals and plurals—see Gordon, 1982b, Chapter I). Let us suppose that these quantificational properties are induced by the child when learning the semantics of the relevant functors. This would then allow for the appropriate bifurcation of the noun category into those nouns that are individuated when quantified (count) and those that are not (mass). Notice that such a method does not require the child to recast the categories in terms of referential properties, only to recognize the proper function that the syntactic categories play in quantification.[5]

In suggesting that individuation might be a crucial factor in dividing the categories, I am not a retreating from claiming that the categories are syntactic, even though a good deal of semantics is required. What is crucial is that it is the right kind of semantics. In particular, that it is the semantic interpretation of the syntax, not some partially correlated referential distinction. Just as the present syntactic claim requires some semantics, it should also be remembered that the semantic account suffers similar impurities. There is no conceivable account whereby categories are *purely* semantic. For categories to be categories of any kind, they have to make a difference to the way

[5]Such a strategy would clearly not work for the case of gender since there is no equivalent semantic function for the distinction. Pinker (personal communication) has suggested that the child might use allomorphy as a basis for appropriately subcategorizing in this case. For example, *un* and *une* would be seen as functionally identical for French learners. Therefore a two-way subcategorization is indicated by the redundancy.

sentences are structured. Thus they must have some syntactic role. It simply doesn't make sense to say that a child has categories otherwise.

To summarize, the present findings consistently fail to support a claim that the count/mass distinction is represented in terms of an object/substance distinction early in development. It was conceded that the children tested might have been too old by the age of 2 to fully assess such a claim. There could conceivably be a short period in the second year of life where categories do have such a representational format. However, in laying out the problems that the semantic categories hypothesis was invoked to solve, I have tried to show either that they don't exist at the level of subcategories, or else they can equally well be solved by assuming a proper semantic interpretation of the syntax (in terms of quantificational differences). If simplicity were the only criterion left for choosing between the two positions, it would seem that an acquisition model that requires no change in representational format should be preferred over one that requires such a change. Unless there is some other reason for proposing that children have different kinds of categorial representations from adults (at least for the count/mass distinction), there seems to be little theoretical or empirical motivation for believing such a claim to be true.

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Résumé

On considère souvent que les catégories grammaticales sont acquises à travers les propriétés sémantiques. Dans le cas de la distinction dénombrable/non-dénombrable, les corrélations semantiques devraient prédisposer l'enfant à acquérir ces sous-catégories comme une distinction entre des objets et des substances. On a testé cette proposition au cours de trois expériences. Des enfants de 3 à 5 ans ont servi de sujets dans les deux premières expériences utilisant un paradigme d'apprentissage de mots dans lequel les indices sémantiques et syntaxiques étaient soit en conflit, soit en accord, soit isolés. Les résultats montrent que les indices syntaxiques sont nettement plus efficaces et prédominent les indices sémantiques pour fonder les sous-catégorisations. La troisième expérience, avec des enfants de 2 à 5 ans, montre que les enfants ne catégorisent pas de façon erronée les noms dont les propriétés sémantiques sont inappropriées ou indéterminées. Ainsi ils ne catégorisent pas de façon erronée un terme tel que "furniture" (mobilier) qui est un nom non dénombrable quoique dénotant une classe d'objets. Ces résultats suggèrent que la distinction dénombrable/non-dénombrable n'est pas acquise à travers une distinction objet/substance quoique les propriétés sémantiques de quantification sont probablement importantes pour les processus d'acquisition.