Categorization and Naming in Children: Problems of Induction

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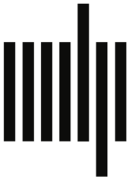

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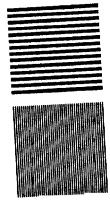

Chapter 9
Mutual Exclusivity

In this chapter I present a more complete discussion of the mutual exclusivity assumption, compare it to other similar assumptions, provide more direct evidence that children expect terms to be mutually exclusive, and draw some of the implications of the mutual exclusivity assumption for language acquisition.

The Mutual Exclusivity Principle

In chapters 7 and 8 I discussed one aspect of systematizing categories and organizing them in relation to one another, namely, the construction of category hierarchies. This kind of systematization focuses on overlap and inclusion among categories. There is also a complementary aspect of systematizing categories concerned with the relationships among catgories in general, but most especially with the relationships among categories at the same level of a hierarchy. This aspect focuses on differences or separation among the categories—exclusion rather than inclusion. The most extreme form of this emphasis on distinguishing categories from each other is to treat them as mutually exclusive. In this chapter I will examine the mutual exclusivity principle primarily with respect to word meanings (although at the end I will consider whether it is more properly viewed as a general principle of category formation and not just as a principle related to language).

Given the nature and function of category terms, they will tend to be mutually exclusive. Categories, especially the richly structured categories and natural kinds discussed in chapters 5 and 6, provide much correlated information about an object. Given an object's basic level category, for example, many properties are implicitly attributed to it. To be a member of more than one such category requires that two or more such richly structured sets of properties be attributable to the same object. A single object cannot be both a chair and a dresser or a table. A single object cannot be both a cow and a bird or a dog. Thus, in order for categories to be informative about objects,

they will tend to be mutually exclusive, especially at the basic level of categorization. Of course, there are exceptions: categories can overlap, as do "dog" and "pet," and they can form inclusion relations, as do "poodle" and "dog." The point here is that mutual exclusivity is a reasonable, though not infallible, assumptions to make. By assuming mutual exclusivity, children would avoid redundant hypotheses about the meanings of category terms, and in many cases would be correct.

Sometimes, of course, children would be led astray by assuming terms to be mutually exclusive. Adhering to this assumption, as I argued in chapter 8, would explain why children find class inclusion difficult (because it violates mutual exclusivity) and why the part-whole relation of collections is simpler (because it maintains mutual exclusivity). We expect, however, that children's lexicons will eventually include many violations of mutual exclusivity. To acquire class-inclusion relations, for example, children must override their initial tendency to assume that terms are mutually exclusive. With enough evidence to the contrary, children will allow multiple labels for the same object. Thus, violations of mutual exclusivity in children's lexicons are not necessarily evidence against this principle. The claim is that children should be biased to assume, especially at first, that terms are mutually exclusive, relinquishing that assumption only when confronted with clear evidence to the contrary.

Related Principles

Three closely related principles have been hypothesized to account for other aspects of language acquisition. I will briefly discuss two of these: Slobin's (1973) principle of one-to-one mapping and Pinker's (1984) uniqueness principle. Since the third—Clark's (1983, 1987) contrastive principle—is the most closely related to mutual exclusivity, I will consider it in greater detail.

One-to-One Mapping

One of Slobin's (1973, 1977) operating principles of language acquisition is that children expect the organization of language to be clear. That is, underlying semantic relations should be marked clearly and overtly. One way of accomplishing this is for languages to establish a one-to-one mapping between the underlying semantic structures and the surface forms. The one-to-one mapping principle was originally formulated for morphemes in a sentence. Extending this principle to category terms, however, would be tantamount to positing mutual exclusivity of the terms. That is, each category would be referred to

by only one category term. Mutual exclusivity is consistent with the one-to-one mapping principle and therefore would also be consistent with expectations that the organization of the lexicon would be clear.

Extending Slobin's principles of overt and clear marking of relations to the category domain provides another way of seeing why class-inclusion relations are difficult for children, relative to part-whole relations. As mentioned earlier, class membership and class inclusion are described by the "is a" relation regardless of the level of the hierarchy. For example, a particular object "is an" oak and "is a" tree. For the part-whole relation, a different relation is used at each level. A given object "is an" oak but "is part of" a forest. Using two distinct relations should be a clearer and more overt way of marking the relation and should be simpler on Slobin's criteria.

The Uniqueness Principle

The uniqueness principle (Pinker 1984; Wexler and Culicover 1980) is another related principle that has been hypothesized to help account for the acquisition of language. The motivation for this principle is to help explain how children can acquire grammatical rules in the absence of negative feedback. If children are not informed that a given grammatical rule they have hypothesized is wrong, how can they reject erroneous hypotheses and settle on the correct grammar for their language? Following Wexler and Culicover (1980), Pinker (1984) argues that the need for negative evidence in language acquisition can be eliminated if children assume the uniqueness principle. That is, when children are faced with a set of alternative structures fulfilling the same function, they should assume that only one of the structures is correct unless there is direct evidence that more than one is necessary. This principle allows children to reject structures even when there is no negative feedback indicating that they are ungrammatical. Languages do violate the uniqueness principle to some extent. According to Pinker, however, children require more evidence to accept a construction that violates the principle than one that does not.

Mutual exclusivity is consistent with the uniqueness principle as applied to category terms. Further, as Pinker argues for the domain of syntax, if children start out biased to assume that terms are mutually exclusive, then they should require more evidence to accept a construction such as class inclusion that violates mutual exclusivity than to accept one that is consistent with it. There is one major difference between the rationale for the uniqueness principle and the rationale for mutual exclusivity. The major impetus behind postulating the uniqueness principle is the problem of lack of negative evi-

dence in language acquisition. There is very little evidence that parents or other adults explicitly correct children's ungrammatical sentences, and even some evidence that they do not (Brown and Hanlon 1970). A theory of the acquisition of syntax cannot depend on children being explicitly corrected when their constructions are wrong. Moreover, even when children do receive negative feedback, there is a serious problem of interpreting what aspect of an utterance is being criticized (Bowerman 1987; Gleitman 1981). The situation is, I believe, quite different in the acquisition of vocabulary. Children are frequently corrected when they use wrong labels for objects or mistakenly use other terms: for example, "It looks like a dog, but it's a wolf," "That's not a dump truck, it's a fire truck." How widespread such corrections are for children at various stages of language acquisition and how children make use of these corrections has not yet been investigated to any great extent, but the situation is clearly different from that of the acquisition of grammar. Nevertheless, children may still be able to make use of the mutual exclusivity principle in a way that is analogous to their use of the uniqueness principle, thus enabling them to reject certain hypotheses about a word's meaning because it would violate mutual exclusivity, even if no negative evidence were provided.

The Contrastive Principle

Clark (1983, 1987) postulates a third related principle to help account for semantic acquisition. Following Bolinger (1977), she argues that every word in a dictionary contrasts with every other word and that to acquire words children must assume that word meanings are contrastive. Mutual exclusivity is one kind of contrast, but many terms that contrast in meaning are not mutually exclusive. Terms at different levels of a class-inclusion hierarchy, such as "dog" and "animal," contrast in meaning in Clark's sense, since obviously the meaning of "animal" is different from that of "dog." Yet these terms violate mutual exclusivity. Mutual exclusivity is one specific way in which terms could contrast in meaning, but only one way among many. Mutual exclusivity is a more specific and stronger constraint than the contrastive principle. Moreover, evidence in favor of one of these principles is not necessarily evidence in favor of the other. Children could act in accord with the contrastive principle and yet violate mutual exclusivity, as just described. On the other hand, children could assume that terms are mutually exclusive but not assume the more general contrastive principle. Some of the evidence that Clark (1987) cites for the principle of contrast is, in fact, evidence in support of mutual exclusivity as well and thus is helpful in considering the latter.

The contrastive principle states that every two forms contrast in meaning. From this principle, Clark (1987) develops three predictions: (1) there are no synonyms; (2) established words have priority in the expression of meaning; and (3) innovative words fill lexical gaps and therefore may not be used in place of established words from the same meanings. Clark (1983, 1987) provides an extensive review of the literature from both linguistics and language acquisition in support of the lexical contrast theory.

As for the first prediction, Clark argues that apparent synonyms are in fact not synonymous. Some, such as "sofa" and "couch" or "autumn" and "fall," mark differences in dialect. Others, such as "cop" and "police," mark differences in register, where terms are marked according to whether they are colloquial, polite, pretentious, and so on. Others differ in connotation, such as "skinny" and "slim," where one has a negative and one a positive connotation. Still others differ in their collocations, such as "rancid" (which can be said of butter and fat) versus "addled" (which can be said of eggs and brains).

According to this argument, then, apparent synonyms do not conflict with the contrastive principle because they are not genuinely synonymous. Any given pair of apparent synonyms actually marks some difference in meaning.

Although Clark's examples are often compelling, there are problems with this line of argument. First, what may be true of a given language is not necessarily true of a given speaker of the language. That is, linguistic facts are not necessarily psychological facts. For example, although the pairs "sofa/couch," "pail/bucket," "autumn/fall" differ in terms of which dialect of English introduced them, it is not clear that they differ in meaning to any given speaker who knows them both. Speakers might use both "pail" and "bucket" equally naturally without having any sense that one is more a part of their dialect than the other, and without having any sense of a difference in their meanings. Thus, there may be cases, perhaps only a few but perhaps more, where for a given speaker terms are genuinely synonymous.

A second problem is that, to preserve the claim that all apparent synonyms really provide contrasts in meaning, differences in register count toward differences in meaning. On this view, "cop" and "policeman" differ in meaning. There are two difficulties with this argument. One is that notions of "formality," such as whether a term is polite versus colloquial, are not on a par with other components of meaning. To see why, consider the more usual kind of semantic feature, such as "animate" or "human." Suppose I know that a given

term includes the feature "human." I can then conclude that any term that is subordinate to that term also includes the feature "human." This same transitivity of features is not true of register differences. Although a captain is a kind of cop, "captain" is not a slang term. So differences in register are not the same as differences in meaning, or, not to prejudge the issue, as other differences in meaning. A second problem with counting register differences as differences in meaning concerns the postulated advantages of the mutual exclusivity principle and presumably the contrastive principle. One advantage of such assumptions is that they prevent a person learning a language from making many redundant hypotheses. Given the contrastive and mutual exclusivity principles, meanings for a given term can be rejected on the grounds that the language already contains a term with the same meaning. Even without negative evidence, many hypotheses can be rejected because they would be redundant. If differences in register can count as differences in meaning, however, then the hypothesis space is markedly increased. On this view, numerous redundant hypotheses could be considered as long as the learner suspects a minor difference in dialect or register could be possible. One way out of this problem might be to rank order certain hypotheses that learners, including children, would consider, and to claim that dialect and register differences are among the last to be considered, and only when the contrastive principle seems otherwise ready to fail.

The second prediction to be made from the contrastive principle is that established forms take priority, whenever an innovative term and an established term would be synonymous. Although we can say "to bicycle," "to skate," and "to ski," we cannot say "to car" or "to airplane" because the terms "to drive" and "to fly" already exist in the English lexicon.

The third prediction to be made from the contrastive principle is that speakers coin new words to fill lexical gaps. That is, new terms are coined when no term exists to convey a particular meaning.

Clark (1987) provides a parallel line of argument to demonstrate that young children first acquiring language assume the contrastive principle. Clark (1983) reinterpreted the data on overgeneralization of terms in light of this view. Her analysis revealed that children narrow down the domains of a previously overextended word by contrasting a newly acquired term with an old one. Children will not overextend a term to cover a new object when they already have a name for that object. Although Clark interprets this observation as evidence for lexical contrast theory, it actually supports the mutual exclusivity hypothesis and raises a problem for the contrastive prin-

ciple rather than supporting it. To take an example from Clark 1987, suppose a child starts out by overextending the word "dog" to cover not only dogs but also cats, sheep, and other four-legged mammals. Once having acquired the word "cat," the child stops overextending "dog" to cover cats. Given the mutual exclusivity principle, it is obvious why this should be the case: the child cannot have two category labels for the same object, so one or the other must be dropped. It is much less clear why this should happen according to the contrastive hypothesis. On this account, the word "cat" would refer to cats, whereas the word "dog" could continue to refer to dogs, cats, sheep, and so on. "Dog" (meaning four-legged mammal) and "cat" (meaning feline animal) would still clearly contrast in meaning. Thus, the contrastive principle alone does not explain why overextension should be narrowed in this way. Similarly, the contrastive principle does not explain why children will not overextend a term to cover a new object when they already have a term for that object. Since one term would be more general than the other, as the normal uses of "dog" and "animal" are, they would contrast in meaning and should, therefore, be legitimate.

Another piece of evidence that Clark (1987) cites for the contrastive principle, which again supports the mutual exclusivity principle, is that 2- and 3-year-olds appear to reject multiple labels for objects. A child told that something is an animal, for example, replied by saying, "It is not an animal, it's a dog." I will return to this source of evidence later when I summarize the best evidence we have for mutual exclusivity per se.

Thus, some of the evidence Clark (1987) cites actually supports the mutual exclusivity hypothesis and not the contrastive hypothesis. Children's rejection of terms is somewhat puzzling on the contrastive assumption alone. Since words can contrast in many different ways, not just by being mutually exclusive, specific and general terms applying to the same object would conform to, not conflict with, the contrastive principle. One way of dealing with this problem would be to supplement Clark's (1987) argument with the added assumption that mutual exclusivity is a favored way of adhering to the contrastive principle.

More support for the contrastive hypothesis comes from bilingual children. Early on (for the first 50–150 words) children acquiring two languages simultaneously tend to learn only one label for a given category even though they are exposed to a label from each language. The argument here is that children start out believing they are learning a single language, and therefore the contrast and mutual exclusivity principles would prevent them from learning two terms in this

language. Later, when they become aware that they are dealing with two languages, they can allow these cross-language synonyms. It is interesting that these constraints on language acquisition are relative to a given language.

One problem with this evidence is that it comes almost entirely from production data. Although we know, for example, that a young child first acquiring French and English who has learned "bird" will not say "oiseau," we do not know whether or not the child might comprehend "oiseau." There may be many reasons why beginning language learners are limited in the amount they can produce, a limitation that would prevent them from expending valuable resources on redundant information. This limitation on production could thus have a very different basis from a constraint on the lexicon such as "Every two forms contrast in meaning." A lexical constraint, if it is operating, should be apparent in comprehension as well as production. In fact, the best evidence for the contrastive or mutual exclusivity hypothesis would come from comprehension, not production.

Clark (1987) reviews other very interesting sources of data that provide more support for the contrastive principle. Children should assume that unfamiliar words fill lexical gaps, and fast-mapping studies such as those of Carey and Bartlett (1978), Au (1987), Au and Markman (1987), and Dockrell (1981) do show that children expect novel terms to map onto unnamed objects or properties. Further, children's word coinages should fill lexical gaps. Children invent new words to supplement their relatively small vocabularies (such as "plant-man" for "gardener"). Because their limited vocabularies contain many gaps that the adult lexicon does not, young children must decide what to do when confronted with a conventional form that is synonymous with one of their innovations. According to Clark (1987), it is because children realize that the two forms do not contrast in meaning that they give up their innovation in favor of the conventional form.

Evidence for the Mutual Exclusivity Principle

As noted, a fair amount of the evidence that Clark (1987) cites for the contrastive principle is in fact evidence for children's adherence to the mutual exclusivity principle.

Another source of evidence for mutual exclusivity can be found in children's early vocabularies. Among the earliest words children acquire are labels for objects—usually labels for objects at the basic level in Rosch et al.'s (1976) sense. For the most part, basic level category terms such as "dog," "apple," and "car" are mutually exclusive. In-

spection of the first words in children's vocabularies (see, for example, Goldin-Meadow, Seligman, and Gelman 1976; Gillham 1979) reveals that they consist of object category labels that are largely mutually exclusive, with no subordinate or superordinate categories.

Part-whole terms do not violate mutual exclusivity, so they should be learned before class-inclusion terms. In fact, although children's early vocabularies do not contain hierarchically organized category terms, they do contain many terms that can be organized into part-whole relations. Even children's early vocabularies contain a number of words referring to parts and wholes of the same object. For example, Gillham (1979) studied the early vocabularies of 14 babies by asking their mothers to record the first 100 words they produced. I found no words in Gillham's data that referred to superordinate categories. In contrast, there were nine that referred to body parts ("eye," "ear," "hair," "hand," "knee," "mouth," "nose," "toe," and "teeth"), as well as some that referred to a whole person ("baby," "boy"). Children also had a few other terms referring to what might be seen as parts of a house or other object ("door," "drawer," "gate," "button"), as well as for the whole objects that would correspond to these parts ("house," "home," "shoe," "coat"). Thus, even very young children acquire terms for both parts and wholes considerably before they acquire subordinate-superordinate terms.

There is also some anecdotal evidence suggesting that children revise their interpretation of words in order to avoid violating mutual exclusivity. Grieve (1975) cites data from an unpublished study by Curtis (1973). A 2-year-old child used the term "car" to refer to all cars. Eleven days later the child used "car" to refer to cars and "Cadillac" to refer to Cadillacs. The child now denied that a Cadillac was a car. When asked, "What's this?", the child replied, "Cadillac." When asked, "Is that a car?", the child replied, "No, Cadillac." Later the same thing happened for "taxi" and for "Rover." When asked, "What's this?", the child replied, "Rover." When asked, "Is it a car, too?", the child said, "No, Rover." Later in the same session the experimenter pointed to the Rover and asked whether it was a car. This time the child said, "Yes, car." But now when asked, "Is it a Rover?", the child said, "No, car." This anecdote suggests that the child was unwilling to allow two different terms to apply to the same object in immediate succession. Clark (1987) presents other examples, such as "Not a plate, it a bowl" (from a child who was asked to take a plate off the table). Related anecdotes have been reported by Valentine (1942) and Macnamara (1982). My daughter Erin has argued with great conviction about a number of such cases. For example, she insisted that she was not her grandparents' granddaughter, emphasiz-

ing, "I'm *not* a granddaughter, I'm a girl." What is so compelling about these reports is the child's explicit denial of the applicability of a term, often in the face of an adult authority labeling the object. It is tempting to interpret the emphatic denials as stemming from a powerful assumption of mutual exclusivity. It is as though the child finds two labels for the object contradictory.

The problem with most of the evidence reviewed so far is that either it is anecdotal, possibly reflecting an interesting, noticeable aberration in the learning of category terms rather than a general principle, or it comes largely from production data. As noted earlier, limitations on production (that is, on mastering the phonology of words, recall of words, and so on) may limit a child's productive lexicon without any constraint from mutual exclusivity. Thus, if evidence for a child's having only a single category term for each object were found only in production and not in comprehension, then the mutual exclusivity principle would not be supported. There are certainly cases in which apparent support of the principle from production data alone would have to be rejected once comprehension data were taken into account. My daughter Erin produced two such examples when she was about 11 months old. Erin's word for duck was "quack quack" and her word for truck was "brmm brmm." At that time she never produced either "duck" or "truck" yet it was very clear that she understood both of these terms. For example, if I asked her to "Find the duck" or to "Find the truck," she had no trouble doing so. Similar pairs were "cow/moo moo," "cat/meow," "coffee grinder/brr brr." Faced with my daughter's lack of filial loyalty in generating violations of mutual exclusivity, I vainly attempted to distinguish between "routines" and "words," hoping that words would adhere to the mutual exclusivity principle and that routines might not. No matter what criteria I came up with at the time to distinguish routines and words, however, "quack quack" and "brmm brmm" functioned as words. For example, if Erin wanted her truck when it was out of reach, she would extend her arm in a reaching motion toward the truck and repeat "brmm brmm, brmm brmm" until someone handed her the truck—exactly the same way she would request other objects using more conventional terms. In this case, then, I was forced to conclude that these were genuine counterexamples. Erin's productive vocabulary contained only one category term per object at this stage, but, in these few cases at least, she could comprehend more than one. At about the same time I noticed one other violation of mutual exclusivity. Erin normally used the term "orange" to refer to oranges, but on a couple of occasions—for instance, after she kicked an orange and watched it roll—she also used the term "ball."

All of these potential counterexamples except the last one have the same character. Erin comprehended the conventional label for the object but produced an interesting sound the object made instead. Although to my knowledge adults never labeled the objects with the sound, adults quite often provided the sound effects after labeling the object—for example, "Here is a duck and it goes quack quack." Because the sounds are so interesting and because they were repeatedly associated with the objects, these may be special cases where the child is given considerable information early on and uses it to overcome mutual exclusivity.

In summary, evidence from a number of sources suggests that children adhere to the mutual exclusivity principle, but the evidence is either largely anecdotal or solely based on production data. Experimental studies of children's comprehension of terms would provide the clearest test of whether they widely assume that terms are mutually exclusive.

Experimental Tests of the Mutual Exclusivity Hypothesis

The simplest situation where the mutual exclusivity principle could be applied is one in which two objects are presented, one that already has a known label and one that does not. If a new label is then mentioned, the child should (1) on the taxonomic assumption, look for an object as a first hypothesis about the meaning of the label; (2) on the mutual exclusivity assumption, reject the already labeled object; and (3) therefore, assume that the novel label refers to the other object.

Three studies have found support for this hypothesis (Golinkoff et al. 1985; Hutchinson 1986; Markman and Wachtel 1988). In a study with 12 subjects, Golinkoff et al. found that 2½-year-olds would pick a novel object over several familiar objects when they heard a novel noun. In general, children presented with four objects—three familiar and one unfamiliar—and told to select one, might prefer to select the novel one whether or not it was labeled. If so, then the results could not be interpreted as revealing a constraint on word meaning but would instead have to be interpreted as a response bias to attend to the novel object. Golinkoff et al. argue that such a bias could not account for their results because children handled both the novel and familiar objects before the start of the session, which, they claim, would make the familiar and novel objects equally salient. It is not clear, however, that the short time spent handling the objects could have achieved this effect. Golinkoff et al. further point out that in a subsequent trial when children were presented with the same novel

referent—this time grouped with two familiar objects and one unfamiliar object—they continued to select the original referent when the label was repeated. They argue that this finding rules out a general preference for picking the novel object. Moreover, when the original object was presented along with another unfamiliar object and a different novel label was mentioned, children now selected the second novel object.

Hutchinson (1986) dealt with this novelty problem by conducting preliminary trials in which children were presented with novel and familiar objects, paired as they would be in the experimental session. The children were asked to select one. If a child preferred the novel object of the pair on two trials, then that pair was dropped from that child's analysis. As it turned out, very few pairs of objects had to be dropped. Hutchinson's study was extensive, comparing children from a broad age range and comparing normal to retarded children. She found that, when a novel label was spoken, normal children as young as 2 years old reliably selected a novel object over a familiar object.

Study 1 of Markman and Wachtel 1988 was a modified replication of these studies that used a control group to ensure that if children select a novel object when they hear a novel label, then it is due to the labeling per se and not just a response bias to choose the novel object. To control for this possibility, the children in one group were simply asked to select an object.

Three-year-olds were presented with six pairs of objects, one member of each pair being an object that they could label (for instance, banana, cow, spoon) and one an object for which they did not yet know the label (for instance, a lemon wedgepress, a pair of tongs).

In the control condition each child was shown the six pairs of objects and asked by a puppet to "Show me one." In the novel label condition the procedure was identical except that the child was asked to "Show me the x," where x was a nonsense syllable, randomly assigned to the object.

Children who heard a novel term applied in the presence of two objects, one of which was familiar and one of which was unfamiliar, had a striking tendency to select the novel object as the referent for the novel term. They selected the novel object in almost 5 of the 6 pairs, mean = 4.90. The tendency to select an unfamiliar object as the referent for a novel label does in fact reflect children's adherence to the mutual exclusivity principle because they do not have such a bias when no labels are provided. In the control condition children perform at chance, selecting a mean of 3.30 unfamiliar objects out of 6.

In summary, in this very simple situation where it is possible to map an unfamiliar word to an unfamiliar object, 3-year-old children use the mutual exclusivity principle in figuring out the meaning of a new word. Note also that in this situation the child can simultaneously satisfy the principles of taxonomic organization and mutual exclusivity. Study 2 from Markman and Wachtel 1988 examined what happens when this simple mapping strategy is no longer possible, and the taxonomic assumption and mutual exclusivity may conflict.

Suppose a novel word is used to describe a single object. As argued in chapter 2, according to the taxonomic assumption (Markman and Hutchinson 1984), a child should first hypothesize that the new word refers to the object as an exemplar of a category of similar objects, and not to a part of the object, the object's substance, and so on. Suppose, however, that the object described by the novel term is an object for which the child already has a label. In this case, in order to adhere to the mutual exclusivity principle, children must reject the novel term as a label for the object. Then, however, they may not have any clear alternative as a possible meaning for the term; that is, since no other object is around to label, the simple novel label–novel object strategy cannot be used. Under these circumstances several options are available. Children could decide to abandon mutual exclusivity in these cases and interpret the novel term as a second label for the object. Another possibility is that they could reject the term as a label for the object without coming up with an alternative meaning. Rejecting one meaning for the term, however, leaves them with a term that is not yet attached to any referent. This in itself may be a motivation for children to try to find some meaning for the novel term. The mutual exclusivity principle does not speak to the issue of how children select among the potential meanings, but one possibility is that they might analyze the object for some interesting part or property and interpret the novel term as applying to it. Such an analysis is considerably more difficult than the simple novel label–novel object matching strategy, and there may be many candidate meanings for a term. The remaining studies examine whether children can use mutual exclusivity, in this more difficult situation, to learn part and substance terms.

Study 2 of Markman and Wachtel 1988 addressed whether children can use mutual exclusivity to reject a novel term as a label for an already labeled object, and whether that motivates them to search for another salient aspect of the object to label. In this study we attempted to teach children labels for objects with prominent parts. The children heard a novel noun attributed to either a familiar or an

unfamiliar object. The term could thus refer either to the object itself or to a salient part of the object.

Three- and 4-year-olds heard either familiar or unfamiliar objects labeled with a novel term and were then tested to see whether they thought the term referred to the object as a whole or to a salient part of the object. The set of familiar and unfamiliar objects, along with their relevant parts, is presented in table 9.1.

Children were assigned to one of two conditions, the familiar condition (where the children knew a label for each object) or the unfamiliar condition (where they did not). In both conditions children were taught a label applied to an object with a noticeable part. The labels used were in fact adult labels for the part. In neither condition did children already know a label for the part being taught. For example, children in the familiar condition were taught "boom" as the part of a (familiar) firetruck and "dorsal fin" as the part of a (familiar) fish. Children in the unfamiliar condition were taught "finial" as the part of an (unfamiliar) pagoda and "trachea" as the part of an (unfamiliar) lung. The prediction was that children would interpret the label as referring to the object itself for unfamiliar objects but as referring to a part for familiar objects.

In order to ensure that children understood the questions about parts and wholes, children in both conditions were asked about familiar objects and their parts using known labels. For example, all children were shown a pencil with an eraser and asked whether the eraser was the whole object or just a part, and whether the pencil was the whole object or just a part. They were shown a cat and asked whether the tail was the whole object or just a part, and whether the cat was the whole object or just a part. These well-known objects and labels are presented in table 9.2.

For the experimental items, the experimenter mentioned what the child was about to see by providing the label, and placed the picture on the table. Then she asked the child, "Which one is the ____? This whole thing (the experimenter circled the object with her index finger), or just this part (the experimenter pointed to the part)?"

The predictions from this study can be summarized as follows. First, children in both conditions should understand the known labels for parts and wholes, and all children should do well on these items. Namely, they should think that a known term for a whole refers to the whole object and that a known term for a part refers to the part. Most important, the predictions for the experimental items differ depending on the condition. Children hearing a label applied to an unfamiliar object should assume that the label refers to the object itself and not just a part of it. Thus, they should give few part re-

Table 9.1
Experimental items for study 2 of Markman and Wachtel 1988

Familiar condition		Unfamiliar condition	
Object	Novel label for object	Object	Novel label for object
Fish	Dorsal fin	*Current detector	Detector
Fire truck	Boom	Pipe tool	Damper
Hammer	Claw	*Ritual implement	Crescent
Camera	Focusing grip	*Pagoda	Finial
Telephone	Receiver	Microscope	Platform
Race car	Air foil	*Lung	Trachea

*These items were used in study 3 as well.

Table 9.2
Known objects and parts for study 2 of Markman and Wachtel 1988 (used in both familiar and unfamiliar conditions)

Known label for whole	Known label for part
Cat	Tail
*Wagon	*Handle
Bird	Beak
*Flower	*Stem
*Pencil	*Eraser
*House	*Chimney

*These items were used in study 3 as well.

sponses. Children hearing a label applied to a familiar object should, on the basis of mutual exclusivity of labels, reject the term as a label for the whole and assume that it refers to the part instead. Thus, these children should give more part responses. The actual results in terms of number of part responses given are shown in figure 9.1.

Children in both conditions were expected to perform quite well on the familiar baseline items, giving part responses for known part terms ("tail") and object responses for known objects terms ("cat"). As can be seen in figure 9.1, children in both conditions performed as expected when known labels were used to refer to parts and wholes.

As predicted, children interpreted a novel term quite differently depending on whether the object was familiar or not. Children gave a mean of only 1.2 out of 6 part responses (20%) in the familiar condition, compared to a mean of 3.4 part responses (57%) in the unfamiliar condition. Thus, as expected by the mutual exclusivity hy-

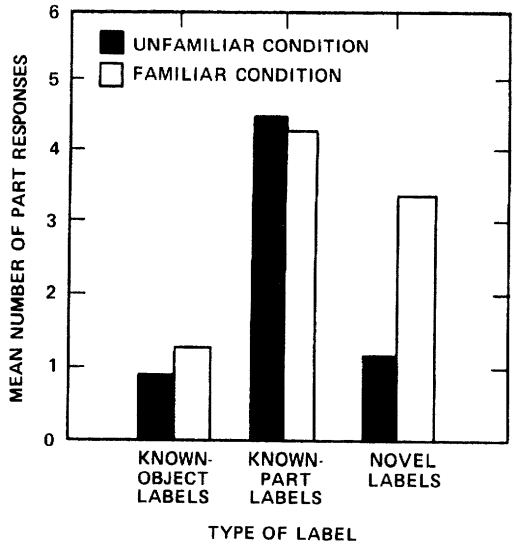

Figure 9.1
Number of part responses (out of a maximum of 6) given by children in the familiar and unfamiliar conditions to known labels for objects, known labels for parts, and novel labels

pothesis, children hearing a novel term in the presence of an object with a known label were less likely to think the novel term referred to the whole object than were children who heard the term in the presence of an object with no known label.

One rather stringent test of the strength of the taxonomic and mutual exclusivity assumptions is to compare children's interpretation of novel terms to their interpretation of the well-known words. The taxonomic assumption predicts that children in the unfamiliar condition should treat the novel terms similarly to the way they interpret known object labels and differently from the way they interpret known part terms. Conversely, the mutual exclusivity assumption predicts that children in the familiar condition should treat the novel terms differently from the way they interpret known object terms and similarly to the way they interpret known part terms.

By and large, the results were in accord with even this stringent test. In the unfamiliar condition children treated the novel label much as they treated known labels for objects and quite differently from the way they treated known labels for parts. Moreover, in the familiar condition children gave more part responses to novel labels (such as "receiver") than to known object labels. This is what one would ex-

pect on the mutual exclusivity hypothesis. On the other hand, they gave fewer part responses to novel terms than they gave for known part terms. The bias to interpret novel labels as labels for objects (as well as the assumption of mutual exclusivity) may have been affecting children in the familiar condition, leading them to make an intermediate number of part responses.

In summary, the results from this study support the mutual exclusivity hypothesis. When shown an unfamiliar object—that is, an object for which they do not yet have a label—young children interpret a new noun as a label for that object. In this study children interpreted new terms as labels for whole objects just as frequently as they interpreted known terms as labels for whole objects. When they are shown a familiar object, however, then by mutual exclusivity children should reject the term as a label for the object and look for some other meaning for the term. In this study, although there was some tendency to interpret the term as labeling the object, children were less likely to interpret the new noun as a label for a familiar object and interpreted it as referring to a salient part of the object instead.

In study 2 the parts and wholes that children were questioned about in the experimental items differed for the familiar and unfamiliar conditions. Study 3 was designed to equate the items in the two conditions. Only unfamiliar objects were used in this study, but some of the children were provided with labels for the objects before the experimental labels were taught. In this way, the same item could be unfamiliar for some children and "familiar" (or at least previously labeled) for other children.

There were two conditions in the study, the familiarization condition and the unfamiliar condition. The labeling procedure and the method of asking children whether the object referred to the part or the whole were virtually identical to those used in study 2. The main difference was that in the familiarization condition children were first taught a label for the object. They were shown a picture of the object (for example, the lung), told what it was called ("This is a lung"), and given a short description of its function ("We all have two lungs in our chest and use them to breathe"). After they were familiarized with the experimental objects in this way, they participated in the standard procedure.

In both conditions children were asked about four of the six unfamiliar objects that had been used in study 2. These are indicated in table 9.1 They were also asked about four objects whose labels and parts were familiar. These are indicated in table 9.2. As before, the experimenter told the children what they were about to see (for example, "Here is a finial"), presented the picture of the object, and

asked what the label applied to: "Which one is the finial, this whole thing (the experimenter circled the object with her index finger) or just this part (the experimenter pointed to the part)?"

In summary, the design of study 3 was very similar to that of study 2. The main difference was that, instead of a familiar condition in which children were taught a term for a familiar object, study 3 included a familiarization condition in which children were first familiarized with a previously unfamiliar object and then were taught the new term.

As in study 2, children's responses were scored according to whether they said that the label referred to the whole object or its part. The results, which are plotted in figure 9.2, replicated those of study 2. As predicted, children interpreted a novel term quite differently in the two conditions. Children in the unfamiliar condition, who heard the term in the presence of an unfamiliar object, more often interpreted it as referring to the object and not its salient part. For example, children who simply saw a picture of a lung interpreted "trachea" as referring to the object (the lung) and not its salient part (the trachea). They gave a mean of 1.27 part responses out of 4 (32%). In contrast, children in the familiarization condition interpreted the novel labels as referring to parts of the object. For example, children who had just heard the picture of a lung labeled "lung" interpreted "trachea" as referring to the salient part (the trachea) and not the object (the lung). They gave a mean of 3.4 part responses out of 4 (85%).

In summary, study 3 again provides evidence for the mutual exclusivity hypothesis. When a novel term is used in the presence of an object that already has a label, children tend to reject another label for the object and, in this case, assume that the term refers to a part of the object instead. This was true in this study, even though the label for the (previously unfamiliar) object was provided only a few moments before another novel label was taught.

In study 1 of Markman and Wachtel 1988 children could use a simple strategy of mapping an unfamiliar label to an unfamiliar object to preserve mutual exclusivity. Because only one object was presented at a time in studies 2 and 3, this simple strategy was precluded. Children still adhered to mutual exclusivity in this case, using it to learn terms for salient parts of objects. Parts of objects are themselves objects or at least objectlike, however. Thus, learning parts of objects may be as close to the simple mapping strategy as one can get using a single object. The next three studies from Markman and Wachtel 1988 examined whether children avail themselves of mutual exclusivity when the experimenter refers to an object made of a

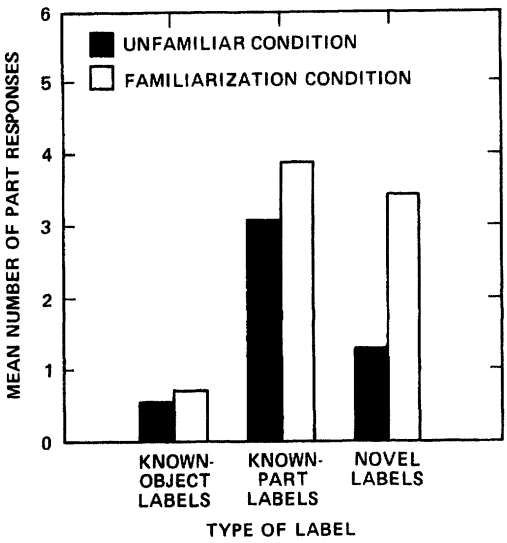

Figure 9.2
Number of part respones (out of a maximum of 4) given by children in the familiarization and unfamiliar conditions to known labels for objects, known labels for parts, and novel labels

salient substance, using an adjective or mass noun. This procedure differs in two ways from that of the studies on learning labels for parts. First, instead of depicting objects with salient parts, we selected objects made of a metallic substance that we thought would be salient and that young children have not yet labeled. Second, in these studies the object was referred to by an adjective or a mass noun: "See this? It's pewter." This is not the typical way, in English, of designating objects. It therefore provides a strong test of the taxonomic assumption. When an unfamiliar object is labeled, the bias to look for object labels may be strong enough to override grammatical form class information. So even when an adjective or mass noun is used to describe an object, children may interpret it as the label for the object. A commonly heard anecdote, for example is that young children think that "hot" is the label for stoves, for example, because parents refer to stoves by the term "hot" before they label them as "stoves": "Don't touch that, it's hot."

Study 4, then, was designed to examine these two issues: First, following the taxonomic assumption, will children interpret even a novel adjective as a label for an unfamiliar object? Second, following the mutual exclusivity assumption, will children reject a novel term as a label for a familiar object made from a salient substance?

In study 4 3- and 4-year-olds heard a puppet refer to an object as "pewter." Half of the children heard the term attributed to a familiar object: a metal cup. Half of the children heard the term attributed to an unfamiliar object: a pair of metal tongs. To introduce the novel term "pewter," a puppet showed the child the object (either the metal cup or the metal tongs) and said, "See this? It is pewter."

If the tendency to expect an object label is strong enough to override form class cues, then children hearing "pewter" ascribed to the metal tongs should interpret "pewter" as the label for tongs. They should then agree that a different pair of tongs, made from a different substance and of a different color—a pair of wooden tongs—is also pewter. In contrast, when children hear "pewter" ascribed to a familiar object, if they try to adhere to the mutual exclusivity principle, then they should reject "pewter" as the label for the cup. They should deny that a cup made from a different substance and of a different color—a ceramic cup—is pewter. The main prediction, then, is that when the children see an object that is similar in kind to the original object but of a different substance, they should agree that it is "pewter" when the object referred to is unfamiliar (the metal tongs) but deny that it is pewter when the object is familiar (the metal cup). Thus, children should agree that a pair of wooden tongs is pewter but deny that a ceramic cup is pewter.

This prediction was confirmed. Of the 12 children who were taught that a metal cup was pewter and then asked whether a ceramic cup was pewter, only 1 child thought that it was pewter. The other 11 children denied that it was pewter. Thus, even in this more difficult situation, children adhered to the mutual exclusivity principle, denying that a new term could be a label for an object even when it might not be clear what else the term referred to. In contrast, of the 12 children who were taught that metal tongs were pewter, 7 of the 12 thought that wooden tongs were also pewter.

The results also indicate that at least to some extent 3- and 4-year-olds are willing to override form class clues in order to interpret a novel adjective or substance term as a label for an unfamiliar object. That is, about half of the children considered "pewter" to be the label for tongs and agreed that wooden tongs were pewter.

Study 5 was a modified replication of study 4 that used a within-subjects design. Each child heard a novel substance term applied to a familiar object and a different novel substance term applied to an unfamiliar object. The two substance terms were "chrome" and "rattan."

The findings from this study replicated those of study 4. First, the bias to assume that a novel term refers to a novel object was again

strong enough to override discrepancies in grammatical form class. Seventy-five percent of the children who heard the term "chrome" or "rattan" attributed to a novel object treated the term as a label for the object. Second, children were less likely to think that the novel term was a label for the object when they already knew a label for it. Only 40% of the children who heard "rattan" and "chrome" attributed to familiar objects treated the terms as labels for the objects; 60% rejected the terms as labels.

In studies 4 and 5 3- and 4-year-old children treated a novel term as a label for a novel object but tended to reject the term as a label for a familiar object. Although we know that children reject the novel term as a label for a familiar object, we do not know whether they have in fact accepted the term as a substance term. Study 6 attempted to get at children's hypotheses about the meanings of the terms more directly by giving children a forced choice between object labels and substance labels.

As in the previous studies, we labeled an object using a novel term: for instance, "See this (a metal cup)? It's chrome." Children were then shown a similar object made of a different substance (in this case a ceramic cup). They were also shown a chunk of the substance itself (in this case an unformed piece of chrome). They were then asked, "Which is chrome? This thing here or this stuff here?" (This is similar to the procedure used by Soja, Carey, and Spelke (1985) in their investigation of children's acquisition of count nouns and mass nouns.) Our question was, would children interpret a term as a substance term in the presence of an object as long as the object had a known label? In other words, would mutual exclusivity help children override their bias for object labels to interpret a novel term as a substance term?

As in studies 4 and 5, children heard a familiar object (a hat) or an unfamiliar object (an odd-shaped container) labeled as rattan. They also heard a familiar object (a cup) or an unfamiliar object (tongs) labeled as chrome. The experimental test for whether children interpreted the term as a label for the object or the substance was to give them a choice between a similar object of a different substance and the substance itself.

To ensure that children understood the questions and procedure, they were asked the same kinds of questions for two familiar objects and two familiar substances before the experimental items were shown. Each child was shown a wooden cat and a hunk of wood and asked, "Which one is the wood, this thing here (pointing to the cat) or this stuff here (pointing to the wood)?", "Which one is the cat, this thing here (pointing to the cat) or this stuff here (pointing to the

wood)?" The same procedure was used for a sand-filled car and a pile of sand.

The two experimental items were then presented. For the experimental forced-choice test, children were asked only one question about each pair: either which of the choices was chrome or which of the choices was rattan. Children were questioned about one familiar item and one unfamiliar item, each of a different substance. The questioning procedure was the same as for the pretest on well-known objects. For the familiar rattan condition, children were shown the rattan hat and told, "See this? It's rattan." They were then shown a plastic hat and a piece of rattan and asked, "Which one is rattan, this stuff here (pointing to the piece of rattan) or this thing here (pointing to the hat)?" The unfamiliar rattan condition was the same except that the crescent-shaped container was substituted for the hat. For the familiar chrome condition, children were shown the metal cup and told, "See this? It's chrome." They were then shown a ceramic cup and a piece of metal and asked, "Which one is chrome, this stuff here (pointing to the piece of metal) or this thing here (pointing to the ceramic cup)?" The unfamiliar chrome condition was the same except that the tongs were substituted for the cup.

When these preschool children were asked about well-known objects and substances, they were quite able to answer the questions correctly. That is, when they were asked about cats and cars, they pointed overwhelmingly to cats and cars, pointing to the object rather than the substance 1.96 out of a possible 2 times. When asked about wood and sand, they pointed to wood and sand, pointing to the object only .48 out of 2 times. Since the object was in fact made of the relevant substance, pointing to the object when asked about the substance is not, strictly speaking, an error. A wooden cat, for example, is wood. Nevertheless, it was relatively rare for children to use that strategy, and for the most part they clearly differentiated between the two kinds of questions they were asked.

Since—as the pretest demonstrated and as expected from the work of Soja, Carey, and Spelke (1985)—3- to 5-year-olds have no trouble understanding this kind of question, we were now in a position to determine whether these children can use mutual exclusivity to reject a new term as an object label for a familiar object and interpret it as a substance term instead. We predicted that when children heard a novel term applied to a novel object (the odd-shaped container or the tongs), they would choose the object as the referent of the term, but that when they heard the term applied to a familiar object, they would choose the substance as the referent of the term. In other words, we predicted that children should select the substance in the

familiar object condition more often than in the unfamiliar object condition. This prediction was supported. The mean number of object responses was .57 out of 1 for the unfamiliar object condition compared to only .13 out of 1 for the familiar object condition. Thus, in support of the mutual exclusivity hypothesis, when children heard a novel term applied to a familiar object, they rejected the term as a label for the object and interpreted it as a substance term instead.

In sum, these studies provide evidence that children do, in fact, assume that words tend to be mutually exclusive. Study 1, along with the studies reported by Golinkoff et al. (1985) and Hutchinson (1986), demonstrate that when children hear a novel object label, they assume that it refers to a novel object rather than to an object whose label they already know. This finding is not due to a general preference for novel objects, as it is seen only when a novel label is mentioned. To use mutual exclusivity in this situation, children can adopt a simple strategy of mapping the novel label onto the novel object. The remaining studies explored whether children adhere to the mutual exclusivity principle when this simple strategy can no longer be used.

If a novel label is applied to an object for which children already have a label, then they should, by mutual exclusivity, reject the new term as an object label. If that object is the only one present, however, then children cannot interpret the term as a label for a different object. Instead, they must analyze the same object for some property or attribute to label. Studies 2–6 provide evidence that 3- and 4-year-olds try to maintain mutual exclusivity of terms even in this more difficult situation. Studies 2 and 3 explored whether children can use mutual exclusivity to reject a term as a label for an object and interpret it as a label for a part of the object instead. In this case a new noun was attributed to an object and children had to decide whether the term referred to the object itself or a salient part of the object. Children interpreted a novel label as referring to the object itself when the object did not yet have a label. In contrast, as predicted, they interpreted the label as referring to the part when the label for the object was already known. Studies 4–6 examined whether children would use mutual exclusivity when taught a substance term, by attributing the substance term to an object. If the object was unfamiliar, then half or more of the children thought that the substance term was the label for the object. They agreed, in this case, that a similar object of a different material should have the same label. Even when the new term was an adjective or mass noun, then, children occasionally still interpreted it as a label for the object. In contrast, if the object was familiar, children rejected the new term as a category

label. They denied, in this case, that a similar object of a different material should have the substance label and instead selected the substance as the referent of the term.

Parental Labeling

The studies and other evidence reviewed so far suggest that children first assume that a new label refers to an object category, and that category terms are mutually exclusive. It would simplify learning if adults' labeling practices conformed to children's expectations. Otherwise, children will misconstrue many terms. First, adults should tend to provide object labels in accord with the child's assumption that novel terms refer to categories of similar objects. Second, if an adult is providing something other than an object label and therefore violating the child's assumption, it would help if the adult clearly marked that this was an exception. That is, the adult should somehow convey to the child that the new term is something other than an object label. If the child assumes that category terms are mutually exclusive, a good way of indicating to the child that the new word is not a category term would be to introduce that new word in the presence of the already known category term. Hearing a known category term applied to the same object should then signal to the child, on the assumption of mutual exclusivity, that the new term is not a category term.

In fact, to the extent we can determine parents' labeling practices from the available evidence, their use of terms accords remarkably well with these assumptions. Ninio and Bruner (1978) studied 40 mothers looking at picture books with their infants. They found that 95% of ostensive definitions referred to the whole object depicted. Thus, the overwhelming majority of the labels mothers gave to infants would fit with the assumption that the first word heard will be the object's label. In the remaining cases mothers explicitly included the category term in the utterance that introduced a term for a part or property of the object. For example, in the 40 dyads, there were 52 naming utterances referring to parts of objects or parts of the body. In all but 2 of these, either the part was named immediately after the whole or the whole was explicitly mentioned along with its relation to the part. For example, mothers said, "Here is a train. Here are the wheels," "These are the girl's eyes," "Where are the girl's feet?", "Look what a lovely doll. Where is the doll's nose?" Ninio (1980) presents evidence that when a mother asks her young child, "What's this?", the child almost invariably answers with an object label, even

when the mother makes clear from an adult's perspective (by touching or tapping a specific part) that she is asking about a part.

Studies on parents' labeling of categories reveal that parents label objects differently depending on whether they are providing basic level or superordinate level category terms (Callanan 1985; Shipley, Kuhn, and Madden 1983). These parental labeling strategies fit well, not just with mutual exclusivity, but also with another assumption that children make about word meanings, namely, that a novel term should refer to the object at roughly a basic level of categorization. Parents rarely use simple ostensive definition to provide a superordinate label for an object, yet this is an exceedingly common way of introducing a basic level label. Although adults would be very likely to point to a helicopter and say, "That's a helicopter," they would be very unlikely to point to a helicopter and say, "That's a vehicle." Adults thereby prevent children from erroneously treating novel superordinate category terms as basic level labels for objects.

Parents introduce superordinate category terms in two ways. The first is by labeling groups of objects rather than single objects (Callanan 1985; Shipley, Kuhn, and Madden 1983). Callanan found this tendency to be so striking in parents that they would explicitly define superordinate terms as referring to a group of things together—as though they were defining collections rather than classes. The parents in her study said, for example, "All of them together are vehicles," "A whole bunch of things together that you ride in are vehicles." (This, of course, is incorrect since even a single vehicle is a vehicle.) Moreover, she found that parents sometimes violated the singular-plural distinction in ways consistent with a collection interpretation. Parents occasionally said things like "What is all this called (pointing to several machines)? Is it a machine?" and "OK, is a car and a truck a machine?" As argued in chapter 8, collections are a simpler hierarchical structure for children because they do not violate mutual exclusivity. This erroneous labeling by parents may fit with children's way of first establishing hierarchical relations.

The second strategy parents use to teach superordinate category labels is to first provide a basic level label for the object and then provide the superordinate category term (Callanan 1985; Shipley, Kuhn, and Madden 1983). In fact, Callanan found that parents used basic level category terms just as much when teaching superordinate level category terms as when teaching basic level category terms themselves. Moreover, parents who were asked to teach their children new superordinate terms first used basic level terms even when the basic level categories were unfamiliar to the children, for example, calling something "a hassock" before calling it "a piece of fur-

niture." When parents do provide the superordinate category term, they often explicitly mention the inclusion relation ("A car is a kind of vehicle"), which might also clarify the relation. As Callanan notes, this basic level anchoring with unfamiliar basic level terms increases the amount of new information children must learn. Such basic level anchoring should be very useful, however, given assumptions of mutual exclusivity and contrast. By first providing the basic level term, parents preemptively block the superordinate category term from being treated as a basic level term.

Multiple Representation

So far mutual exclusivity has been discussed as a constraint that children place on language per se. On the other hand, mutual exclusivity could derive from children's beliefs about objects, not just from their beliefs about object labels. That is, children may believe that an object has one and only one identity—that it can only be one kind of thing—and that an object's identity is revealed by object labels. Mutual exclusivity would then be an assumption that children make about objects, which leads to a parallel assumption about object labels. Flavell (in press) argues that young children assume that each thing in the world has only one nature—an assumption that adults may sometimes share. Unlike adults, however, children do not understand that each thing may, nevertheless, be mentally represented in more than one way. For example, children's poor performance on perspective-taking tasks is said to involve problems in dual coding. On this view, young children find it hard to understand that a given perceptual array can look quite different from two different perspectives because they treat two different appearances of the same object as though they implied two different identities for the same object. According to Flavell (in press), this limitation on multiple representation is revealed in a number of diverse tasks, including visual and conceptual perspective taking and understanding the appearance-reality distinction, as well as assuming mutual exclusivity.

The Generality of the Mutual Exclusivity Constraint

The question of whether the mutual exclusivity assumption in language derives from an assumption about objects raises a more general question: What is the best level at which to formulate this constraint? One possiblity is that it is narrowly specified as a constraint on word meanings. That is, it may be specifically a linguistic constraint. Another possibility, as just discussed, is that it could have

its origin in children's beliefs about objects—that an object can have only one identity. Because labeling confers identity on objects, mutual exclusivity would be seen in language as well, but it would not be primarily a linguistic constraint. A final possibility is that mutual exclusivity, or perhaps some more general principle such as one-to-one mapping, might be a domain-general constraint, appearing in various manifestations across many diverse domains. Karmiloff-Smith (1979), Karmiloff-Smith and Inhelder (1975), and Carey (1978) have argued that children may begin acquiring knowledge in a domain by learning basic concepts in relative isolation but that after a while they are driven to try to organize and systematize their knowledge. Mutual exclusivity and a one-to-one mapping principle are simple, primitive forms of systematization. Basically, they work to keep relations between elements distinct and to maximize the predictability from one element to another. Some implications of a general one-to-one mapping bias are that it would lead children to expect perfect correlations between elements in a domain, to reject counterexamples and exceptions to general rules and to exaggerate regularities in their environment. Thus, mutual exclusivity might be either a language-specific constraint or a domain-general constraint, and at this point it is unclear which is the more appropriate level at which to characterize it. Whatever the generality of the constraint, however, it clearly applies to language.

The Principle of Taxonomic Organization

In some cases the assumptions of taxonomic organization and mutual exclusivity are in conflict, one leading the child toward object labels and the other leading away from object labels. The assumption of taxonomic organization directs children, upon seeing an object and hearing a novel term, to interpret the term as a label for the object—not as a label for one of its parts, not as a label for its substance, and so on. The obvious limitation of this assumption is that children must learn many kinds of terms, not just object labels. The assumption of mutual exclusivity, on the other hand, directs children to reject a novel term as a second label for an object and motivates them instead to interpret the term as a label for one of its parts, its substance, or some other property. The taxonomic assumption clearly has priority when the object being labeled has no previously known label, since mutual exclusivity does not apply in such a case. When one object has a known label and another has no known label, then both mutual exclusivity and the taxonomic assumption can be met. When only one object is present, for which the child already has a label, these

two principles may to some extent compete. In these cases, when children find some other property of the object reasonably salient, they should adhere to mutual exclusivity and interpret the term as referring to this property. If, on the other hand, there is no obvious alternative interpretation for the meaning of a novel term, children may violate mutual exclusivity and follow the taxonomic principle, treating the term as a second object label.

Implications for Language Acquisition

Taken together, the present studies suggest how the assumption of mutual exclusivity can help children acquire not only cateogry terms but other kinds of terms as well. First, at a minimum, it enables children to reject one hypothesis or one class of hypotheses about a term's meaning; the new term should not be another object label. Second, the mutual exclusivity assumption has a motivational force. Having rejected one meaning for a term, children would be left with a word for which they have not yet figured out a meaning. This should then motivate them to find a potential meaning for the term, leading them to analyze the object for some other property to label. In this way, the mutual exclusivity assumption motivates children to learn terms for attributes, substances, and parts of objects. It also predicts that children should be much better able to learn color terms, shape terms, and so forth, on objects that have already been labeled.

As mentioned earlier, this function of mutual exclusivity helps overcome a major limitation of the taxonomic assumption that leads children to look for object labels. Although the taxonomic assumption provides a critical first hypothesis about word meanings, children must eventually be able to learn terms for properties of objects and not just terms for objects alone. These two principles complement each other, then, the taxonomic principle applying first, and the mutual exclusivity principle applying in cases where children already know a label for an object, motivating them to learn terms other than object labels. To envision how the mutual exclusivity principle can be used to successively constrain the meanings of terms, suppose a child who already knows "apple" and "red" hears someone refer to an apple as "round." By mutual exclusivity, the child can eliminate the object (apple) and its color (red) as the meaning of "round" and can try to analyze the object for some other property to label.

There are still many unanswered questions about how this analysis would proceed. There might be a hierarchy of hypotheses that children consider on hearing a new term, beginning with an object label

and then moving in some predetermined order through part terms, substance terms, size, color, weight, temperature terms, and so on. Alternatively, the strategy might be to analyze each object for its most salient characteristic and to take that as the meaning of the novel term. That is, substance, for example, might be a likely candidate meaning for some objects but not for others. The potential hypotheses will very likely be affected by other cues, including grammatical form class and the linguistic and nonlinguistic context in which a new term is heard. The mutual exclusivity principle does not speak to these issues about how hypotheses are generated, but it does suggest that, as each successive word is learned, it further constrains the meanings of those yet to be learned, thereby helping children figure out their meanings.

Although in many cases the lexicons of natural languages are consistent with mutual exclusivity (as in many basic level category terms), there are inconsistencies as well. As mentioned earlier, one reason that children may have trouble dealing with hierarchically organized category terms is that they violate mutual exclusivity. At some point children obviously violate the assumption to allow multiple labels for the same object. It seems unlikely that the mutual exclusivity principle is abandoned at some age, never to be used again. Adults almost certainly would be likely to perform just as children did in study 1 of Markman and Wachtel 1988. When hearing a novel label in the presence of an object with a known label and an object without a known label, adults too would likely interpret the term as referring to the as yet unlabeled object. Although the assumption probably persists into adulthood, it might weaken with age or experience, as the speaker learns that many categories are organized into class-inclusion hierarchies and overlapping sets. Another possibility is that early in life children have the capacity to override mutual exclusivity, on a case-by-case basis, as long as there is enough evidence that it should be violated. It remains to be seen what constitutes "enough" evidence. Perhaps hearing a second label ("animal") applied repeatedly to an object with a known label ("dog") would eventually enable children to violate mutual exclusivity and accept the second label. This should be especially true, for slightly older children, if someone provides information about the relation between the two labels, for example, by stating that a dog is a *kind of* animal. Thus, the mutual exclusivity principle is resistant to multiple labeling but not impervious to it. The principle should be most useful and most evident, then, on children's initial exposure to a new term.