ELSEVIER

Cognition 84 (2002) 267–293

COGNITION

www.elsevier.com/locate/cognit

Adjectives really do modify nouns: the incremental and restricted nature of early adjective acquisition

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Received 19 February 2000; received in revised form 23 March 2001; accepted 12 March 2002

Abstract

By 24 months, most children spontaneously and correctly use adjectives. Yet prior laboratory research that has studied lexical acquisition in young children reports that children up to 3-years-old map novel adjectives to object properties only in very limited situations (Child Development 59 (1988) 411; Child Development 64 (1993) 1651; Child Development 71 (2000) 649; Developmental Psychology 36 (2000) 571; Child Development 69 (1998) 1313). In Experiments 1 and 2 we introduced 36-month-olds (Experiment 1) and 24-month-olds (Experiment 2) to novel adjectives while providing rich *referential* and *syntactic* information to indicate what the novel words mean. Specifically, we used a given novel adjective to describe multiple familiar objects which shared a salient property; in addition we used the adjectives in full noun phrases, not in conjunction with pronouns. Under these conditions, both groups mapped novel adjectives onto object properties. In Experiment 3 we asked whether the rich referential information was responsible for the successful outcome of the previous two experiments; we introduced novel adjectives to 2- and 3-year-olds as in Experiments 1 and 2, but the adjectives modified nouns of vague (very general) reference ("one", or "thing"). Under these conditions the children failed. We suggest that young word learners require access to the taxonomy of the object type so that the relevant property can be identified. The *taxonomically specific* nouns of Experiments 1 and 2 accomplish this, whereas the more general, semantically bleached nominals in Experiment 3 do not. Taken together with related findings in the literature, these findings favor an account of lexical acquisition in which layers of information become available incrementally, as a consequence of solving prior parts of the learning problem.

Keywords: Language acquisition; Adjectives; Nouns; Pronouns; Taxonomy; Toddlers

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0010-0277/02/$ - see front matter
PII: S0010-0277(02)00047-1

1. Introduction

Most 2-year-old children use a number of adjectives in their everyday speech and appear to understand that, in so doing, they are referring to the properties of things. That is, they call Dobermans "big dogs" and Chihuahuas "little dogs". Yet it has been difficult to demonstrate adjective learning experimentally with children this young (Gelman & Markman, 1985; Hall, Waxman, & Hurwitz, 1993; Taylor & Gelman, 1988). In a typical laboratory setting, the experimenter introduces, say, a toy spotted dog and says "This is a *zav* one. Can you show me more *zav* ones?", while displaying various other toys – a pig, a truck, a horse – some of which are spotted and some of which are not. The 2-year-olds try, but fail to select all and only the spotted things as an adult would in these same circumstances.

In the present paper, we attempt to add to the literature seeking to understand this laboratory-to-world mismatch (in particular, following upon and extending a series of important probes and discussions from Waxman and her collaborators, see especially Klibanoff & Waxman, 2000; Waxman & Klibanoff, 2000; Waxman & Markow, 1998). This case is an important one for it shows the difficulty of making good on the everyday – and surely correct – idea that vocabulary items are learned by noticing the extralinguistic contingencies for their use. Alluding to such a world-to-word pairing theory, Locke famously remarked:

> If we will observe how children learn languages, … to make them understand what the names of simple ideas or substances stand for, people ordinarily show them the thing whereof they would have them have the idea; and then repeat to them the name that stands for it, as 'white', 'sweet', 'milk', 'sugar', 'cat', 'dog'. (Locke, 1690/1964; Book 3.IX.9)

Part of the difficulty in word learning, as is by now widely recognized, is that "the thing" that cues the word meaning (the concept, or "idea", in Locke's terms) does not present itself to inspection unambiguously. One can't observe an instance of sugar without its whiteness and its sweetness tagging along. Which of the concepts exemplified in the complex referential situation does the newly heard word express? This aspect of word learning is known as the mapping problem: whatever innate linguistic knowledge prelinguistic infants may have, they still confront the task of matching up the conceptual categories with their phonetic labels in the exposure language. The requirement, that is, is to learn that in English /waIt/ labels the concept 'white' whereas in Spanish it is /bl*a*nko/, a task rendered formidable by the complex and widely varying circumstances in which words are uttered.

The need for a procedure that disentangles viable alternatives in solving the mapping problem requires, at a minimum, the capacity of the learning machinery to operate cross-situationally. One must parse out of successive events in which some word appears that which is "the same" for all of them (Kako, Gleitman, & La Mont, 2001; Pinker, 1984). But this first friendly amendment to word-to-world pairing will not be sufficient, as the phenomenon at hand makes eminently clear: English-learning toddlers easily acquire such terms as *sugar*; they do not mistake it to mean 'white'. So far so good. But the spoiler is they do not as easily or unerringly acquire *white*; rather, in effect, they mistake it

as meaning 'sugar' (cf. Hall et al., 1993). Glaring asymmetries in noun vs. adjective (and verb) frequencies in novice vocabularies, compared to their frequency in input speech, persist until about the third birthday (Bates, Dale, & Thal, 1995; Gentner, 1978; Gentner & Boroditsky, 2001). Before turning to an experimental inquiry into this problem, we will review some of the many reasons why adjectives may pose a special problem for the learning child.

1.1. The problematic status of adjectives

In a language like English, object properties such as color, size, texture, and other physical attributes can be described with adjectives. For example, a leaf can be *brown*, *crinkly*, *bumpy*, *sharp*, *big*, and so on. However, it is not a universal property of language that these meanings can be expressed with adjectives. Dixon (1982) reviews the adjectival systems of a range of languages, some that have no adjective category at all, others that have a closed class of a dozen or so adjectives, and yet others, such as English and Diyrbal, that have a large, open, adjective class. According to Dixon, in languages that have only a handful of adjectives, those adjectives are generally restricted to meanings belonging to the semantic types he calls AGE, DIMENSION, VALUE, and COLOR. Thus, the languages Igbo, Hausa, and Venda each have a minor adjective class, and each has an adjective for 'small', 'old', and for 'white', but not 'rough', 'difficult', or 'fast'. Languages with restricted adjective classes (or with no adjectives at all) use nouns and verbs to express semantic types that surface as adjectives in adjective-rich languages like English. For example, in languages with a restricted adjective category such seemingly prototypical (in English) adjectival meanings as 'rough' and 'smooth' (what Dixon calls PHYSICAL PROPERTY terms) are generally expressed as *verbs*. Other semantic distinctions such as 'happy', 'jealous', and 'mean' (which Dixon classifies as HUMAN PROPENSITY terms) generally surface as *nouns*. These cross-linguistic comparisons show one (of many) ways in which the mapping from conceptual to lexical structure varies exceedingly. Some properties expressed as adjectives in English (and in other adjective-rich languages) are assigned to the noun and verb classes in other languages. Thus, one potential explanation for why acquiring adjectives is hard has to do with the possibility that they fall into a variety of conceptual classes whose conflation under a lexical categorization, as in English, is more arbitrary than natural. Compare this situation with the case for terms labeling whole concrete objects; just about universally, with only very minor quirks, these surface as nouns cross-linguistically – the linkage of form to meaning is quite transparent (Pinker, 1984). The learning task seems much more formidable for property terms, as the learner cannot begin with even a weak conjecture as to how they will be lexicalized in the exposure language. Even in English, where there is a robust adjective category, it certainly isn't the case that all property descriptions surface under this categorization (e.g. *triangle* is a noun, but means 'something triangle-shaped')[1] or that adjectives always describe properties (*former*, *similar*, and *mere* are not

[1] Wierzbicka (1986) links this to the fact that shape properties (e.g. *triangle*, *circle*, *square*, etc.) delimit countable entities, and are thus good candidates for expression by nouns.

properties of the nominal concepts they modify). A different approach is from Bierwisch (1967) and Landau and Gleitman (1985), who suggest that the prototype for adjectival categorization even in English is for relative polar pairs such as big/small, and clean/dirty, making these easier to acquire than the words for property terms such as color and absolute size terms.

For extensive linguistic discussion concerning the structural, distributional, and semantic characteristics of adjectives within and between languages the reader is referred to several excellent linguistic sources including Bhat (1994), Bierwisch (1967), Dixon (1982), Stowell (1981), Wetzer (1996), and Wierzbicka (1985). Whatever the ultimate explanation of these formal and substantive complexities, we should not expect learning for the category adjective to be uniform and seamless, but rather to be like noun learning (to the extent that adjectives are like nouns) and like verb learning (to the extent that adjectives are like verbs). So let us step back a moment to these other, evidently more basic, lexical categories and very briefly sketch basic facts that are known about their learning.

1.2. Why nouns are easy to learn

In English and many other languages, it has been observed that the earliest child vocabularies disproportionately favor items that are, in the adult language at least, nouns (Bates et al., 1995). Unsurprisingly, these noun-like infant words are not infrequent, complex, or abstract terms like *thought* or *invidiousness* or *modernization*; rather, the emphasis is on names for cohesive (in the sense of Spelke, 1982) whole objects, under their so-called basic level interpretations, that surface as count nouns (Goldin-Meadow, Seligman, & Gelman, 1976; Huttenlocher, 1974; Woodward & Markman, 1998). Action and property terms are underrepresented in earliest vocabularies despite the fact that middle-class caregivers are furiously teaching their toddlers "their colors" and "their shapes". Although prelinguistic infants are sensitive to events (Kellman & Arterberry, 1998; Spelke, Breinlinger, Macomber, & Jacobson, 1992) and to at least some of the properties of things (see, e.g. Bornstein, 1975, on color preferences in young infants), it has been convincingly argued that whole objects have a natural conceptual priority by being the most easily and reliably individuated entities (Bloom, 2001; Gentner & Boroditsky, 2001).

Several proposals are to the effect that the noun dominance in early vocabularies is not only (or not so much) an effect of early conceptual biases as of linguistic biases (natural or rapidly learned) about what words encode. Shown a new object and told "This is my gorp", there is apparently a strong bias to interpret that label as naming the whole object rather than its parts, texture, etc. (Markman & Hutchinson, 1984; Soja, Carey, & Spelke, 1991). As learning proceeds further, count noun morpho-syntax in languages like English may materially enhance such a bias (Bloom, 2001; Brown, 1957). To the extent that infants are in thrall to "things", we see another basis on which to predict that adjective learning should be hard: all candidate lexical items suffer insofar as they are not nouns and do not label whole objects. Consistent with such a supposition, 2-year-olds in laboratory settings try to acquire nominal terms even when internal linguistic evidence ought to suggest that they aren't there: they often interpret novel adjectives (defined positionally and morphologi-

cally, e.g. "Give me the zavish one") as labels for the objects that they are shown rather than for properties of those objects (Hall et al., 1993).[2]

1.3. Why verbs and adjectives are harder to learn

The whole-object bias has transparent advantages for early learners as it radically narrows their search-space for an interpretation under ambiguous observational conditions. Of course, to succeed in acquiring the vocabulary as a whole, the acquisition device eventually must overcome the very bias that gave it the first leg up. Below we describe a number of cues that are known to improve the learner's chances of identifying a novel word as an adjective or verb rather than, by default, as a noun.

1.3.1. Familiarity

One basis for rejecting the idea that some new word refers to the whole object in view is to recognize (implicitly, of course) that one already has a familiar vocabulary item labeling that object. Perhaps the most famous example is from Markman and Wachtel (1988). When they showed young children a pair of tongs (an unfamiliar object for which the children had no vocabulary item) and said "This is pewter", the children thought that *pewter* meant 'tongs', as shown by their generalization performance on a later test. But when shown a cup (a familiar object with a known linguistic label), the children inferred that *pewter* referred to the material kind of the cup. Markman and her colleagues explained the finding in terms of a primitive theory of *mutual exclusivity*: only one linguistic label should be applied to any one thing in the world. While this particular explanation has been debated (see Clark, 1997, for a different perspective on these and related findings), there is no doubt about the power of familiarity to lead learners to interpret a novel labeling term as a label for something other than the whole object.

1.3.2. Basic level exemplars

Early word learning not only favors whole-object interpretations, but favors these interpretations under "basic level" representations. That is, babies often extend 'Fido' to all dogs, but they do not extend the terms any further than that, say, to include all animate things, all objects, etc. Adults in laboratory experiments, identifying known words from examining their contexts of use, have been shown to exhibit the same differential success with basic level representations (Snedeker & Gleitman, in press).

It seems odd at first glance to be asserting that basic level cues might aid in *adjective*

[2] The reality of the whole-object bias and its vocabulary concomitants have been questioned. Several authors have suggested that it is an input effect, and is much diminished in languages where the verb/noun ratio in maternal speech differs from the English case. This happens especially in languages that allow significant argument-dropping at the surface (e.g. Gopnik & Choi, 1995; Naigles, Gleitman, & Gleitman, 1993; Tardif, Shatz, & Naigles, 1997). Depending on data collection procedures, noun preponderance even in English-speaking toddler speech varies significantly (to see why, consider conversations about naming animals in the zoo vs. conversations about how to ride a unicycle). Therefore, maternal checklists of words that toddlers know yield a higher noun to verb ratio than corpus transcripts, and in our view give a fairer measure: they sample all that the child knows, rather than what he is most likely to say. For important reviews that extract the noun-dominance effect and the whole-object bias from the complex matrix of factors that affect them, see Gentner and Boroditsky (2001), and Kuhn and Siegler (1998).

learning, since we just argued that they reinforce and amplify nominal interpretations. But basic level terms can aid adjective learning indirectly by revealing that since the head noun is one of them, then its modifier cannot be that very one. Klibanoff and Waxman (2000) showed just this, by producing an effect that is reminiscent of the Markman and Wachtel (1988) finding for basic level object terms: exhibiting several basic level exemplars of a nominal category releases children from interpreting a modifier as an object term. They showed 3- and 4-year-olds, say, a toy horse with some salient property, e.g. covered with bumps, saying "This is a very blickish horse, this horse is blickish."[3] Next the children were shown two other horses of the same general appearance, e.g. both painted the same color, but only one of which was bumpy; and then they were asked "Can you give [a puppet] another horse that's blickish?" The original bumpy horse was visible as the question was asked. The children succeeded in selecting the property-matched object more often than they did in another (*across-basic-level*) condition in which the test objects were from a *different* basic level class (e.g. "This is a very blickish horse; can you give [the puppet] a rhinoceros that's blickish?"). After the children in the within-basic-level experimental condition were coaxed to apply "blickish" to various horse-breed toys, they were able to take the term further afield, to other basic level types. But not so in the across-basic-level (rhinoceros) condition. So adjectives were easier to learn when the properties that these represented were repeatedly differentiated from the basic level kinds in which they inhere. (In effect, these children were led to notice that *blickish* could not mean 'horse' just because the word for 'horse' is already known to be *horse*.)

1.3.3. Effects of language on language learning

Of particular interest in the present context is that verb learning is generally more dependent on linguistic information than is noun learning. (We have already discussed one account for why this should be: verbs suffer just because they do not encode the favored object concepts. For further discussion of other factors affecting verb learning, see Gentner (1978, 1982), Gillette, Gleitman, Gleitman, and Lederer (1999), Snedeker and Gleitman (in press), and Snedeker and Li (2000).) In particular, syntactic features reflecting argument structure have been shown to provide powerful supportive information that influences mapping solutions in both young children and adults (Naigles, 1990; see also Fisher, 1996; Fisher, Hall, Rakowitz, & Gleitman, 1994; Gleitman, 1990; Landau & Gleitman, 1985). Thus, while noun learning can begin as soon as the infant begins to inspect the extralinguistic world, verb learning generally requires a substantial amount of internal linguistic support. Because that information concerns selectional information about nouns and aspectual and subcategorization information about sentences, in general verb learning is parasitic on and subsequent to the acquisition of a stock of nouns.[4] As we next will suggest in the context of three experiments, adjectives are hard to learn (at least

[3] Notice that the exhibited *object* is not what's "basic level"; that object can be represented as a horse, an animal, a thing, etc.; that is the whole problem. The utterance of the priorly known word *horse*, while exhibiting a horse, is what makes this "a basic level exemplar".

[4] It is important to note that further, and crucial, background features of all word learning are not reviewed at all in the present article, e.g. the social-referential conditions under which a learner will believe that newly heard words are making reference to the passing scene (Baldwin, 1995; Tomasello & Kruger, 1992, *inter alia*; and for an important overview, Bloom, 2000).

in part) because their learning too is parasitic on the noun vocabulary. The interpretation of adjectives is conditioned by the nouns with which they co-occur (compare, for example, the sense of *good* in *a good knife*, *a good wife*, *a good fife*, and *a good life*; Katz, 1964). Moreover, adjectives coherently modify nouns belonging to distinctive taxonomic classes. Hence, while a *purple cow* may be rare, a *green idea* is a category error (except of course in metaphorical extensions as an anonymous reviewer has reminded us). All these considerations are suggestive for why adjectives are on average acquired later than nouns: like verbs, they are most efficiently identifiable if linguistic-contextual information supports the extralinguistic information available when they are heard. The specific information required has to do with just how they appear in construction with nouns.[5]

1.4. Summary, and an experimental prospectus

We began this introduction by pointing to ways in which word-to-world mapping is particularly problematic when acquiring adjectives, emphasizing the well-documented bias toward basic level object terms in earliest novice vocabularies. As we stated, the very seductiveness of such representations of heard words makes it hard for children to learn any others. We next described a variety of linguistic and referential cues that have been shown to override the object-term advantage in the process of acquiring an adult vocabulary. One of our aims in the experiments that follow is to show two of these cues in action with 2-year-olds, for whom it has heretofore been difficult to show adjective learning. Sometimes the difficulty with laboratory investigations is not that they are on the wrong track about these cues, but that they do not provide enough of them at once. In this paper, we will provide laboratory demonstrations that provide the youngster with more than one cue, with the effect that 2-year-old laboratory performance improves markedly, dovetailing better with the data from spontaneous speech. Prosaically enough, then, adjective learning, like all word learning, can be improved by adding to the cues that are made available in some setting.

The experiments also engage a second problem. This is that even when the environment

[5] For the case of adjectives, a particularly interesting case of linguistic support for vocabulary growth is the learning advantage of paired antonymous adjectives over other adjectives. The antonymous adjectives are those that generally describe relative polar pairs, such as *clean/dirty*, *long/short*, and the like (by "relative" we mean that the term is relative to the nominal class being modified, e.g. a small wooly mammoth is significantly larger than a big centipede; cf. Keenan & Faltz, 1985). These items represent ranges at the "high" or "positive" vs. "low" or "negative" ends of some dimension (Clark, 1988; Dixon, 1982; Givon, 1970). The items at the positive end of the scale usually double as measure words that get used to name the dimension without regard to the position of the nominal on it. We readily say "How tall is that dwarf?" despite his or her shortness while the negative member of the pair is rarely used this way, e.g. "How short is that giant?" is a distinctly odd locution. These special usage properties of the positive member were invoked both by Clark (1990) and Landau and Gleitman (1985) to account for the fact that antonymous adjectives are far more errorlessly and early-acquired than the multivalued non-polar adjectives. Thus, *light/dark* have a learning advantage over hue terms, *tall/short* over length terms, and so forth. Landau and Gleitman argued that the difference lay in the availability of linguistic cues. The multiple color terms have to be acquired by brute-force observation of the real-world contingencies for their use whereas for the antonymous pairs there is a stable linguistic differentiation of the two members of the pair. In addition, Justeson and Katz (1991) (see also Charles & Miller, 1989) showed that antonym pairs have very high co-occurrence rates in specific syntactic contexts within sentences. This could be another cue that heightens the association of these words and affects the ease with which they are acquired.

instantiates the required information, the child at early points in language acquisition may not be able to access it. Learners do not arrive on earth pre-equipped with access to all the cues that are required for acquiring broad segments of the lexical stock. Rather they have to build the cue systems themselves in the course of acquiring the linguistic categories and functions (Gillette et al., 1999). The first-learned words (concrete nouns) enable novices to build more sophisticated linguistic representations which, in turn, make possible the learning of other kinds of words (verbs and adjectives). Such arm-over-arm learning procedures are often called "bootstrapping", for they build new categories out of more primitive materials of quite a different character (e.g. Gleitman, 1990; Grimshaw, 1981; Hermer & Spelke, 1996; Pinker, 1984). The same term metaphorically emphasizes the potential question-begging property of any such procedure unless its initial steps can be grounded in some database that is pre-given, or itself acquired by other means. We therefore briefly described, above, present evidence to the effect that basic level noun learning plays this grounding role; that is, forms the scaffold on which other word learning is based. In these experiments we examined the role of known nouns in facilitating adjective learning.

In detail, the experiments further investigated the cue conditions under which 2- and 3-year-olds successfully acquire novel (nonsense) adjectives. As in most prior experiments, these terms were introduced in modifier and predicative positions in noun phrases. Experiments 1 and 2 demonstrate that generalization of new property terms is improved if two stimulus conditions are obtained. The first was that the structural information was made as transparent as possible. This was done by having the noun phrase contain a lexical noun rather than a pronoun ("a stoof *dog*" rather than "a stoof *one*"). The second was that the child subjects were provided with several exemplars that crossed the basic level category whilst sharing the same property. Experiment 3 asked whether the multiple exemplar feature of this training did all the work or whether the simultaneous presence of the lexical noun was crucial for 2- and 3-year-olds acquiring their first modifiers. After all, as we have mentioned earlier, all children who successfully acquire adjectives have antecedently acquired a stock of common nouns, along with their meanings. It may very well be that the newly built scaffold of simple nominal phrases provides the most useful structural context for acquiring adjectives. Within this structure, the lexical noun selects the domain (a taxonomic set) for the modification and restricts the interpretation of the adjective. Thus, if taxonomic selection enters into adjective learning, we should find that a child will do better when she hears "The stoof horsie" compared to hearing "The stoof one". If we are right, adjectives really do modify nouns.

2. Experiment 1

The goal of Experiment 1 was to determine if 36-month-olds would map novel adjectives to object properties when presented with multiple examples of word-to-property matches across different known objects. As mentioned in introductory remarks, previous studies (Hall et al., 1993; Klibanoff & Waxman, 2000) have demonstrated that, with single training exemplars, 3-year-olds fail to map novel adjectives to object properties unless training and initial test items are from the same basic level category. In addition to

providing multiple word-to-property exemplars, we used common known nouns to label the objects (e.g. "This is a *stoof* horsie!"), rather than pronouns (e.g. "This is a *stoof* one!"). We predicted that such a learning situation would provide sufficiently rich linguistic and referential cues to allow 3-year-olds to successfully assign property interpretations to novel adjectives.

2.1. Method

2.1.1. Subjects

The subjects were 24 children approximately 36 months old ($M = 36.3$, SD 2.5). Three more children were tested but were not included due to failure to respond in at least three trials. Subjects were tested individually in Philadelphia area daycares and at the University of Pennsylvania.

2.1.2. Materials

Each subject received six test trials in which they were presented three *training* objects which were common toys (e.g. horse, ball, car, etc.). For a given trial, all three training objects shared one salient property from the following set of six properties: covered in felt, striped yellow, covered in Velcro, wrapped in thin wire, drilled with holes, covered with blue stars. Subjects were also shown two *test* objects on each trial: a Kind-Matched object and a Property-Matched object. The Kind-Matched object was the same kind of object as the last training object the subject saw (e.g. another ball), but differed in its salient property from the three training objects. The Property-Matched object was a common toy which differed in kind from all of the training objects in that trial, but which shared the training objects' salient property. (Notice that the subjects were being asked to acquire non-polar adjectives rather than antonymous pairs. Though it is of great interest to consider both types of linguistic item in the learning context, we had in mind in the present experiment to hold this factor unchanged from prior studies, for comparability.) Trials were designed so that no test object would appear more than once as the Property-Matched object in the experiment, and likewise so that no test object would appear more than once as the Kind-Matched object. The training and test objects for each trial and the order of presentation within each trial are shown in Table 1.

Table 1
Stimulus sets, Experiment 1

Training Objects	Property	Test	
elephant block ball	FELT	car-FELT	ball-VELCRO
car cup rabbit	STARS	fish-STARS	rabbit-STRIPES
block cup horse	WIRE	elephant-WIRE	horse-HOLES
elephant car fish	VELCRO	rabbit-VELCRO	fish-STRIPES
ball horse boat	HOLES	block-HOLES	boat-WIRE
block horse cup	STRIPES	boat-STRIPES	cup-STARS

2.1.3. Procedure

The entire experiment was set up as a show and tell game. A Tweety Bird puppet was described as the experimenter's friend who wanted to show his toys to the subject using "Tweety Bird Language". Subjects were tested individually and were randomly assigned to one of two conditions: Adjective or Deictic. For each trial in both conditions, Tweety Bird removed the three training objects one at a time from a closed container and give them to the subject to examine. In the Adjective condition, each training object was presented while Tweety Bird described the object using a nonsense adjective. The adjectives were: *stoof*, *zav*, *rup*, *bisk*, *drin*, and *prall*; the examples below use *stoof*. The training sentences (descriptions) were of the form, "Look at this *stoof* horsie! This horsie is very *stoof*." Each sentence form was used at least once in describing each object; for variety, *really* was sometimes used instead of *very*.[6]

After the three training objects were presented to the subject, the puppet would say, "See, these things are all *stoof*", while indicating the three training objects. The experimenter would then show the subject the two test objects side by side, and ask, "Look at these two things. Can you give Tweety Bird the *stoof* one? Can you show Tweety Bird which of these two things is *stoof*?" The left–right order of the test objects (Property-Matched vs. Kind-Matched) was random. A response was recorded if the subject picked up or pointed to one of the two test objects. If the subject chose the object that had the same property as the training objects, a Property-Matched response was recorded. If the subject chose the object that was of the same basic level kind of the last training object, a Kind-Matched response was recorded. If subjects failed to respond, the question was repeated for up to a total of three times. If no response was obtained after the third attempt, a *No Response* was recorded. A *Both* response was recorded if the subject selected both objects. The sentences in each trial used a different nonsense adjective.

The Deictic control condition was designed to replicate the non-linguistic aspects of the Adjective condition and to rule out the possibility that consistent Property-Matched choices in the Adjective condition were due to greater saliency of the Property-Matched objects, or to a general bias for subjects to match properties in their choices, regardless of the linguistic context. In the Deictic condition the three training objects were paired with sentences that did not contain an adjective or the name of the object and were of the form, "Look at this!", or "Wow! Here's something else!" After the three training objects were presented to the subject, the puppet would say, "Look at all these things!", while indicating the three training objects. The experimenter would then show the subject the two test objects, side by side, and ask, "Now you give Tweety Bird something. Give Tweety Bird one of these two things." Responses were recorded in the same way as in the Adjective

[6] Some readers may wonder why we chose not to make the morpho-syntactic information stronger by using adjectival endings such as *-ish*, *-y*, or even *-ed*. Although these endings could provide a strong cue to the syntactic category of the novel word, we were concerned that the available semantic interpretations might be affected if we used them. The stems these affixes occur with are sometimes words themselves (e.g. *luck/lucky*, *small/smallish*, *stripe/striped/stripy*), but there are restrictions on which affixes can occur with a stem (e.g. *smally*?). To the extent that these restrictions are correlated with semantic properties (and to the extent that children are sensitive to these correlations), the choice of affix might subtly affect the kinds of meanings a child is willing to attribute to a novel adjective and perhaps bias them *against* the property interpretations that would be otherwise available. Therefore, we chose to use adjectives without derivational morphology.

condition. We expected that subjects would respond at chance in this condition, or perhaps show a predominance of Kind-Matched responses.

There were four different trial order lists for each condition. For the Adjective condition, each of the four trial order lists varied which adjective was paired with each property. Trials were designed so that the last training object which was presented to the subject matched in kind with one of the test objects: specifically, the test object that did not share the salient property with the three training objects.

2.1.4. Response scoring

The total number of Property-Matched responses was recorded for each subject. Property-Matched responses were coded as 1 and Kind-Matched responses were coded as 0. Since there were six *training-test* trials per subject, the maximum score is 6. Responses where both test objects were chosen, or where the subject did not respond, were scored as 0.5 (neither a Property-Matched nor a Kind-Matched response). The number of Property-Matched responses was tallied for each subject and averaged across subjects. If subjects performed at chance in choosing the test object, the mean number of Property-Matched responses should be 3.

2.2. Results

Every subject except for two gave a response in each trial; two of the subjects chose a test object in five out of the six trials. Another subject in the Adjective condition responded in one trial by choosing both test objects. In the Deictic condition, all subjects selected an object in all six trials. One subject chose both test items in two trials, and another subject chose both test items in one trial.

Fig. 1 shows mean Property-Matched response for subjects in the Adjective and the Deictic conditions. The mean Property-Matched responses were 4.4 (SD 1.8) and 2.9 (SD 1.4) for subjects in the Adjective and Deictic conditions, respectively. Subjects in the Adjective condition were better than chance at choosing the test object with the property which matched the training items ($t(11) = 2.76$, $P < 0.05$). Subjects in the Adjective condition were also significantly more likely to pick Property-Matched test objects than subjects in the Deictic condition ($t(22) = 2.27$, $P < 0.05$). Subjects in the Deictic condition performed at chance ($t(11) = 0.2$, n.s.).

An analysis by item was also performed in which the number of Property-Matched responses was tallied for each test trial and averaged across the 6 items in each condition. The chance Property-Matched response for each item was 6. Items elicited a significantly greater number of Property-Matched responses than would be expected by chance in the Adjective condition ($M = 8.8$, SD 1.5, $t(5) = 4.72$, $P < 0.01$). Property-Matched responses elicited by items in the Deictic condition were at chance level ($M = 5.8$, SD 1.7, $t(5) = 0.24$, n.s.). Items in the Adjective condition elicited significantly more Property-Matched responses than items in the Deictic condition ($t(10) = 3.24$, $P < 0.01$).

2.3. Discussion

The results just reported suggest that 36-month-old children can learn the meanings of novel adjectives from a few exposures to their real-world contingencies, at least when that

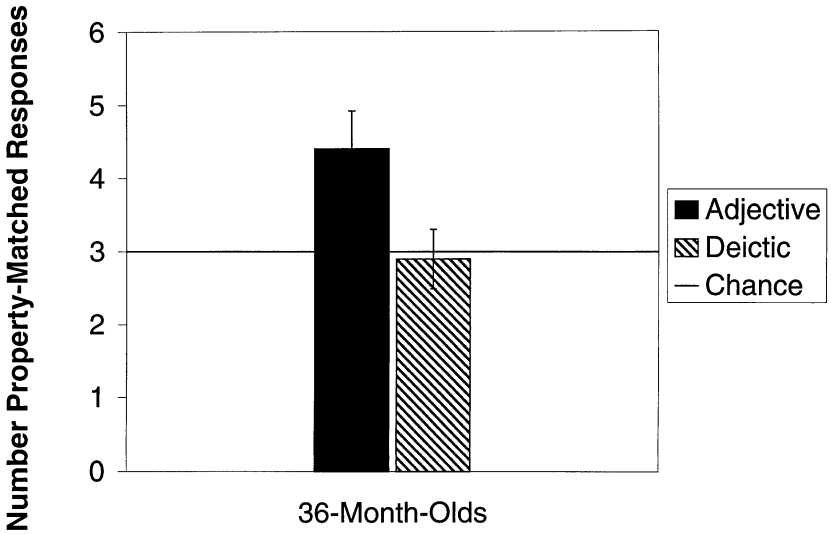

Fig. 1. Average number of property responses (36-month-olds).

adjective modifies a count noun. Notice that under these training conditions, the 3-year-olds did not require the support of within-basic-level use of a novel adjective to infer and generalize its meaning (Klibanoff & Waxman, 2000).

3. Experiment 2

Here we test whether the Experiment 1 training procedures are sufficient for even 2-year-olds to acquire novel adjectives. As we stated in the introductory remarks, it has not been easy to show adjectival learning in children until they are 3 or even 4 years of age. The findings in this literature for 2-year-olds have been even more dismal, excepting only the situation in which there is explicit repetitive training with a single basic level nominal (Hall et al., 1993; Taylor & Gelman, 1988; Waxman & Markow, 1998). Here we ask whether 24-month-old children would benefit from the enriched training situation that benefited the 36-month-olds in Experiment 1.

3.1. Method

3.1.1. Subjects

The subjects were 24 children approximately 24 months of age ($M = 24.1$, SD 1.4). Five more children were tested but were not included due to failure to respond in at least three of the trials. Subjects were tested individually in Philadelphia area daycares and at the University of Pennsylvania.

3.1.2. Materials

The materials were identical to those used in Experiment 1, except that three object

types were replaced with new objects. All rabbits were replaced with pigs, all boats were replaced with monkeys, and all fish were replaced with kangaroos. The objects from Experiment 1 that were excluded were poorly featured plastic sand molds; pilot studies showed that 24-month-olds had difficulty identifying these objects. The within-trial presentation order of the objects was identical to that of Experiment 1 (see Table 1), but with the rabbits, boats, and fish replaced with pigs, monkeys, and kangaroos, respectively.

3.1.3. Procedure

The procedure was the same as the one used in Experiment 1, with the following exceptions. For each trial, before the training objects were described to the subject, subjects were shown and allowed to play with all five training and test objects for that trial. Pilot studies with these younger subjects suggested that their initial encounter with the objects attracted their attention away from the puppet's description of the objects during training and the experimenter's requests during testing, resulting in high rates of non-response. The brief pre-training exposure period familiarizes the subject with all of the objects in the trial. In addition, subjects who were tested in daycares during pilot studies often did not respond to the puppet or the experimenter. Therefore, 1 or 2 days before the experiment was carried out, the experimenter played with the subjects in a group with their peers. This interaction allowed the subjects to become comfortable with the experimenter, and they were much more responsive during the experiment. Subjects who came into the lab did not receive this pre-experiment play, but at least one parent was in the testing room with them.

3.1.4. Response scoring

Despite our additional efforts to make the task acceptable to 24-month-olds, there were nonetheless a portion of trials for some subjects to which the subject did not respond. (Subjects who did not respond to at least three trials were not included in the study; see Section 3.1.1.) Therefore, scoring the mean number of Property-Matched responses per subject was not an appropriate measure here, as it was in Experiment 1. Instead, difference scores were computed for each subject by scoring Property-Matched responses as 1, Kind-Matched responses as -1, and summing these scores; non-responses and Both-Object responses were scored as 0. Chance performance would thus yield a mean difference score of 0. Positive difference scores indicate that subjects preferred Property-Matched responses, and negative scores indicate that they preferred Kind-Matched responses.

3.2. Results

In the Adjective condition, four of the 12 subjects selected a test object in all six trials. Of the eight who did not respond in all trials, two subjects failed to select at least one test item in three trials, five subjects failed to select a test item in two trials, and one subject failed to select a test item in only one trial. One subject in the Adjective condition selected both test items on one trial – the same subject also failed to make a choice in two trials. In the Deictic condition, eight subjects selected a test object in all six trials. Of the four who did not respond in some trials, two subjects failed to select a test item on two trials, and two

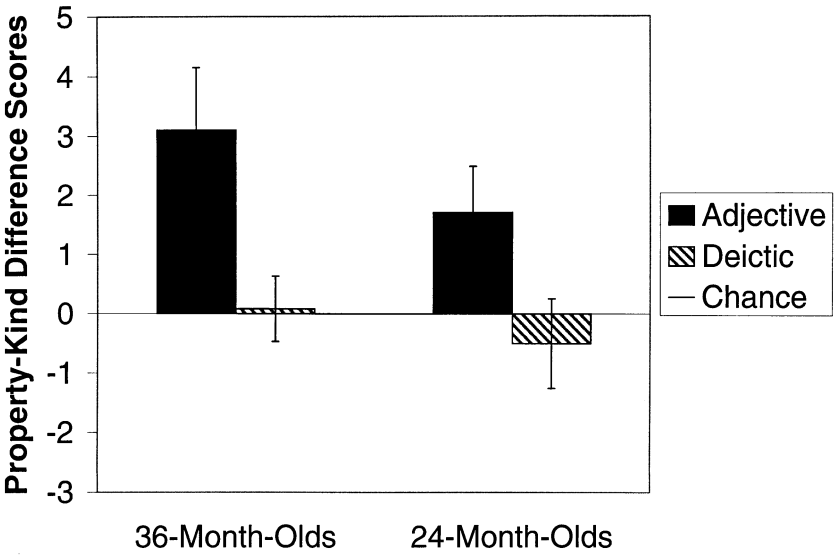

Fig. 2. Difference scores; Experiments 1 and 2.

subjects failed to select a test item on one trial. Three subjects in the Deictic condition selected both test items on two of the six trials – one of these subjects also failed to respond on one of the other trials.

Difference scores were computed for each subject and then averaged across subjects in each condition. The mean difference scores were 1.7 (SD 1.9) and −0.5 (SD 2.6) for subjects in the Adjective and Deictic conditions, respectively. Fig. 2 shows the difference scores for subjects in Experiment 2 as well as the data for subjects in Experiment 1 replotted as difference scores for comparison.[7]

Subjects in the Adjective condition were significantly more likely to make Property-Matched than Kind-Matched responses ($t(11) = 3.08$, $P < 0.05$). Subjects in the Adjective condition also made more Property-Matched over Kind-Matched responses than subjects in the Deictic condition ($t(22) = 2.34$, $P < 0.05$). Subjects in the Deictic condition were at chance in their choice of test objects ($t(11) = 0.66$, n.s.).

An analysis by items showed that the mean difference score for items in the Adjective condition was 3.3 (SD 4.4), and in the Deictic condition −1 (SD 2.19). The items analysis showed that there was a trend towards items eliciting a greater number of Property-Matched vs. Kind-Matched responses in the Adjective condition than would be predicted by chance ($t(5) = 1.87$, $P = 0.06$, one-tailed). The item effect is not as strong as it was in Experiment 1, however all items but one elicited more Property-Matched responses than Kind-Matched responses.[8] Items also elicited more Property-Matched over Kind-Matched

[7] All the reported results from Experiment 1 hold when the same analyses are performed using difference scores instead of absolute number of Property-Matched responses.

responses in the Adjective condition than in the Deictic condition ($t(10) = 2.17$, $P < 0.05$, one-tailed). Items in the Deictic condition elicited chance performance ($t(5) = 1.18$, n.s.).

3.3. Discussion

Taken together, Experiments 1 and 2 show that, as early as their second birthday, children can use the invariance of word-to-property mapping across multiple objects to learn the meanings of novel adjectives in the case where the noun phrase contains a lexically specified head noun.

From these results, we could not tell exactly where the burden of information really lay in the enriched training situation we created for our young subjects in Experiments 1 and 2. Would the stronger linguistic support (full lexical noun phrases) be enough, even without the enriched extralinguistic support (multiple exemplars)? That is, if one says "That is a *stoof* horse", any listener would be well advised to reject "horse" as the meaning of *stoof*, even though there is uniformly a horse in sight. Perhaps this factor in the experimental situation explains why our subjects were as successful as they were. The prior literature supplies part of the answer to this question: Klibanoff and Waxman (2000) showed that the provision of lexically specific noun phrase contexts (with a single training exemplar) is insufficient to produce the adjective learning effect in children this young. What is unknown, though, is whether multiple cross-categorial training exemplars alone – that is, without linguistic support – will do the trick. We next examine this possibility.

4. Experiment 3

In Experiments 1 and 2 we provided toddlers with strong linguistic support for word-to-property mappings. By using noun labels that the toddlers knew we plausibly weakened their default search for a nominal interpretation. But as we just mentioned, full lexical noun phrases do not seem to be sufficient to produce property interpretations in 3- and 4-year-olds. In Experiments 1 and 2 we also provided rich extralinguistic support with the multiple exemplars, each licensing the same property interpretation. In the present experiment, we took these factors apart. Specifically, we asked whether the enriched extralinguistic evidence alone is sufficient for inducing adjective meanings in 2- and 3-year-olds.

4.1. Method

4.1.1. Subjects

The subjects were 24 children tested individually in Philadelphia and Los Angeles area daycares, and at the University of Pennsylvania. Subjects were divided into two groups of 12 children according to age: children in one group were approximately 24 months old ($M = 24.6$, SD 2), and children in the other group were approximately 37 months old

[8] The set of objects covered in Velcro was the only set to elicit more Kind-Matched responses than Property-Matched responses. It is not clear why these materials should elicit the opposite effect from all the others, however the Velcro set was also the set in Experiment 1 that elicited the fewest number of Property-Matched responses in the Adjective condition.

($M = 37.4$, SD 1.4). Four more children were tested but were not included because of failure to respond in at least three of the trials (three), or due to experimenter error (one).

4.1.2. Procedure

Experiment 3 used the same toy objects as Experiment 2. Presentation of the objects was identical to the method used in Experiments 1 and 2, except that the sentences describing the objects were different. The sentences were similar to the sentences in the Adjective condition in Experiments 1 and 2, but with the noun label replaced by the word *one* or *thing*. Thus, if the adjective being taught was *stoof*, while being shown an object with a novel property the subject would hear, "Wow! Look at this *stoof* thing! This one is really *stoof*!" As in the previous studies, a given object was described with two or three sentences that varied the adjectival frame used.

A potential concern with using the vague label, *thing*, in place of common nouns, is that subjects might find the use pragmatically odd, given that they know more specific nominal terms to refer to the objects. If that were the case, their performance on the experimental task might be affected by the perceived oddity of the discourse. However, we do not believe that this concern is warranted in the present experiment, given that the subjects' discourse partner in the game that we have constructed is the Tweety Bird puppet. The very premise of the game is that the words that Tweety Bird knows (e.g. *stoof*, *zav*, etc.) are different from the words that the subject knows. Thus, it is quite natural that Tweety Bird would refer to something as *thing*, even though our subjects might know the object to be a *ball* or a *toy*. In short, in the context of a game which is premised on the mismatch in the vocabulary of the subject and her interlocutor, the latter's use of *thing* when a more specific noun could be used seems very much in keeping with the nature of the game.

A slightly different concern arises with the use of the pronoun *one*. The felicitous use of *one*, in combination with an adjective, requires both that a domain of reference already be established ("one of *what*?") and that at least two members in the domain – one of which being the specific referent of *one* – contrast along some property dimension. These constraints dictated a procedural control such that Tweety Bird always referred to a training exemplar with *thing* before referring to it as *one*. The use of *thing* specifies, albeit vaguely, the domain, 'things', of which *one* can then select a specific member.[9] In sum, we ensured that the pragmatics of the exemplar descriptions was perfectly normal, despite the use of vague labels.

4.2. Results

Fig. 3 plots results from Experiment 3 with those of the previous experiments for comparison. Neither 2- nor 3-year-olds mapped the novel adjectives to object properties. Both groups were at chance performance in making a Kind-Matched vs. Property-Matched response. The mean difference scores were -0.167 (SD 2.55, $t(11) = -0.23$, $P = 0.83$) for the 24-month-olds and -0.33 (SD 3.39, $t(11) = -0.34$, $P = 0.74$) for the 37-month-olds. Thus, a switch of the object label from a known noun to a vague label produced a dramatic change in the interpretation of the novel adjective.

[9] We thank an anonymous reviewer for encouraging us to make this point clear.

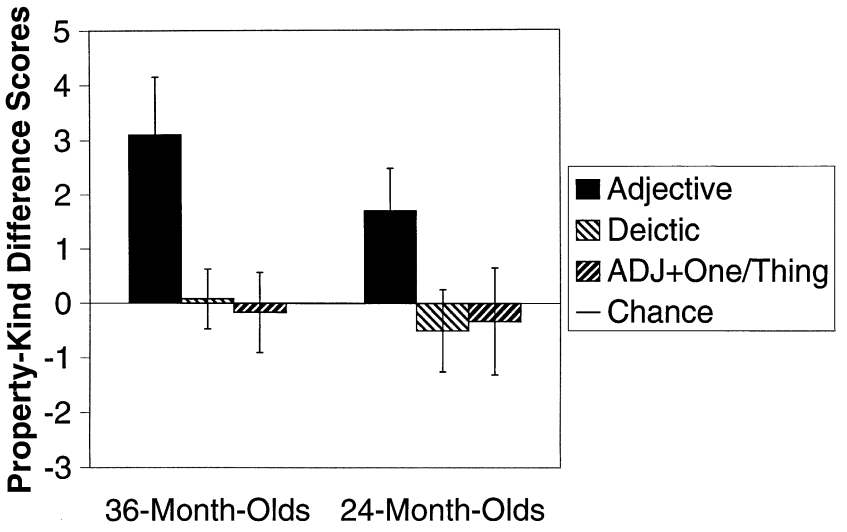

Fig. 3. Difference scores; Experiments 1, 2 and 3.

4.3. Discussion

As we have just seen, subjects in the present experiment failed to acquire modifier meanings when linguistic information like "This is a *stoof* one" replaced the more specific "This is the *stoof* horsie". This was so even though we supplied the enriched extralinguistic information of multiple exemplars, as in Experiments 1 and 2. Based on these findings taken together, we can now state a set of conditions that are necessary and – at least in the test cases – sufficient for adjective learning in very young children: the children succeed when (a) they view multiple cross-categorial exemplars, displayed while (b) the experimenter is uttering lexically specific noun phrases ("here's a *zav* horse; here's a *zav* cup…"). This is what Experiments 1 and 2 showed for 3-year-old and 2-year-old subjects, respectively. Children fail to learn, as Klibanoff and Waxman (2000) showed, when the lexically specific noun phrases are presented with single rather than multiple exemplars. And they fail to learn also, as shown in Experiment 3 of the present series, if the multiple exemplars are provided without the lexically specific noun phrases. In short, rich and specific extralinguistic and linguistic support are jointly required in the first fragile moments of adjective acquisition.

Before we turn to a general discussion of the results of our three experiments and related work, we would like to address two potential concerns with our interpretation of the results of Experiment 3. The first concern is whether our training exemplar descriptions are pragmatically felicitous, and the second is whether they are referentially clear.

4.3.1. Are the object descriptions pragmatically felicitous?

As we mentioned in our explanation of the procedure for Experiment 3, we were aware of the potential pragmatic infelicity of using the labels *one* and *thing* when referring to

items that were known to the subjects, and we therefore used a procedure that satisfied the pragmatic constraints. We obtained further assurance that the pragmatics of the situation were normal by testing adults in the Adjective condition of Experiment 3. Twelve undergraduates at the University of Southern California received course credit to participate in the study. They were given the same instructions as the children in Experiment 3. They were further advised that the experiment might seem a little silly because it was designed for children, but that we were training the experimenter to run the study on children. After the adults completed the six trials, they were asked if they thought anything was strange, or weird about the experiment.

All but one adult subject uniformly made Property-Matched responses; one subject made five out of six Property-Matched responses (the mean difference between Property-Matched and Kind-Matched responses was 5.83, SD 0.58). Thus, the adults had no trouble mapping the novel adjectives to object properties. While some of the adults commented on the strangeness or silliness of talking to a puppet, none of them made any comments that it was strange to use *one* or *thing* instead of an object name, nor did they make any responses that could be interpreted in that way. Although the adults are clearly different in important ways from the toddlers in Experiment 3, the fact that none of them found the exemplar descriptions odd further supports our claim that the context we created in the experiment makes our use of *one* and *thing* pragmatically felicitous.

4.3.2. Did subjects understand that the labels one/thing referred to the referent objects?

There is, however, an alternative, trivializing interpretation of the results. This alternative would be that the conditions of the experiment did not allow the child to identify the intended referent toy (because Tweety Bird did not refer to it with a specific label), and therefore there was no basis on which to figure out the meaning of the novel adjective. One argument against this alternative interpretation is simply our subjective experience that the toddlers were perfectly aware what the presentation sentences referred to. They looked at and manipulated the objects as Tweety Bird described them, and their general engagement in these activities was, by our observation, no different when vague labels were used than in Experiments 1 and 2 when object names were used.

To provide additional evidence in support of children's understanding of the referents of *thing* and *one*, we analyzed children's own productions of noun phrases containing a modifying adjective and *thing(s)* or *one(s)* as the head noun. We analyzed the utterances of 25 English-learning children from the CHILDES database (MacWhinney, 2000), up until they were 3.5 years old. (The specific corpora we analyzed are listed in Appendix A.) We searched for all occurrences of *one(s)* and *thing(s)* for each child, and recorded the words that came before each occurrence. We then classified each prior word as either an Adjective or Other. We classified the word as Adjective if the word was unambiguously an adjective in the adult language (such as *blue*, or *little*). For ambiguous words (such as *orange*, which could be an adjective or a noun, or *packing*, which could be an adjective, a noun, or a verb) we consulted the corpus transcript for the contexts in which the phrase was used and based our assignment on that. If the contexts did not disambiguate the category of the word, we conservatively classified it as Other.

Our purpose in performing this analysis was simply to confirm that toddlers actually use [ADJECTIVE *thing/one*] constructions to refer to objects. If they use such sequences

productively, it would indicate that they understand that such constructions refer to objects. Such evidence would argue against an account of the results of Experiment 3 that links toddlers' failure to make Property-Matched responses to their failure to understand the referents of *thing* and *one*. We used two criteria to determine whether a given child used the [ADJECTIVE *thing/one*] construction productively. First, the child had to produce a sentence which contained an adjective followed by either the singular or plural form of *one* or of *thing* (following the adjective criterion described above). Second, the adjective itself had to be used in at least one other lexical environment, to provide evidence that the *adjective-one/thing* sequence was not a frozen form akin to a single lexical item.

The results of this analysis are shown Table 2. Table 2 shows, for each corpus, the frequency of these noun phrases as well as their proportion to the overall occurrences of *one(s)* and *thing(s)*. As can be seen, only one of the 25 children (Eric) used neither *one* nor *thing* modified by an adjective. All other children used noun phrases with these labels modified by an adjective. To show that the adjectives that are used with *one(s)* and *thing(s)* are also used in other constructions, Table 2 shows the token frequency of the adjectives (indicated by ADJ_{one} and ADJ_{thing}) and shows the proportion of the frequency of the relevant construction to the total frequency of the adjectives that occur in that construction. The results clearly show that children within the same age range as those in our study use the labels *one(s)* and *thing(s)* to refer to objects and, furthermore, that they productively combine these labels with adjectives. Thus, our use of the form [ADJECTIVE *thing/one*] to refer to an object should not, in and of itself, be problematic for the children in our study. We believe that these results, bolstered by our impressions of the children's involvement in the experimental task, make it difficult to support an interpretation of the results of Experiment 3 in which children fail to understand that the vague label noun phrase refers to the exemplar training object. Rather, 24- and 36-month-olds do not seem to map novel adjectives to object properties without the support of a full noun, despite the fact that they use vague labels in combination with adjectives. We now turn to a discussion of why this might be so.

5. General discussion

We began this article by outlining some reasons why adjective learning is a difficult task. These included an early word-learning bias towards basic level object terms, as well as the cross-linguistic variability of the adjective category. The studies we have reported in this paper were motivated by the view that vocabulary learning exploits multiple adventitious cues to tame the proliferation of conjectures about word-to-world mappings that are often available. Prior investigators have shown, for example, that children's earliest adjective learning can be enhanced when the extralinguistic context exhibits a property contrast among a set of objects all of which are instances of the same basic level kind. Under this introducing condition, 3-year-olds can extend the use of adjectives, so acquired, across basic level categories (Klibanoff & Waxman, 2000). But after all, the situation in which youngsters are shown a series of spotted snakes or a collection of bumpy rhinoceroses can't be all *that* common in real life. As these investigators would surely agree,

Table 2
Occurrences of [ADJ *one*] and [ADJ *thing*] and proportions to total occurrences to each element of the construction

Corpus	[ADJ *one*]	*one*	ADJ_{one}	[ADJ *one*]/*one*	[ADJ *one*]/ADJ_{one}	[ADJ *thing*]	*thing*	ADJ_{thing}	[ADJ *thing*]/*thing*	[ADJ *thing*]/ADJ_{thing}
Bloom/Peter	38	347	565	0.11	0.07	8	1693	54	0.15	0.00
Bloom/Eric	0	2	N/A	0.00	N/A	0	N/A	1	0.00	N/A
Brown/Adam	17	372	591	0.05	0.03	4	72	34	0.12	0.06
Brown/Eve	19	308	628	0.06	0.03	0	N/A	9	0.00	N/A
Brown/Sarah	29	171	1025	0.17	0.03	0	N/A	5	0.00	N/A
Clark/Shem	55	277	511	0.20	0.11	5	136	44	0.11	0.04
Kuczaj/Abe	79	552	2508	0.14	0.03	22	1144	96	0.23	0.02
MacWhin./Ross	19	93	1251	0.20	0.02	11	823	23	0.48	0.01
Man/Anne	155	917	1764	0.17	0.09	11	221	31	0.35	0.05
Man/Aran	95	633	518	0.15	0.18	1	45	22	0.05	0.02
Man/Becky	118	835	1499	0.14	0.08	1	45	10	0.10	0.02
Man/Carl	323	1338	2280	0.24	0.14	1	166	10	0.10	0.01
Man/Dom.	187	1291	1795	0.14	0.10	2	133	14	0.14	0.02
Man/Gail	186	926	1249	0.20	0.15	15	45	36	0.42	0.33
Man/Joel	204	702	1667	0.29	0.12	3	43	27	0.11	0.07
Man/John	133	471	1061	0.28	0.13	2	124	5	0.40	0.02
Man/Liz	273	738	1835	0.37	0.15	0	N/A	9	0.00	N/A
Man/Nicole	47	364	1471	0.13	0.03	0	N/A	5	0.00	N/A
Man/Ruth	168	537	2264	0.31	0.07	3	525	5	0.60	0.01
Man/War.	155	1204	2218	0.13	0.07	0	N/A	16	0.00	N/A
Peters/Seth	34	100	340	0.34	0.10	4	75	7	0.57	0.05
Sachs/N	38	298	614	0.13	0.06	24	425	49	0.49	0.06
Snow/Nath.	8	143	130	0.06	0.06	0	N/A	25	0.00	N/A
Suppes/Nina	24	323	1390	0.07	0.02	3	644	59	0.05	0.00
Valian	13	158	158	0.08	0.08	3	10	24	0.13	0.30

other cooperating cues must be operative in the early induction of property-term interpretations. This is likely because laboratory demonstrations usually fail for 2-year-olds and often for 3-year-olds as well, and yet we know that most 2-year-olds spontaneously (and appropriately) utter some adjectives. We therefore asked how we might enrich the input situation so as to bring laboratory-evoked adjective learning into line with what is observed in the world of normal 2- and 3-year-old usage.

Our *modus operandum* in these experiments was to provide young learners with rich extralinguistic and linguistic information to support their learning. We essentially accomplished this mission in Experiments 1 and 2, by showing children different kinds of objects, all with a common salient property, and by using common, basic level nouns to name the objects. The outcome was that now even 2-year-olds succeeded in extracting the intended property-term interpretations of the nonsense words. Then, once we had brought the spontaneous and experimental induction of adjective acquisition into better alignment in this way, we re-examined the situation we had created in the laboratory, to try to discover which of the "enrichments" had done the trick. Part of this work had been done for us, so to speak, in the elegant experimental work of Klibanoff and Waxman (2000): they showed that filling out the noun phrase with a lexically specific head noun is insufficient in the presence of only a single referential exemplar. Therefore, in Experiment 3, we compared the effects of a multiple exemplar input with and without a full lexically specified noun phrase. Summarizing the overall result: the young adjective learner succeeds if the environment provides at least two interlocked evidentiary resources: rich extralinguistic information in the form of multiple exemplars coupled with rich linguistic information in the form of a noun phrase with a lexically specific head. We now discuss in some further detail why the cues we investigated had the effects that they did.

5.1. The effect of multiple exemplars

The first of our findings is self-evident. It can be no surprise to discover that novices are aided by multiple exemplars; that is, by cross-situational observation. How could it be otherwise? Any single situation is open to many interpretations, including many reasonable and conversationally salient ones. As we have emphasized throughout, multiple contextual exposures would seem to be especially important for little children trying to learn property terms as their first tendency is to assume that any new word heard labels the tiger rather than his stripes, his temperament, his growl, or indeed any single trait. It stands to reason that learners will be aided if the tigers, the cars, the horses, come and go across successive scenes in which one hears "zav" uttered, while some property of each remains constant. Some failures of prior experimentation to show adjective learning in 2-year-olds is likely a consequence of their providing only a single target exemplar, which is then to be compared to one of two targets ("another zavish one"). By providing multiple exemplars, we made it easier for subjects to overcome their basic level whole-object bias.

5.2. The effect of noun selection

Despite its power, the multiple exemplar situation, stripped of collateral cues, turns out not to give decisive evidence for property-term learning to these young children, as shown

in Experiment 3. Along with the multiple exemplars, there has to be a clear indication of the object type whose properties are at issue. The most straightforward way to accomplish this clarity of reference is linguistically: the noun which the adjective modifies needs to be *taxonomically specific*. We use the expression *taxonomically specific* to refer to the property that any common noun has of carving out a set of entities within a taxonomy. For example, an instance of the word *dog* selects an entity (or entities in the case of *dogs*) from a fixed taxonomic set (namely, the set of all dogs), just as an instance of the word *animal* selects an entity or set of entities from a taxonomic set (the set of all animals). Any use of a common noun invokes a specific taxonomic set of which it is a member.

A case in which establishing a taxonomy clearly is necessary for acquiring an adjective is that of relative adjectives. A relative adjective selects a point along a continuum relative to a standard that is specified by the noun (for example, *big* in "a big mouse" selects a high value on the size dimension, relative to a standard mouse size). The criteria for being *big* are different for a *big mouse* and a *big elephant*, in as much as the standards differ. Moreover, even for a single object referent, the taxonomic construal of the object affects how a relative adjective is interpreted: a particular entity construed as a *mouse* may be *big*, but construed as an *animal* would be *small*. It is noteworthy that many of the first adjectives children learn are relative adjectives (see footnote 5 for some comments on why this might be), and further that there is considerable overlap between the semantic types of children's early adjectives and the types that make up the adjective categories of languages with only a few adjectives (Dixon, 1982). These facts suggest that the dependence of an adjective's interpretation on the noun it modifies is an essential characteristic of the adjective category, and one that learners are sensitive to early on.

However, our experiments show that the sensitivity to this dependency is apparent in 2- and 3-year-olds even in situations where relative adjectives are not being acquired. The properties we intended for adjective mapping in these experiments were not relative like the dimensional adjectives just discussed. For example, when *stoof* was intended to mean 'drilled with holes', the particular taxonomic construal of the described object was irrelevant. Nevertheless, when we substituted "the *stoof* one" for "the *stoof* horsie" in Experiment 3, our young subjects failed to extract the property interpretation. This behavior is understandable when one considers that the learner does not know, *a priori*, whether the novel adjective is relative or not, and therefore must apply a learning strategy which will be successful in either case – one that requires taxonomic specificity. But beyond this, establishing a taxonomy is important in these non-relative cases to help narrow down the possible meaning of the adjective. For instance, horses cannot be three-sided as triangles are, or scientific as theories are, or heartfelt as wishes are. The pronominal head offers the learner no such aid in this regard. Because one, and even thing, are essentially unrestricted in the entity referred to, *a fortiori* so is its material-kind reference. For toddlers, then, adjectives really do modify nouns.

In sum, an important – perhaps required, in the very young – precondition for learning an adjective is specification of the taxonomic class whose range is to be restricted by the modification. As we showed, the obvious way to inform the learner of this range restriction is by presenting the new property term with a lexical noun. Another way is to label and exhibit a number of entities that fall under the same taxonomic class, "This is a *blickish* horsie; which of these two horsies is *blickish*?" (Klibanoff & Waxman, 2000).

Young children can sometimes succeed even when the linguistic stimulus itself is pronominal ("the *zav* one") and therefore does not designate a taxonomic class. In a second set of studies, Waxman and Klibanoff (2000) showed older toddlers two exemplars of the same basic level kind (e.g. two elephants) which contrasted on a property (e.g. *spottedness*); the spotted one was described as "a *blickish* one", and the other one was described as "not a *blickish* one". When asked to select "another *blickish* one" from a spotted and solid frog, 3.5-year-olds successfully selected the spotted frog. Thus, exemplars which contrast on the property dimension, plus the negative construction *not X*, seem to serve as sufficient cues to an adjective's meaning for older toddlers, and hence a specific label is not required. In another experiment, Waxman and Klibanoff show 3.5-year-olds two exemplars from different basic level categories, sharing a property (e.g. a spotted elephant and a spotted rabbit), and describe them as "a *blickish* one", and "another *blickish* one". The toddlers were then shown two objects from yet a third basic level kind (e.g. a spotted frog and a solid frog) and asked to find "another *blickish* one". Although this experiment is similar in some respects to our Experiment 3, unlike in our experiment, these toddlers correctly mapped the novel adjective to the shared object property and chose the spotted frog. The toddlers' success here might be due in part to their older age (some of their subjects were 3;11), but Waxman and Klibanoff's study is different from Experiment 3 in another, perhaps more significant way. In over half the trials, the three object-kinds (two training-, one test-) were from the same superordinate category (either all *animals* or all *tableware*). In these strongly biasing referential contexts, the term *one* might be sufficient to allow the children to pick out a taxonomic set, just as the noun does in our experiments. The biasing trials might serve as a basis for generalizing mapping behavior to the trials which were not so strongly biasing. Thus, Waxman and Klibanoff's studies suggest that older toddlers, at least, can use multiple cues to select the relevant taxonomic class. If noun labels are not available, strong referential cues can be used.

5.3. Multiple cues to word meaning

The experiments we have reported demonstrated that cross-situational comparisons are something even the youngest 2-year-olds can make use of in the hard case of adjective learning, but only when accompanied by strong indicators of the entity being modified. It is no use asking "which" such cue eases the path to adjective learning. It was the two cues in tandem, and neither one of them alone, that did the trick in our manipulations. Other cooperating cues, several of them investigated by our predecessors and mentioned in introductory comments and discussions, have related enhancing effects. The point is that the world is so full of a number of things, and the observer is so sophisticated in culling meaning from the world, that multiple linked cues are required if there is to be convergence on a single interpretation.

Most generally, this work fits into an emerging picture of language acquisition that explains the child's lexical accomplishments in terms of layers of information that become available in sequence as a consequence of solving parts of the learning problem. At the first step of this incremental learning procedure, novices have no information other than their natural ways of organizing the world as these can be mapped against word use. In this initial knowledge state, they can acquire a small stock of concrete nouns based on two

coupled facts. The first of these is conceptual (they can conceive; for example, of elephants) and the second is the plausible conditions for making reference ("elephant" is more likely to be uttered in the presence of elephants than of gnus). This first learning is limited to *favored representations* (Markman's object bias) of *concrete* (i.e. directly observable) basic level objects (Snedeker, 1999). The early noun learning now serves as a scaffold on which children build a rudimentary representation of the phrase structure of the input language (Fisher, 1996; Fisher et al., 1994), enabling the learning of words from non-nominal categories. Specifically, in the presence of phrase structure knowledge the learners can work back and forth between their representations of the world and their implicit knowledge of how these are linked to information – selectional and syntactic – that is displayed across the input sentence (Landau & Gleitman, 1985; Pinker, 1984). In the present experiment, we were able to model adjective learning in our young subjects by allowing them to leverage their hard-won knowledge of the noun phrase in the service of this task.

Acknowledgements

We would like to thank all the parents and children who made this work possible. This research was supported by a postdoctoral fellowship to the first author from the Institute for Research in Cognitive Science at the University of Pennsylvania, and by NIH Grant HD37507 to Lila Gleitman and John Trueswell, and also by the Zumberge Faculty Research Innovation Fund at the University of Southern California. Manuscript preparation was partially supported by an Intel Equipment Grant. Data from this paper were presented at the Twentieth Annual Meeting of the Cognitive Science Society and at the Boston University Conference on Language Development.

Appendix A. CHILDES (MacWhinney, 2000) corpora analyzed for use of *one(s)* and *thing(s)*

Corpus	Sub-corpus	File range
Bloom (1970)	Eric	eric01–eric03
Bloom (Bloom, Hood, & Lightbown, 1974; Bloom, Lightbown, & Hood, 1975)	Peter	peter01–peter20
Brown (1973)	Adam	adam01–adam31
Brown (1973)	Eve	eve01–eve20
Brown (1973)	Sarah	sarah001–sarah036
Clark (1979)	Shem	shem01–shem40
Kuczaj (1976)	Abe	abe001–abe105
Manchester (Theakston, Lieven, Pine, & Rowland, 2000)	Anne	anne01a–anne34b
Manchester	Aran	aran01a–aran34b
Manchester	Becky	becky01a–becky34b
Manchester	Carl	carl01a–carl34b
Manchester	Dominic	domin-1a–domin34b
Manchester	Gail	gail01a–gail34b
Manchester	Joel	joel01a–joel34b

(*continued*)

Corpus	Sub-corpus	File range
Manchester	John	john01a–john34b
Manchester	Liz	liz01a–liz34b
Manchester	Nicole	nic01a–nic34b
Manchester	Ruth	ruth01a–ruth34b
Manchester	Warren	warr01a–warr34b
MacWhinney (2000)	Ross	ross20–ross41
Peters (Peters, 1987; Wilson & Peters, 1988)	Seth	19_2–41_3
Sachs (1983)	Naomi	n01–n89
Snow (MacWhinney, 2000)	Nathaniel	nath01a–nath27
Suppes (1974)	Nina	nina01–nina56
Valian (1991)	All	01a–21c

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