

The origins and evolution of links between word learning and conceptual organization: new evidence from 11-month-olds

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Abstract

How do infants map words to their meaning? How do they discover that different types of words (e.g. noun, adjective) refer to different aspects of the same objects (e.g. category, property)? We have proposed that (1) infants begin with a broad expectation that novel open-class words (both nouns and adjectives) highlight commonalities (both category- and property-based) among objects, and that (2) this initial expectation is subsequently fine-tuned through linguistic experience. We examine the first part of this proposal, asking whether 11-month-old infants can construe the very same set of objects (e.g. four purple animals) either as members of an object category (e.g. animals) or as embodying a salient object property (e.g. four purple things), and whether naming (with count nouns vs. adjectives) differentially influences their construals. Results support the proposal. Infants treated novel nouns and adjectives identically, mapping both types of words to both category- and property-based commonalities among objects.

Introduction

What resources do infants recruit in the process of mapping words to the objects and events they perceive in the world? We know that infants take advantage of the rich social and pragmatic contexts in which novel words are introduced to determine their meaning. For example, by their first birthday, infants spontaneously follow a speaker's eye-gaze to discover the object or event of interest in a naming episode (Baldwin & Markman, 1989). In addition, during this period, infants' growing sensitivity to perceptual cues within the ongoing speech stream permits them to successfully parse novel words from familiar ones (Jusczyk & Kemler Nelson, 1996; Morgan & Demuth, 1996; Werker, Lloyd, Pegg & Polka, 1996) and to distinguish open-class from closed-class words (Shi, Werker & Morgan, 1999).

However impressive these early social and perceptual achievements may be, they are not (singly or jointly) sufficient for successfully mapping a novel word to its meaning. This is because many different *types* of words may be offered in a naming episode. Importantly, each type of word highlights a different aspect of the observed scene. For example, for speakers of English, count nouns ('Look, it's an *elephant*') typically refer to the named object itself and are extended spontaneously to other members of the same object kind (other elephants); proper nouns ('Look, it's *Babar*') refer to the named

individual alone and are not extended further; and adjectives ('Look, it's *pink*') refer to a property of the named individual and are extended to other entities sharing that property.

By the time they are 2 years of age, infants appear to be sensitive to many of these word-to-world links (for a review, see Waxman, 1998 or Woodward & Markman, 1998). But which of these links, if any, are available at the onset of lexical acquisition? We have proposed that infants begin the task of word learning with a broad expectation that novel open-class words highlight commonalities among objects. This initially general expectation guides infants' first word-to-world mappings and supports the early establishment of reference. The infant's growing lexicon can then serve as the foundation upon which infants begin to notice correlations between particular *types* of words and particular *types* of relations among objects. In this way, an initially general expectation sets the stage for the evolution of more specific expectations which are calibrated in accordance with the particular correlations between grammatical form and meaning in the language under acquisition (Waxman, 1999; Waxman & Markow, 1995; Waxman, Senghas & Benveniste, 1997).

The existing evidence documents that novel words influence infants' attention to objects even before the onset of lexical acquisition. By 9 months of age, infants devote more attention to objects that have been named

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than those that have not (Balaban & Waxman, 1997; Baldwin & Markman, 1989). This increased attention to named objects has consequences for conceptual development. Naming distinct objects (e.g. a dog, horse, monkey, giraffe) with a *common* name (e.g. 'animal') serves to highlight commonalities among the objects and, in this way, promotes the formation of object categories (Balaban & Waxman, 1997; Waxman & Markow, 1995; Waxman, 1998). Conversely, naming distinct objects (e.g. ball, duck) with *distinct* names (e.g. 'ball', 'duck') promotes the process of object individuation at 10 months (Xu, 1999). Thus, even before infants begin to produce words on their own, naming promotes attention to individuals and to categories of objects.

Existing evidence also reveals that as early as 14 months of age, infants have begun to establish specific expectations linking different types of words to different classes of meaning (Waxman & Markow, 1995; Waxman, 1999; Waxman & Booth, 2001). For example, in our most recent work (Waxman & Booth, 2001), we asked whether naming (with either novel count nouns or adjectives) influenced infants' construals of the very same set of objects (e.g. purple horses) as either (a) belonging to the same object category (horses) or (b) embodying the same property (e.g. purple). To this end, we familiarized 14-month-old infants with four objects that were members of the same object category and painted with the same color (e.g. purple horses). For half of the infants, these objects were labeled with a novel count noun (e.g. 'These are *blickets*'). For the other half, they were labeled with a novel adjective (e.g. 'These are *blickish* ones'). After the familiarization objects were presented and labeled, we examined infants' extension of the novel word. Infants were presented with a target (one of the familiarization objects) and two test objects, one of which was familiar (e.g. a purple horse), the other of which was novel. For half of the infants in each condition, the novel test object contrasted with the familiarization objects in category membership only (e.g. a purple chair). This constituted a Category test. For the remaining infants, the novel object contrasted with the familiarization objects in property only (e.g. a blue horse). This constituted a Property test. Infants were asked, 'Can you give me the *blicket*?' (*Noun* condition) or 'Can you give me the *blickish* one?' (*Adjective* condition).

We reasoned that if novel words focus infants' attention on category-based, rather than property-based commonalities among objects, then on Category test trials (e.g. purple horse, purple chair) infants should prefer the familiar test object (e.g. the purple horse). On Property test trials (e.g. purple horse, blue horse), where both objects are members of the same category as the familiarization stimuli, they should reveal no preference. How-

Table 1 The proportion of word-extension trials on which the familiar test object was selected on category and property test trials by 14-month-old infants in Waxman and Booth (2001)

	<i>M</i>	<i>SD</i>
Noun		
Category:	.68*	.13
Property:	.44	.15
Adjective		
Category:	.50	.18
Property:	.52	.17

Note: * $p < .05$ versus chance of .50

ever, if novel words focus infants' attention on property-based, rather than category-based commonalities, then on Property test trials, infants should prefer the familiar test object (e.g. the purple horse). On Category test trials, where both objects instantiate the same property as the familiarization stimuli, they should reveal no preference. Finally, if novel words focus infants' attention broadly on commonalities among objects then they should be equally likely to select the familiar test object on both Category and Property test trials.

Results revealed that 14-month-old infants' expectations for novel nouns differ from their expectations for novel adjectives. (See Table 1 for a summary of the data.) Infants hearing a set of objects described with a novel noun focused primarily on category-based, rather than property-based commonalities. In contrast, infants hearing the same objects described with novel adjectives apparently attended to a wider range of commonalities, focusing equally on category- and property-based alternatives. It therefore appears that infants at 14 months have a more precise expectation for novel nouns than for novel adjectives (also see Waxman & Markow, 1995; Waxman, 1999).

In the current experiment, we examine the developmental precursors of this early linkage between count nouns and object categories, using precisely the same procedure as Waxman and Booth (2001) with infants at 11 months of age. Recall that we have proposed that infants begin the task of word learning with an initially general expectation linking open-class words (in general) to commonalities (in general). If this proposal is correct, then 11-month-olds, who are just on the brink of word learning, should not yet distinguish count nouns from adjectives in this task. Instead, they should exhibit a general expectation linking words (both count nouns and adjectives) to commonalities (both category and property based) among objects. In the context of the current design, infants hearing either novel count nouns or novel adjectives should select the familiar test object equally on both Category and Property test trials, and

they should do so at a rate that exceeds that in a *No Word* control condition.

Method

Participants

Seventy-two infants (34 male; 38 female) with a mean age of 11.71 months (range: 11.1 to 12.3 months) were recruited from a population of middle-class families in the greater Chicago area. All were in the process of acquiring English as a native language. Infants who made clear choices on at least 75% of the word-extension trials (described below) were included in the final sample. Two additional infants were excluded, one for failing to reach this criterion, and one due to experimenter error.

Materials

The materials included 52 small commercially manufactured toys, ranging in size from 5.5 to 19 cm. These were selected to form four different sets of 13 objects each (see Figure 1 for an example, and Appendix A for a complete list of stimuli). Each set included a basic-level (e.g. four discriminably different purple horses) and a superordinate-level (e.g. four different purple animals) version of the familiarization stimuli. Each infant was

exposed to only one of these versions. For each set, there were also two types of test pairs, both of which pitted a familiar (e.g. a purple horse) against a novel object. For *Property* test pairs, the novel object was drawn from the same category as the familiarization objects, but had a novel property (e.g. a blue horse). For *Category* test pairs, the novel object had the same property as the familiarization objects, but was drawn from a novel category (e.g. a purple chair).

Procedure

Infants were tested individually in a laboratory playroom. They sat in an infant-seat, directly across from the experimenter. Parents, who were seated behind their infants, completed the MacArthur Communicative Development Inventory (Fenson, Philip, Reznick, Bates, Thal & Pethick, 1994) during the experimental session. Parents were instructed not to talk (either to the infant or the experimenter) or to influence in any way the infant's attention. Sessions lasted approximately 15 min and were videotaped for later coding.

The procedure included three distinct phases: familiarization, contrast and test. Each infant completed this procedure with four different sets of objects that were presented in one of two orders. Two basic-level set versions and two superordinate-level set versions were presented to each infant, with an equal number of infants

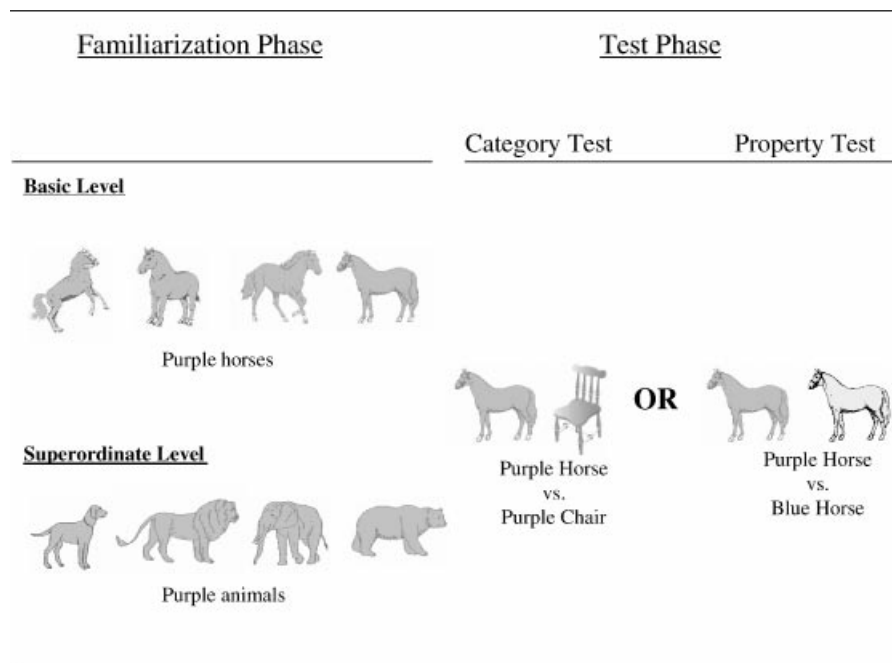


Figure 1 An example of one representative set of familiarization and test stimuli. Infants saw either the basic-level or superordinate-level version of the familiarization stimuli and either the Category or Property test stimuli.

Table 2 A representative set of introductory phrases

	Familiarization	Contrast	Test
Noun:	These are blickets. This one is a blicket and this one is a blicket	Uh-oh, this one is not a blicket!	Look at these! Can you give me the blicket?
Adjective:	These are blickish. This one is blickish and this one is blickish	Uh-oh, this one is not blickish!	Look at these! Can you give me the blickish one?
No Word:	Look at these. Look at this one and look at this one	Uh-oh, look at this one!	Look at these! Can you give me one?

seeing basic-level and superordinate-level sets first. The level of each set presented was counterbalanced within conditions. Infants were randomly assigned to a *Noun*, an *Adjective* or a *No Word* condition. Infants in all conditions heard infant-directed speech (see Table 2 for a summary of the introductory phrases used in each condition). The *Noun* and *Adjective* conditions differed only in the syntactic context in which the novel words were presented (see below). Within each condition, half of the infants were presented with Property test pairs throughout while the other half were presented with only Category test pairs.

Familiarization phase

The experimenter introduced infants to two familiarization objects at a time. In the *Noun* condition, the experimenter introduced each pair, saying, 'These are *blickets*.' After 10 s had elapsed, she pointed to each individual within the pair, saying, 'This one is a *blicket* . . . and this one is a *blicket*.' After another 10 s had elapsed, she removed the first pair, and presented the second, in precisely the same fashion. In the *Adjective* condition, the introductory phrases were, 'These are *blickish*' followed by, 'This one is *blickish* . . . and this one is *blickish*.' In the *No Word* condition, the introductory phrases were 'Look at these' followed by 'Look at this one . . . and look at this one.' Infants manipulated the objects freely throughout familiarization.

Contrast phase

Next, the experimenter presented a new object (e.g. an orange carrot), drawn from a contrastive object category and embodying a contrastive object property. She shook her head solemnly, and said either 'Uh oh! This one is not a *blicket*' (*Noun* condition), 'Uh oh! This one is not *blickish*' (*Adjective* condition) or 'Uh oh! Look at this one' (*No Word* condition). She then re-presented a target object drawn from the original set of familiarization objects (e.g. a purple horse), and happily exclaimed, 'Yay, this one is a *blicket*' (*Noun* condition), 'Yay, this one is *blickish*' (*Adjective* condition) or 'Yay, look at this

one' (*No Word* condition). She placed this target object in front of the infant. She then outstretched her palm and asked, 'Can you give me the *blicket*?' (*Noun* condition), 'Can you give me the *blickish* one?' (*Adjective* condition) or 'Can you give me that one?' (*No Word* condition).

Test phase

Half of the infants in each condition received *Category* test trials (e.g. a purple horse vs. a purple chair). The remaining infants received *Property* test trials (e.g. a purple horse vs. a blue horse). Each infant completed a novelty-preference task followed immediately by a word-extension task. Both tasks involved the same two test objects. To assess *novelty-preference*, the experimenter placed the test pair easily within the infant's reach, saying, 'Look at these.' No labels were provided. Infants manipulated these objects freely. After 20 s had elapsed, the experimenter retrieved the test pair. Next, to assess *word-extension*, she presented a target object, drawn from the set of familiarization objects (e.g. a purple horse), and drew attention to it by pointing and saying, 'This one is a *blicket*' (*Noun* condition), 'This one is *blickish*' (*Adjective* condition) or 'Look at this one' (*No Word* condition). She then presented the two test objects, placing them easily within the infant's reach, approximately 30 cm apart, saying, 'Can you give me the *blicket*?' (*Noun* condition), 'Can you give me the *blickish* one?' (*Adjective* condition) or 'Can you give me one?' (*No Word* condition).

For each set of objects, infants completed the familiarization, contrast and test phases. Then, the contrast and test phases were repeated. On this second round, a new contrast object was presented, but the same two test objects were re-presented, with their left-right placement reversed.

Coding

The videotaped sessions were transcribed with the sound removed to insure that the coders, who were blind to the experimental hypotheses, were also blind to condition assignment. We calculated the proportion of trials on which an infant selected the familiar test object. The

probability of selecting the familiar test object by chance on each trial is .50. A primary coder rated all infants. A second coder independently rated 8 infants, 4 per condition. Agreement between coders was 100%.

Predictions

We have proposed that infants begin the task of word learning with a general expectation linking novel words to commonalities among objects. If this is the case, then infants should perform identically in the *Noun* and *Adjective* conditions. Words from both grammatical categories should focus infants' attention on both the category- and property-based commonalities among familiarization objects. Therefore, infants in both the *Noun* and *Adjective* conditions should extend these novel words to the familiar test object on both Category and Property test trials. We also predicted that infants hearing novel words (either nouns or adjectives) would perform differently than those in a *No Word* control condition. If words (in general) direct infants' attention to commonalities (in general), then infants hearing novel words should be more likely to select the familiar test objects than those in the *No Word* control.

Results and discussion

Language inventory

Infants' median productive vocabulary was 4.5 words, ranging from 0 to 40 words.

Word-extension task

Infants made clear selections on 92% of their trials. The results are presented in Table 3. We first analyzed infants' tendency to select the familiar object in the experimental conditions using an ANOVA with Condition (2: *Noun* versus *Adjective*) and Test-type (2: *Category* versus *Property*) as between-participants factors, and Level (2: Basic versus Superordinate) as a within-participants factor. As predicted, no main effects or interactions emerged from this analysis, suggesting that infants performed equivalently across condition and test type. However, this result does not simply reflect a null effect. First, and most importantly, infants in the *Word* conditions (*Noun* and *Adjective*) ($M = .57$) were significantly more likely to select the familiar test object than were those in the *No Word* condition ($M = .48$), ($t(70) = 2.26$, $p < .05$). Second, performance in the *Word* conditions exceeded the rate predicted by chance alone ($t(47) = 2.72$, $p < .01$).

Table 3 The proportion of word-extension trials on which the familiar test object was selected on category and property test trials by 11-month-old infants in the current study

	<i>M</i>	<i>SD</i>
Noun		
Category:	.57	.24
Property:	.55	.14
Adjective		
Category:	.59	.24
Property:	.58	.15
No word		
Category:	.46	.15
Property:	.49	.09

General discussion

In the current experiment, we asked whether infants on the very brink of word learning are guided by any expectations regarding word-to-world mappings. Previous work indicated that by 14 months, infants have begun to distinguish novel words presented as count nouns from those presented as adjectives, and that they treat these differences as relevant to word learning (Waxman & Markow, 1995; Waxman, 1999; Waxman & Booth, 2001). Infants hearing a set of objects (e.g. four purple animals) described with novel count nouns attended to category-based, and not property-based, commonalities. In contrast, infants hearing the same objects described with novel adjectives apparently attended to a wider range of commonalities, focusing on both category- and property-based commonalities.

The current experiment was designed to assess the precursors to this phenomenon by attempting to identify its origins in infants just beginning to produce words on their own. We sought to discover whether 11-month-old infants could construe the very *same* set of objects (e.g. four purple animals) either as members of an *object category* (e.g. animals) or as embodying a salient *object property* (e.g. purple things), and to ascertain whether and how naming these objects (with either count nouns or adjectives) might influence their construals.

The results of this experiment make three new contributions. First, because infants performed differently in the context of hearing a novel word (*Noun* or *Adjective*) than in a *No Word* control condition, we conclude that words do indeed influence infants' attention, even before they have begun to build a substantial lexicon (also see Balaban & Waxman, 1997).

Second, 11-month-old infants' performance in the *Noun* and *Adjective* conditions was indistinguishable. This is consistent with our proposal that infants at the

threshold of word learning are guided by a general expectation linking novel words (both nouns and adjectives) to commonalities among objects (both category- and property-based). The source of this initially general expectation has yet to be fully described. One possibility is that infants do not yet distinguish count nouns from adjectives on the basis of surface cues like the ones we provided here. Another possibility is that infants do indeed distinguish between these forms, but have not yet discovered which forms map to which types of meaning in the language under acquisition.

Third, the current results document that infants' expectations in word learning are sufficiently strong, even by 11 months of age, to guide their extension of novel words to new referents.

Bolstered by the current evidence, let us return to a question we posed at the outset. What expectations, if any, do infants recruit in the process of mapping their first words to the objects and events they perceive in the world? We proposed that infants begin the task of word learning with a broad initial expectation that links novel words (independent of their grammatical form) to commonalities among named objects. The results of the current experiment are entirely consistent with this proposal. Eleven-month-olds do appear to begin the task of lexical acquisition with a general expectation linking novel words (in general) to commonalities among objects (in general). More specific expectations linking particular kinds of words to particular types of meaning (e.g. noun-to-category) begin to emerge later, sometime close to 14 months of age. We suspect that infants discover these more specific expectations once they have acquired a substantial lexicon (Waxman & Markow, 1995; Waxman, 1999; Waxman & Booth, 2001) that permits them to notice the correlations between particular grammatical forms and their associated meanings in the native language (Waxman, 1999; Waxman & Booth, 2001; Waxman & Markow, 1995). Importantly, these more specific expectations do not emerge all of a piece. Instead, some expectations (e.g. that linking nouns to object categories) appear earlier than others (e.g. that linking adjectives to properties).

On the basis of the currently available evidence, we cannot be certain why the noun–category link emerges first. This important outcome is consistent with several theoretical alternatives. For example, it is consistent with the possibility that a link between count nouns and object categories is a universal feature in the design of human languages. Cross-linguistic analyses confirm that across languages, the grammatical form *noun* is always represented, and that a core semantic function of this grammatical form is to pick out individual objects and categories of objects. In contrast, there is substantially

more cross-linguistic variation in the grammatical form *adjective*, and considerably more variation in the types of meaning that this form conveys (Lyons, 1977; Waxman, 1998). It therefore stands to reason that a specific expectation regarding adjectives would not be available at the outset of lexical acquisition, but instead would emerge later, as infants come to identify the adjectives in the input and to discover how these map to meaning in the particular language under acquisition. The universal pattern for the grammatical form *noun* may be a result of an innate predisposition in the design of language. On the other hand, this universal pattern may itself be learned. Because nouns constitute the greatest proportion of words in infants' early lexicons, and because these words refer predominantly to individual objects and categories of objects, it is possible that this link between nouns and object categories happens to be the one that is most readily discovered.

Whatever its origins – induced or innate – the early emergence of a noun–category linkage is likely universal. This interpretation accords well with most current theories of language acquisition, which assume that the learner must be able to identify the nouns in the input and map them to entities in the world if they are to discover the other grammatical forms and their links to meaning (Dixon, 1982; Gentner, 1982; Gleitman, 1990; Grimshaw, 1994; Huttenlocher & Smiley, 1987; Maratsos, 1998; Pinker, 1984; Talmy, 1985; Wierzbicka, 1986; Waxman, 1999). The current results suggest that if infants are to learn the noun–category linkage from correlations between grammatical form and meaning in the linguistic input, they must do so between 11 and 14 months of age. Future research will be necessary in this age range to specify the precise mechanism of acquisition.

The current evidence suggests other avenues for further empirical inquiry as well. For example, it will be important to specify the breadth of infants' initial expectation linking words to commonalities among objects. We have examined only two grammatical forms (count nouns and adjectives) and two types of commonalities among objects (category- and property-based). We suspect that this initially general word-to-world link is limited to open-class words (Shi *et al.*, 1999). However, there is another alternative. Although we believe it to be unlikely, it is possible that by 11 months of age, infants can distinguish between count nouns and adjectives on one hand, and other grammatical forms (e.g. verbs or mass nouns) on the other, and that these different types of words influence attention and word extension in unique ways. Evidence using additional grammatical forms (e.g. mass nouns, verbs) and additional object relations (e.g. shared context, motion or function) will be necessary to evaluate this possibility.

A second critical approach to understanding the evolution of infants' expectations for novel words will be to conduct cross-linguistic research. One advantage to our developmental account is that it is flexible enough to account for the fact that infants naturally acquire a wide range of human languages, and that these differ in the

ways in which they recruit the particular grammatical forms to convey particular types of meaning. Careful examination of the order in which specific links between grammatical form classes and aspects of meaning emerge in infants exposed to different languages will be critical to testing our proposal.

Appendix A: complete list of stimuli

	Familiarization		Contrast		Test	
	<i>Trial 1</i>	<i>Trial 2</i>	<i>Distractors</i>	<i>Target</i>	<i>Category</i>	<i>Property</i>
<i>Purple</i>						
Basic	2 purple horses	2 purple horses		purple horse		
Superordinate	2 purple animals (bear/lion)	2 purple animals (elephant/dog)	orange carrot, brown rolling-pin	purple dog	purple horse vs. purple chair	purple horse vs. blue horse
<i>Yellow</i>						
Basic	2 yellow ducks	2 yellow ducks		yellow duck		
Superordinate	2 yellow animals (cat/lion)	2 yellow animals (fish/elephant)	blue cup, brown hat	yellow lion	yellow duck vs. yellow spoon	yellow duck vs. pink duck
<i>Green</i>						
Basic	2 green cars	2 green cars		green car		
Superordinate	2 green vehicles (boat/plane)	2 green vehicles (helicopter/truck)	pink cat, yellow banana	green truck	green car vs. green frog	green car vs. black car
<i>Red</i>						
Basic	2 red apples	2 red apples		red apple		
Superordinate	2 red fruits (grapes/tomato)	2 red fruits (pear/strawberry)	purple boot, silver pot	red tomato	red apple vs. red hammer	red apple vs. green apple

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