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Information Sources for Noun Learning

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Abstract

Why are some words easier to learn than others? And what enables the eventual learning of the more difficult words? These questions were addressed for nouns using a paradigm in which adults were exposed to naturalistic maternal input that was manipulated to simulate access to several different information sources, both alone and in combination: observation of the extralinguistic contexts in which the target word was used, the words that co-occurred with the target word, and the target word's syntactic context. Words that were not accurately identified from observation alone were both abstract (e.g., *music*) and concrete (e.g., *tail*). Whether a noun could be learned from observation depended on whether it labeled a basic-level object category (BLOC). However, the difference between BLOC labels and non-BLOC labels was eliminated when observation was supplemented with linguistic context. Thus, although BLOC labels can be learned from observation alone, non-BLOC labels require richer linguistic context. These findings support a model of vocabulary growth in which an important role is played by changes in the information to which learners have access.

Keywords: Psychology; Language acquisition; Concepts; Human experimentation

1. Introduction

Children learn some kinds of words before they learn others. No child learning English has *and* as his or her first word, despite its massive frequency in every caregiver's speech. Nouns in particular enjoy a special advantage in early vocabulary development (Au, Dapretto, & Song, 1994; Bates, Dale, & Thal, 1995; Benedict, 1979; Caselli, Bates, Casadio, & Fenson, 1995; Fenson et al., 1994; Fernald & Morikowa, 1993; Gentner, 1982; Goldin-Meadow, Seligman, & Gelman, 1976; Rescorla, Alley, & Christine, 2001; Robinson & Mervis, 1999). In fact, it is not until about the middle of the 3rd year of life that the proportion of nouns that children produce relative to other words decreases to approximate the proportion of nouns in the speech of their caregivers (Gentner & Boroditsky, 2001). Many factors influence the magnitude of this "noun bias" from language to language, including the frequency and relative salience of words from

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different classes, but it nonetheless holds to a greater or lesser degree in all languages in which the vocabularies of beginning language learners have been studied (Gentner & Boroditsky, 2001).[1]

Many studies of vocabulary development have suggested that some nouns have an advantage over other types of nouns—in particular, that early vocabularies tend to be heavily populated by labels for basic-level kinds or categories. I will have much more to say about the nature of the basic level later in the Introduction, but for now it is enough to say that basic-level categories occupy the middle level of the hierarchies in which they are embedded, because the members of those categories are highly similar to one another but are also distinct from the members of other categories (Murphy & Lassaline, 1997; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). The category DOG, for example, is the basic level of a hierarchy that includes ANIMAL as its superordinate, and COLLIE, TERRIER, POODLE, and so on, as its subordinates.[2]

In their pioneering article on the nature of the basic level, Rosch et al. (1976) analyzed the words produced by the child named Sarah, who was among the three whose language development was studied by Brown (1973). Rosch et al. found that the vast majority of the words that Sarah produced in Brown's Stage I (early in development, when utterances are quite short and simple; see Brown, 1973, for details) were labels for basic-level kinds. Using a different method—the naming of pictures in sets of photographs containing examples from the subordinate, basic, and superordinate levels—Anglin (1977) found that children ranging from 2 to 5 years old were much more likely to use basic-level labels to name sets of photographs, both at the basic level (e.g., different kinds of dogs, or different kinds of flowers) *and* at the subordinate level (e.g., different collies, or different roses). Using a combination of measures—diaries kept by six mothers, interviews with those mothers, and comprehension tasks—Rescorla (1981) found that children between the ages of 12 and 18 months experienced rapid growth in the stock of labels for basic-level kinds in the superordinate categories of vehicles, animals, and fruit. And Nelson, Hampson, and Shaw (1993), using the Early Language Inventory (Bates, Bretherton, Shore, & Snyder, 1984; Dale, Bates, Reznick, & Morisset, 1989), found a fair degree of heterogeneity in the vocabularies of the 20-month-olds they studied. Nonetheless, nouns outnumbered verbs; and among nouns, labels for basic-level kinds outnumbered other types of labels.

Supporting results come from studies that attempted to teach new words. Horton and Markman (1980) taught children from preschool through kindergarten names for artificial animal categories. When the word was taught with simple ostension, children interpreted the novel label as referring to the basic level. Using a preferential-looking paradigm, Graham, Baker, & Poulin Dubois (1998) presented infants between 16 and 19 months of age with an object, followed by a basic-level match or superordinate-level match; this target was either labeled or unlabeled. When the target was labeled, infants looked longer at the basic-level match than at the superordinate-level match. Collectively, these results suggest that basic-level kinds have a privileged status in early vocabularies.

This article asks two interrelated questions. First, why are labels for basic-level object categories (BLOCs) often learned earlier—and more easily, even for children whose word-learning careers are well underway—than other types of nouns? And second, what changes occur over the course of development to allow more efficient learning of nouns that are initially at a disadvantage? Using evidence from adults acting as simulated word learners, I argue that BLOC labels have an advantage because the members of BLOCs are readily available from perception and because BLOCs have a privileged psychological status. I will also argue that non-BLOC labels can be learned much more readily once the child has access to additional, nonperceptual cues about the meanings of words—in particular, the linguistic contexts in which they appear. To put it another way, the trajectory of word learning changes, in part, because the information to which the learner has access changes. I refer to the notion that BLOCs are especially label friendly as the BLOC privilege hypothesis, and to the idea that access to linguistic-contextual information leads to changes in the composition of vocabulary as the information change hypothesis (the latter following the terminology of Gillette, Gleitman, Gleitman, & Lederer, 1999).

In the remainder of the Introduction, I argue, based on the considerable research that has accumulated over the last 3 decades, that BLOCs have a special cognitive status, both for adults and for infants and preschoolers. I also develop the case for the information change model of word learning, a goal that I accomplish in part by reviewing prior work using the so-called Human Simulation Paradigm (HSP), originally developed by Gillette et al. (1999) to study the learning of verbs.

Before we proceed, I wish to emphasize two things. First, to say that BLOC labels make up a sizable portion of early vocabularies is not to deny that early vocabularies contain other sorts of words. Indeed, there is ample evidence that the first 50 to 100 words include names for individuals (*mommy, daddy*), substances and materials (*juice, wood*), activities (*lunch, party*), and social-affective words (*ouch, bye-bye*; e.g., L. Bloom, Tinker, & Margulis, 1993; Dale & Fenson, 1996; Nelson et al., 1993). Second, the aim of this article is to argue that information change plays a crucial role in vocabulary development. However, it is certainly not the only force behind word learning. Indeed, if word learning were a car, it would have a hybrid engine, driven, at various times, by different energy sources. In addition to linguistic-contextual information (e.g., Brown, 1957; Gleitman, 1990; Hall & Graham, 1999; Naigles, 1990), these include intention-reading abilities (e.g., Akhtar, Carpenter, & Tomasello, 1996; Baldwin, 1991, 1993; Baldwin et al., 1996; P. Bloom, 2002; Tomasello & Barton, 1994) and conceptual development in domains such as event cognition (e.g., Baillargeon & Wang, 2002; Golinkoff & Kerr, 1978; Gordon, 2004) and theory of mind (e.g., Astington & Gopnik, 1991; Cassidy, 1998; Flavell, 1999). Nothing I say in this article should be taken to preclude a role for these other sources of energy in the propulsion of word learning.

1.1. The privileged psychological status of BLOCs

1.1.1. Evidence for the privileged psychological status of BLOCS among adults

Among modern psychologists, the first to suggest the existence of something like the basic level was Roger Brown (1958), who argued that parents tend to label objects for children at what he called "the level of usual utility," which categorizes objects "as they need to be categorized for the community's nonlinguistic purposes" (p. 16). Thus, according to Brown, we are more likely to call a particular dime a *dime* or (perhaps *money*) than we are to call it a 2002 *dime* or a *thing,* because the first label is too specific, and the second too general.

Brown's (1958) rather informal notion was made much more rigorous by the seminal experimental work of Rosch et al. (1976). In the nearly 30 years since this work was published, it has been described and redescribed countless times in the literatures on many topics. Because the notion of a basic level figures so centrally in the BLOC privilege hypothesis, I, too, redescribe that work here in some detail.

Rosch et al. (1976) identified the basic level as the level with the highest cue validity. Formally, they defined *cue validity* as the conditional probability of "a given cue *x* as a predictor of a given category *y*" (or y|x). (Because the number of cues associated with a given category is quite large, this probability can sum to more than 1.) Informally, a category with high cue validity is "more differentiated from other categories than one of lower total cue validity" (p. 384), meaning that the members of a given category share many more attributes in common with one another than the category to which they belong shares with other categories. Thus CHAIR is a BLOC because the various types of chair (KITCHEN CHAIR, LIVING ROOM CHAIR, etc.) have more attributes in common than do different types of the superordinate category FURNITURE (TABLE, LAMP, CHAIR, etc.).

In a series of experiments, Rosch et al. (1976) demonstrated that BLOCs have psychological validity, and a privileged cognitive status. For instance, naive experimental participants freely generated properties for superordinate, basic level, and subordinate categories in a way that supported the high cue validity of BLOCs: The members of BLOCs shared many more of these attributes than members of superordinate categories. What is more, there was little increase in the number of attributes shared by the members of subordinate categories over those shared by the members of BLOCs.

In another experiment, Rosch et al. (1976) asked participants to list the motor movements they would execute when interacting with members of different category levels. Once again, a similar pattern emerged: The motor movements ascribed to the members of BLOCs were much more similar than those ascribed to the members of superordinate categories, and about equally as similar as the motor movements listed for members of subordinate categories. Further experiments showed that the shapes of BLOC members (as represented by traced silhouettes) overlapped more markedly than did the shapes of superordinates, and images of BLOCs were identified more rapidly following the presentation of BLOC labels than following the presentation of superordinate labels. The results of these experiments (and of others reported in the same article) all converge to suggest that BLOCs are cognitively special.

The work of Rosch et al. (1976) has proven enormously influential, inspiring a host of research programs focusing on adult cognition and cognitive development. However, as Murphy (2002) pointed out in his comprehensive review of the literature on concepts and categories, it has proven notoriously difficult to identify a mathematical or quasi-mathematical metric for BLOC-hood. The original metric that Rosch et al. (1976) proposed cannot be correct, as the highest cue validities belong to superordinate categories. (For instance, given that cue validities can sum to more than 1, the probability that something is a member of the category CAT, given that it has a tail, is actually *lower* than the probability that something is a member of the category MAMMAL, given that it has a tail, because many things besides cats have tails.) Alternative metrics have also proven flawed, leading Murphy to suggest that the basic level is best identified through behavioral measures. An accretion of such measures over the years has further strengthened the claim that the basic level is cognitively special (see Murphy's Table 7.2, p. 214, for a summary).

1.1.2. *Evidence for the privileged psychological status of BLOCs among infants and children*

Many studies support the ability of preverbal infants to categorize in fairly sophisticated ways (Eimas & Quinn, 1994; Quinn, Eimas, & Rosenkrantz, 1993; Roberts, 1988; Younger, 1985, 1993; Younger & Cohen, 1986). In one such study, Eimas and Quinn asked whether infants from 3 to 7 months of age could form basic-level representations of the natural kinds CAT and HORSE. Infants were first shown a series of photographs of horses or cats (in pairs, with different photographs on either side of a panel). Crucially, during the familiarization phase, infants saw pictures from only one natural kind. Following familiarization, infants were shown additional pairs of objects. If they had been familiarized, say, to horses, they were then shown a novel horse alongside a zebra, then another novel horse alongside a cat, and then yet another novel horse alongside a giraffe. The measure of interest was the degree to which infants attended to the category-external exemplar. Even the youngest infants were able to establish natural-kind categories that excluded nonmembers. Similar findings were obtained by Roberts (1988). Thus, it would appear that infants can form BLOCs quite young, well before they can comprehend or produce much of anything. This early-deployed capacity positions them well for learning BLOC labels.[3]

Studies with preschoolers suggest that the primacy of the basic level persists beyond infancy. Mervis and Crisafi (1982) introduced children ranging from 2.5 to 5.5 years to nonsense stimuli from two superordinate categories distinguished by being angular in one case and curved in the other. Stimuli were constructed so as to include members from a basic level (which were similar in shape, with attributes not shared by any other basic-level categories) and subordinates (which differed from one another only slightly). Children were presented with a standard, then asked to select from two options which one was the "same kind of thing" (a question they were asked repeatedly, for all combinations of levels). Children chose the item that matched at the basic level more often than they chose the item that matched at the subordinate or superordinate levels. Indirect evidence for the primacy of BLOCs comes from Klibanoff and Waxman (2000), who found that 3-year-olds successfully extended novel adjectives when the test item belonged to the same basic level as the teaching item, suggesting that BLOCs serve as a kind of anchor for word learning and, therefore, more broadly, as an anchor for generalization.

1.2. *Criteria for identifying BLOCs*

Notwithstanding Murphy's (2002) observation that successful metrics for BLOC-hood have proven hard to come by—and the fact that researchers who study word learning have typically identified BLOCs using largely informal criteria—a test of the BLOC privilege hypothesis would be made much more rigorous if we could articulate specific criteria for distinguishing BLOCs from non-BLOCs. I here offer three such criteria. Note that I return to these criteria in the Discussion, where I attempt to situate them both in the context of this study and in the context of work on word learning among toddlers and preschoolers.

1.2.1. BLOCs pick out whole objects

Basic-level kinds are whole objects. It is hard to imagine coherent categories based on properties (e.g., THINGS THAT ARE RED or THINGS THAT ARE VELOUR), because many different kinds of things—things that differ in ontological status (animate, inanimate), shape, or function, or all three—can all share the same property. On the other hand, it is much easier to imagine categories of things that are parts of other things—WING, TAIL, ARM, ZIPPER, HANDLE, and so on—precisely because such things often *do* share shape or function or both. In point of fact, however, these categories are never (to my knowledge) treated as basic level, because they rarely appear in the world on their own.[4] Rather, to echo the language of Rosch et al. (1976), they are *cues* to the category membership of the objects they comprise.

1.2.2. BLOCs pick out kinds independent of situation

Another attribute of BLOC labels is that they name *situation-independent* kinds, such as PERSON or DOG, as opposed to *situation-restricted* kinds, such as PASSENGER or PUPPY (Hall & Waxman, 1993). As Macnamara (1986) pointed out, following Gupta (1980), the two kinds of identity have very different quantificational properties. Put another way, they permit two different kinds of counting. To take an example adapted from Gupta: Once a woman boards a plane, she is both a person and a passenger. Separate head counts of people and of passengers (excluding the crew) would yield the same number. Once the woman leaves the plane, however, she ceases to be a passenger but continues being a person. Should she board a plane for a return trip (even the very same plane), the airline would again count her as a passenger, but not the *same* passenger. Similarly, if a dog enthusiast (with lots of land, one assumes) has 20 dogs, 5 of which are puppies, one can say *both* that he has 20 dogs *and* that that he has 5 puppies. Provided he keeps all 20 dogs and all the puppies grow to adulthood, he will still have 20 dogs but *no* puppies. Because BLOCs provide a means to quantify members of a category across spatially or temporally contingent circumstances or both, they are conceptually more basic.

1.2.3. BLOCs pick out objects that are similar in shape

As Rosch et al. (1976) demonstrated in their original work on basic-level categories, the members of a basic-level kind are more similar in shape to one another than distinct basic-level kinds are to one another. I hasten to point out that there is some controversy over the importance of shape to concrete object categories, both for children and for adults. Although a number of researchers have argued that our categories depend crucially on the shapes of objects, apart from whatever functions those objects might have (Landau, Smith, & Jones, 1998, 1998; Tomikawa & Dodd, 1980), others have argued that, for artifacts, function also plays an important role—possibly even more important (e.g., Kemler Nelson, 1995; Kemler Nelson, Frankenfield, Morris, & Blair, 2000; Nelson, 1973, 1974). Although there can be little doubt that function plays a crucial role in our artifact concepts, there are circumstances under which shape seems to take precedence, even for adults (Gentner, 1978b; Malt, 1993; Murphy, 2002). For the purposes of operationalizing the notion of BLOC, it is enough that shape is a central feature of our object concepts, not that it be the only feature that matters.

1.3. The BLOC privilege hypothesis and Gentner's natural partitions hypothesis

In a series of influential articles, Gentner (1978a, 1981, 1982; Gentner & Boroditsky, 2001) developed an account of the advantage that nouns have over verbs that bears some resemblance to the notion that BLOCs also have a privileged status. According to Gentner's natural partitions hypothesis, nouns are learned earlier than verbs because many nouns label whole, readily individuated objects, and the meanings of verbs show more cross-linguistic variation than do the meanings of nouns. The languages of the world show tremendous consistency in packaging such concepts into nouns (Baker, 2001; Pinker, 1984), meaning that learners have relatively little to figure out before noun learning can begin. When it comes to building a vocabulary of nouns, world and word cooperate in an elegant, transparent fashion. Verbs, by contrast, typically label the relations between or among participants in the event that the verb labels, as in *The bat hit the ball,* or *Mary put the ball on the table.* Such relations might be harder than objects to parse from the many sorts of relations that hold true in the world at any given time. Moreover, languages vary in their mapping of event components, such as manner or path of motion, onto lexical items (e.g., Talmy, 1975, 1985). Therefore, according to the natural partitions hypothesis, verb learning will at first proceed more slowly than noun learning, because learners must first determine how such mappings are done in their native language. That is, it is not nounness per se that produces a learning advantage. Rather, nouns have an advantage because the mapping of nouns to their referents is relatively straightforward, whereas verbs are disadvantaged because (a) the capacity to parse events may take some time to develop, and (b) learners must determine how the various components of events map onto lexical items.

The BLOC privilege hypothesis and the natural partitions hypothesis are similar in at least two ways. Both hold that concrete object labels are early learned because their referents are perceptually available and physically discrete, and both admit that some concepts may be inherently more complex or more easily entertained than others. The two proposals also differ in at least one important way, with respect to the way each characterizes the set of objects whose labels can readily be learned. For Gentner, the property of objects that facilitates label-learning is individuateability: Any entity that is easily segmented from its background (in a fashion reminiscent of Gestalt psychological principles) is label friendly. Such label-friendly entities include whole objects, which are also label friendly according to the BLOC privilege hypothesis. However, label friendliness under the BLOC privilege hypothesis depends on more than just individuation: Individuation must happen at the basic level. The natural partitions hypothesis does not distinguish between the concept PERSON and the concept PILOT, as a single, individuateable object can (under the right circumstances) be construed as a member of either category. As discussed previously, however, the two concepts differ in their quantificational properties. I revisit the differences between the two hypotheses in the Discussion, when I consider them further in light of the findings of this study.

1.4. The information change hypothesis

We turn now to the second major question that animates this article: What eventually allows the learning of nouns other than BLOC labels? As I stated earlier, there can be little doubt that part of the answer lies with the information available from intention reading and from conceptual development. At this point, I will now more fully develop the argument that learners also profit tremendously from changes in the linguistic-contextual information to which they have access. Consider a sentence uttered by one of the mothers in this study, with the target noun converted to nonsense: “Can you help the *gorp* to drive the plane?” A mature learner—one who has built a respectable vocabulary and can compute what words mean in combination—might infer that *gorp* means something like “driver of the plane”—in other words, PILOT.

Evidence for this position comes from a recent experiment by Gillette et al. (1999). Using adult participants as model word learners—in a procedure they called the Human Simulation Paradigm—Gillette et al. identified an important source of the early noun bias documented by Gentner (1982) and others. Because the research I report also uses the HSP, it is essential that the logic of the paradigm be clear. I thus describe the research by Gillette et al. in some detail.

1.4.1. An important preliminary

Despite its many strengths as a method—strengths that I enumerate later, after describing the method in more detail—there are some potentially significant differences between word learning in children and performance among adults in the HSP. The process of word learning among children is frequently described as solving “the mapping problem” (e.g., P. Bloom, 2000; Gleitman, 1990, among many others), because children must successfully map phonological forms to the correct concepts—for instance, /dog/ to DOG in English, but /perro/ to DOG in Spanish. The process of mapping involves identification of the correct concept, which is then “paired with” a word, such that the child can apply it to all and only the appropriate referents (objects, substances, events, states, and so on). As will become clear, adults in the HSP have a different task. Because they must identify words in English that they already know, they do not engage in a process that could properly be referred to as mapping. Rather, their task is to *identify* or to *select from* the set of word–concept pairs they already know. Because of this difference, I refer to the adult task as *identification,* or as *guessing the meaning of the mystery word.*

I later argue, in the Discussion, that the identification problem that adults must solve in the HSP bears a strong—and therefore informative—resemblance to the mapping problem in children, even if the two are not identical. For now I simply note that neither psychologists nor computer scientists have been shy about constructing computer simulations of human language and its learning, and then generalizing from the results of these simulations onto the child acquisition case (e.g., Brent, 1994; Mintz, 2003). The average adult is certainly more like a child than is a disembodied neural network or collection of algorithms. It is this comparison, between human adult and computer models, that has led to the term *human simulation* (Gillette et al., 1999).

1.4.2. Prior findings using the HSP

In their original work with the HSP, Gillette et al. (1999) videotaped mothers playing with their toddler children and extracted from the transcripts of those tapes the 24 most common nouns and the 24 most common verbs that the mothers had uttered. In one condition, participants were given access only to a set of six scenes (edited from the videotaped sessions) during which the mothers had uttered a given word, with the audio completely removed; participants were, however, provided with an indication, in the form of a "beep," of when the word was spoken. Their task was to guess the meaning of the "mystery word" that the beep had replaced. Participants who were exposed only to the scenes correctly guessed many of the nouns, but only a small proportion of the verbs—44.9% as against 15.3%.

One of the signal findings from Gillette et al. (1999) was that success at guessing a particular word was predicted not by its grammatical category, but by its *imageability,* a close cousin of *concreteness*. For example, the noun *elephant* and the verb *throw* were both rated as highly imageable (6.9 and 6.0, respectively, on a 7-point scale[5]), and participants easily identified both from their associated video clips (at 89.3% and 85.7% correct, respectively). In contrast, *thing* and *want* were rated as less imageable (2.9% and 2.3%, respectively), and they proved much harder to identify from observing similar instances of their use (at 3.6% correct for both).[6]

After establishing that nouns were guessed more easily from observational cues than were verbs, Gillette et al. (1999) focused on the information sources that enhanced success with verbs. When a different group of participants was exposed to the *sentences* the mothers had used, their success rate with verbs shot up dramatically, rivaling their success rate with nouns. To learn verbs such as *think* or *want,* which refer to internal mental states and therefore cannot be observed (expect, perhaps, through weak perceptual correlates, such as facial expressions), learners must have access to information that augments whatever they can extract from engagement with the perceptual world. The information they need comes in the form of syntactic context—in particular, the semantics of the syntactic frames in which verbs appear (Fisher, Gleitman, & Gleitman, 1991; Gleitman, 1990; Kako, 2005; Naigles, 1990; Naigles & Kako, 1993).

Identification rates improved over the course of the six exposures, lending support to the idea that multiple observations can make word learning more accurate (e.g., Pinker, 1994). But, as noted previously, the success of this procedure depended heavily on the kind of word being guessed. This evidence suggests that word-to-world pairing is a more efficient source of evidence for acquiring noun meanings than it is for acquiring verb meanings. More important, imageability (see Note 5) rather than nounness accounted for these differential accuracy rates, as the nouns were overall more imageable than the verbs.

Gillette et al. (1999) further investigated whether performance with the verbs might be enhanced by altering the type of information to which participants had access. Specifically, they investigated the usefulness of two sources of linguistic evidence, both alone, together, and in combination with the videotaped scenes: the nouns with which the mystery verb had co-occurred in maternal sentences, and the verb's syntactic context.

Different adults were the participants in each condition. The evidence presented in each condition was for the *same* six instances of maternal speech (for each mystery word) that had been used in the earlier video-clip condition. Table 1 presents the design of this experiment (which is also the general design of the experiment reported later), along with mean accuracy rates for each of the conditions. Co-occurrence information—for instance, *Markie, phone, you* for the verb *call*—turned out to be as informative as the videotaped scenes. Both information sources produced accuracy rates of about 15% after six exposures. When co-occurrence information was presented together with the videotaped scenes, participants identified nearly 30% of the verbs; that is, the information from these two sources of evidence was roughly additive.

Table 1
Experimental Design of Gillette et al. (1999)

Condition	Source(s) of Information	% Accuracy
1. Observation	Video clips	15.3
2. Co-occurrence	Alphabetical lists of nouns in sentence	16.5
3. Syntax	Sentences with nonsense content words	51.7
4. Co-occurrence + Observation	Video clips and lists of nouns (Conditions 1 + 2)	29.0
5. Syntax + Co-occurrence	Sentences with only verb as nonsense (Conditions 2 + 3)	75.4
6. Full Information	Sentences and video clips (Conditions 1 + 5)	90.4

In a third condition, syntactic information was presented to a new pool of participants in a form that resembled the verse from Lewis Carroll's "Jaberwocky" (1872): The six sample usages of the mystery verbs were presented with all content words converted to nonsense, but with word order and functional vocabulary preserved—for instance, *Lo PUNG what the floky pilks are varging.* As Table 1 shows, this kind of information proved highly informative. Indeed, presentation of syntactic frames led to higher accuracy rates than did the videotaped scenes and their noun contents taken together. Thus, for verbs at least, syntactic context can "pick up the slack" that observation leaves behind.

Although Gillette et al. (1999) focused on verbs rather than nouns, the data from the observation condition revealed a striking pattern: Some nouns were identified more accurately than others. Crucially, although the successfully identified nouns were all imageable, not all imageable nouns were successfully identified. Thus, although differences in imageability could explain why *ball* and *plane* were easy to guess from observation of the situations in which they were uttered (imageability ratings and percentage correct: for *ball,* 6.8% and 78.6%; for *plane,* 6.5% and 100%), it cannot explain why *pilot* and *hand* were difficult to guess under identical experimental conditions, as both were rated as moderately to highly imageable (imageability ratings and percentage correct: for *pilot,* 5.2% and 3.6%; for *hand:* 6.8% and 14.3%). As I demonstrate experimentally, the notion of BLOC-hood has the explanatory scope of imageability *and* can cover cases that imageability cannot.

1.4.3. Advantages of the HSP as a method

The HSP has three main advantages as a method. First, it allows us to assess the potency of the evidence available to word learners, from observation, from linguistic-contextual cues, and from a combination of the two. The adult participants in this paradigm act as cognitively sophisticated information extractors. They allow us to answer the following question: If we grant the learner access to one or more types of information, how much could he or she infer *in principle* about the meaning of an unknown word? At minimum, adults provide a kind of upper-bound estimate of the information to be found in the signal: If, given information type *I,* adults can infer nothing about a word's meaning, it is extremely unlikely that children could infer anything from *I,* either. If *I* does contain potentially useful information, it is of course a separate question whether and to what extent children actually make use of it (a question to which I return in the Discussion).

Second, the use of adults in the HSP allows us to control for the possible role of conceptual development in word learning. As noted previously, college-age adults (sophisticated or otherwise) have mastered all the concepts labeled by the mystery words. Nonetheless, if the BLOC privilege hypothesis is correct, adults who have access only to the muted scenes will succeed at guessing BLOC labels more often than they succeed at guessing non-BLOC labels. If the information change hypothesis is correct, adults who are given access to linguistic-contextual cues should succeed at guessing non-BLOC labels as well, and they should do especially well when linguistic-contextual cues are combined with exposure to the scenes. To be sure, such an outcome would not rule out conceptual development as an explanation for some aspects of vocabulary growth, but it would mean that such explanations may not be necessary, or may have a more limited scope.

Finally, one of the great advantages of the HSP is that it introduces additional realism into the experimental study of word learning. Whereas most studies of word learning artificially engineer exposures to test the learner's capacity to make use of different information types—whether by severely limiting the number of possible referents or by constructing artificially stripped-down linguistic contexts with specific properties—the HSP uses naturalistic input and places few constraints on the space of possible referents. Because the linguistic information comes from naturalistic interactions between mothers and children, we can plausibly assume that any cues that adults find useful are also available to learners roaming free "in the wild." Later, in the Discussion, I return to this issue, presenting further evidence that caregivers regularly provide such information, and—crucially—that children make use of it.

1.5. Experimental prospectus

Prior work using the HSP (Gillette et al., 1999) established that the 24 most frequent nouns in a large sample of maternal speech were identified quite efficiently by adults who had observed only six videotaped occasions of their use (at about 45% correct). But the focus of that work was on the informational conditions that enable the efficient learning of verbs, not nouns. Here I extend the use of the HSP to explore the case of nouns in some depth. If the information change model of word learning is to succeed as a general approach, it ought to explain how *nouns* that are difficult to learn from observation alone ultimately enter the learner's vocabulary. It is thus important to use the same paradigm to discover which nouns can be identified from which sources of information.

As described previously, earlier work using the HSP found that syntax alone was highly informative about the meaning of the mystery word. Nouns and verbs differ importantly in their syntactic behavior, however, so we should not expect syntax alone to be as informative about the meanings of mystery nouns as it is about the meanings of mystery verbs. The links between a verb's meaning and its syntactic (subcategorization) frame are rich and complex (Chomsky, 1981; Grimshaw, 1990; Levin, 1995; Pinker, 1989, to name just a few). Moreover, the syntactic contexts in which verbs appear reliably predict their semantics (Fisher et al., 1991); indeed, it is this systematicity that led to accurate guessing of verb meanings when participants in Gillette et al. (1999) had access only to the syntactic contexts in which verbs had been used.

By contrast, the syntax of noun phrases, especially in English, is fairly impoverished. To be sure, there are some systematic links between the semantics of a noun and its associated syntax (e.g., P. Bloom, 1994a). For instance, nouns that label kinds of individuals, both concrete nouns such as *chair* and *dog,* as well as abstract nouns such as *belief* and *suggestion,* are "count nouns," and they have a characteristic syntactic signature: When only one individual is enumerated, count nouns appear with the determiners *a* or *the* (*a dog, the belief*); when multiple individuals are enumerated, they take the plural marker *s* (*three chairs, four suggestions*). Count nouns can be preceded by the quantifiers *some* and *many,* but only in the plural (*some chairs, many suggestions,* not **some chair, *many suggestion*). On the other hand, nouns that label kinds of portions, both concrete nouns such as *confetti* and *wood,* and abstract nouns such as *knowledge* and *respect* can also be preceded by *some,* but they do not pluralize (**three confettis, *four knowledges*). Like count nouns, they can appear with the determiner *the,* but not with the determiner *a* (**a confetti, *a knowledge*). There are a few other links between noun semantics and noun phrase syntax (see, e.g., Grimshaw, 1990), but the meanings that can be gleaned from these patterns are extraordinarily coarse.[7] We should therefore not expect syntax by itself to be very helpful to participants in the HSP. Rather, a combination of syntax and other information sources should be necessary.

The research presented in this article tests four predictions, divided here into two sets. The predictions in the first set offer comparisons with the results of Gillette et al. (1999). The predictions in the second set represent the central focus of this article, relating, as they do, to the informational conditions that should enable the guessing of different types of labels.

1.5.1. Prediction Set 1: Effects of information richness on accuracy: The impact of multiple exposures and combinations of information sources

Prediction 1a: Consistent with the results of Gillette et al. (1999), accuracy at guessing nouns should generally improve over successive guesses.

Prediction 1b: In contrast to the results that Gillette et al. obtained with verbs, syntactic information alone should not prove very informative for identifying nouns. Indeed, because the syntax of noun phrases is relatively impoverished, performance should be fairly poor when syntactic information is the only type available. Instead, accurate performance will require richer information.

1.5.2. Prediction Set 2: BLOC labels versus non-BLOC labels: Ease of identification under different informational conditions

Prediction 2a: BLOC labels should be easier to guess from observation alone than non-BLOC labels (the BLOC privilege hypothesis).

Prediction 2b: Non-BLOCS should become much easier to guess when participants have access to rich linguistic-contextual information (the information change hypothesis).

2. Methods

2.1. Participants

There were 172 participants altogether (including those in the observation condition of Gillette et al., 1999), drawn from the undergraduate populations at the University of Pennsylvania and Swarthmore College. All either received credit in their introductory psychology course, or were paid $7. All were native speakers of English or had learned English before the age of 6.

Before participants were debriefed, they were asked if they had developed any strategies for guessing the mystery noun. A few reported that they had tried to think of a word that sounded like the mystery word (despite having been told that the target word and mystery word did not necessarily sound alike). In general, however, participants did not report the use of any such irrelevant strategies.

Note that the data for the observation condition come from Gillette et al. (1999); the procedures described in the following section are based on the procedures outlined in that article.

2.2. Procedure

Testing was done in groups of one to five in classrooms with the appropriate audiovisual equipment. Participants were fully informed about the purpose of the study. They were told that they would see videotapes or transcripts or both of mothers interacting with their children, and their task was to guess the meanings of nouns the mothers had used during these interactions.

Participants were also told that they should make a guess after each exposure, that they could change their responses from one guess to another, and that they would be asked to make a final guess following the sixth exposure. This final guess did not have to match any of their previous guesses. After participants read a copy of the instructions, the experimenter summarized them verbally and asked for any questions. In conditions involving written transcripts, the instructions included an (invented) example to help participants understand the nature of the task. Videotapes were played on a large monitor visible to all participants, whereas transcripts were displayed via an overhead video projector on a screen at the front of the room. After revealing each exposure, the experimenter paused for approximately 10 sec before playing or revealing the next exposure.

2.3. Stimuli

2.3.1. Videotaped stimuli

The videotaped stimuli in this experiment were originally assembled by Gillette et al. (1999), who recorded four hour-long videotaped sessions of 3 mothers and their 18- to 24 month-old children as they explored a box of toys brought by the experimenter. Gillette et al. then transcribed these interactions to identify the 24 nouns and the 24 verbs the mothers had uttered most frequently.

In the edited tapes, which contained these most common nouns and verbs, each clip began roughly 30 sec before the word was used and ended roughly 10 sec later.[8] The original audio was erased, and a beep inserted exactly where the word was spoken. In many cases, the mother repeated the target word during this 40-sec period; when such repetition occurred, the clip began 30 sec before the first use of the word and ended 10 sec after the final use. Regardless of the number of clips, there were always six exposures total for each noun. (In case of repetition, then, each utterance of the noun received its own "beep" and thus counted as one of the six exposures.) Uses of the target word were excluded if the referent was off-camera but had been visible to the real child observer, or if the mother's lips were visible enough to permit lipreading.[9] A 10-sec segment of color bars appeared between each block of six exposures for each word. Participants were randomly assigned to two noun-order groups; the order of noun presentation in each group was the reverse of the order in the other group.

2.3.2. Linguistic stimuli

The linguistic stimuli were constructed from the same maternal sentences recorded in the videotapes described previously. This commonality is important given that the aim is to compare the power of different information sources to reveal the meanings of the same words. Different samples of maternal input would have introduced far too much variance, making it difficult to detect the influence of different information sources in the learning of specific words.

In these linguistic conditions, all prior exposures for a noun remained visible until participants made their seventh and final guess. Participants were again randomly assigned to two noun-order groups. Examples of the stimuli from each condition can be found in Table 2.

In the co-occurrence condition, participants were given a list of the other nouns and verbs that had appeared with the mystery noun in its original sentence. As there were six exposures per noun, there were six lists of these co-occurring words. To remove all syntactic information, the co-occurring words were arranged alphabetically within each sentence. Pronouns were converted to nominative case (e.g., *her* appeared as *she* and *them* as *they*), and all verbs appeared tenseless in their root forms (e.g., *was* appeared as *be,* and *drives* appeared as *drive*). All function words and social words (e.g., *hi* and *please*) were omitted, as were all pronouns acting as possessives (e.g., *his*). The words *here* and *there* were included only when they were the objects of prepositions. Participants were informed at the outset that all these changes had been made.

In the syntax condition, participants were given information about the syntactic environment in which the noun had originally appeared, but no information about the content of the co-occurring words. All content words, including pronouns, were converted to nonsense, whereas all closed-class morphemes (determiners, prepositions, auxiliaries, tense markers, etc.) were left in English. Social words were also left in English. Every effort was made to respect the probabilistic phonological properties of words in English (Kelly, 1992): Pronouns contained just one syllable with no coda; nouns on average contained more syllables than verbs; and adjectives ended with *y,* whereas adverbs ended with *ly.* Replacements were made consistently throughout

Table 2
Sample Exposures for the Target Word Elephant ("RENCK")

Exposure	Co-Occurrence	Syntax	Syntax + Co-Occurrence
1	be, it	Mo eoz a RENCK.	It's a RENCK.
2	give, hug, you	Why don't ko jat the RENCK a poga?	Why don't you give the RENCK a hug?
3	—	Oh, a RENCK.	Oh, a RENCK.
4	do, what	What does the RENCK fab?	What does the RENCK do?
5	see, trunk	Sorf the RENCK's reb?	See the RENCK's trunk?
6	nose, see	Sorf the RENCK's peb?	See the RENCK's nose?

the transcriptions, so that the same content word was always replaced with the same nonsense word. Function words, including *wh*-words and existential *there,* were left as English, as were the words *here* and *there* when they appeared as the objects of prepositions.

In the syntax + co-occurrence condition, only the mystery word was converted to nonsense. All other words remained in the original English.

2.3.3. Combinations of linguistic and visual input

Each linguistic condition was next paired with the matching scenes to yield three new conditions: co-occurrence + observation, syntax + observation, and full information (syntax + co-occurrence + observation). In each of these conditions, the transcripts and tapes were shown at the same time.

Pilot testing revealed that the simultaneous presentation of videotaped and transcribed material took noticeably longer than presentation of the transcribed material alone (owing largely to the mechanical constraints of stopping and starting the videocassette recorder and moving back and forth between the television and the computer). To prevent participant fatigue, we divided the 24 items into two lists of 12 each, balanced for imageability. Because each participant was exposed only to half the total number of nouns, I later constructed "super-subjects" by combining the data from the participants exposed to List A with the data from participants exposed to List B. (As I demonstrate later, the factor of list had no discernible effect on accuracy).

Once again nouns were presented in two orders, one the reverse of the other. Although prior scenes obviously did not remain visible to participants, prior transcript exposures remained visible on the projection screen.

2.4. Coding and analysis

Responses were coded as correct if they contained the same base morpheme as the target word. Slight morphological variations—specifically, number (*drums* instead of *drum*) and the presence of a diminutive marker (*piggy* instead of *pig*)—were ignored. All statistical tests were two-tailed, and all *p* values are stated at two levels of significance, .05 and .01.

3. Results

Accuracy rates for each of the 24 nouns in all seven conditions, separated by BLOC-hood, can be found in Table 3. (Note that Table 3 also contains the imageability ratings collected for these nouns by Gillette et al., 1999). I first analyze the data for effects of the control variables and then turn my attention to each of the predictions outlined in the Introduction.

3.1. Control variables

To assess the effect of the control variables, analyses of variance (ANOVAs) were performed on the conditions that provided linguistic information alone and on those that provided both linguistic and visual information. As will become clear, none of the control variables exerted a reliable effect.

Table 3
Percentage Correct on Final Guess, by BLOC, Target, and Condition, With Imageability Ratings

Label Type and Target	Imageability[a]	Observation[b]	Co-occurrence	Syntax	Co-occurrence + Observation	Syntax + Observation	Syntax + Co-occurrence	Full Information
BLOC								
bag	6.6	85.7	0.0	0.0	81.2	93.8	6.2	93.8
ball	6.8	78.6	68.8	0.0	93.8	87.5	87.5	100.0
camera	6.7	46.4	0.0	0.0	50.0	50.0	0.0	56.2
drum	6.5	89.3	0.0	0.0	75.0	87.5	25.0	100.0
elephant	6.9	89.3	37.5	0.0	93.8	81.2	87.5	100.0
hammer	6.6	71.4	6.2	0.0	93.8	100.0	6.2	100.0
hat	6.6	28.6	0.0	18.8	31.2	68.8	25.0	81.2
peg	4.4	10.7	0.0	0.0	25.0	43.8	0.0	43.8
people	4.8	39.3	0.0	0.0	12.5	62.5	0.0	87.5
pig	5.0	89.3	0.0	0.0	81.2	87.5	31.2	100.0
plane	6.5	100.0	0.0	12.5	93.8	93.8	0.0	93.8
shoes	6.5	3.6	0.0	12.5	6.2	18.8	56.2	81.2
swing	5.7	96.4	0.0	0.0	100.0	100.0	37.5	100.0
M	6.1	63.7	8.7	3.4	64.4	75.0	27.9	87.5
Non-BLOC								
daddy	6.4	3.6	12.5	25.0	0.0	6.2	18.8	37.5
hand	6.8	14.3	37.5	6.2	50.0	68.8	81.2	93.8
hole	5.2	57.1	0.0	0.0	37.5	62.5	37.5	87.5
kiss	4.9	7.1	6.2	0.0	43.8	50.0	31.2	87.5
mommy	6.4	3.6	0.0	6.2	12.5	43.8	31.2	100.0
music	4.4	39.3	0.0	0.0	6.2	43.8	81.2	93.8
nose	6.1	67.9	12.5	6.2	62.5	50.0	87.5	93.8
pilot	5.2	3.6	50.0	0.0	50.0	31.2	50.0	68.8
tail	5.3	25.0	43.8	18.8	43.8	75.0	93.8	100.0
thing	2.9	3.6	0.0	0.0	0.0	0.0	25.0	43.8
toy	4.8	25.0	6.2	43.8	12.5	87.5	93.8	100.0
M	5.3	22.7	15.3	9.7	29.0	47.2	57.4	82.4
Overall *M*	5.7	44.9	11.7	6.2	48.2	62.2	41.4	85.2

Note. BLOC = basic-level object category.
[a]Imageability ratings on a scale of 1 to 7; data from Gillette et al. (1999), Experiment 2. [b] Data from Gillette et al. (1999) Experiment 1.

3.1.1. Linguistic-only conditions

The proportion correct on the final trial was submitted to a 3 (condition) × 2 (noun order) ANOVA over subject means and to a similar 3 × 2 repeated measures ANOVA over item means. As predicted, there was an effect of condition, $F1(2, 46) = 84.72$, $p < .01$, and $F2(2, 46) = 22.15$, $p < .01$, but no effect of noun order, $F1(1, 46) = 0.28$, *ns,* and $F2(1, 23) = 0.98$, *ns,* and no interaction between the two, $F1(2, 46) = 0.34$, *ns,* and $F2(2, 46) = 0.41$, *ns.* Because there were no effects of noun order, subsequent analyses collapse across the levels of this variable.

3.1.2. Combinations of linguistic and visual information

The proportion correct on the final trial was submitted to a 3 (condition) × 2 (noun order) × 2 (list) ANOVA over subject means, and to a similar 3 × 2 × 2 repeated measures ANOVA over item means. As predicted, there was an effect of condition, $F1(2, 84) = 43.90$, $p < .01$; $F2(2, 44) = 29.27$, $p < .01$. None of the control variables exerted a stable effect in both subjects and items analyses. There was an effect of noun order only in the items analysis, $F2(1, 22) = 6.71$, $p < .05$, and an interaction among condition, list, and noun order only in the items analysis, $F2(2, 44) = 4.20$, $p < .05$; no other main effects or interactions were reliable in either analysis. Subsequent analyses thus collapse across noun order and combine lists (which, recall, contained different nouns).

3.2. Effects of information richness on accuracy

We now turn to the first set of predictions, which focus on the effects of informational richness on identification accuracy.

3.2.1. Prediction 1a: Accuracy should improve over successive guesses

As Figure 1 suggests, subjects' accuracy increased over trials, though more rapidly in some conditions than in others. Moreover, overall accuracy differed as a function of condition. To test the reliability of the increase in accuracy as a function of trial, the mean proportion correct on each trial was submitted to a 7 (condition) × 7 (guess#) subjects ANOVA, with guess# as a repeated measure, and to a similar items ANOVA, with target as an additional repeated measures factor. All effects evident in Figure 1 proved reliable: condition, $F1(6, 117) = 223.16$, $p < .01$; $F2(6, 138) = 37.26$, $p < .01$; guess#, $F1(6, 702) = 306.68$, $p < .01$; $F2(6, 138) = 27.41$, $p < .01$, and the interaction between them, $F1(36, 702) = 16.08$, $p < .01$; $F2(36, 828) = 5.46$, $p < .01$. Thus subjects generally profited from repeated exposures across the conditions.

3.2.2. Prediction 1b:Accuracy on the final trial should require rich linguistic-contextual information

To determine the relative potency of the information sources represented by the seven conditions, I ordered the conditions by mean proportion correct on the final trial (lowest to highest): syntax (0.06), co-occurrence (0.12), syntax + co-occurrence (0.41), observation (0.45), co-occurrence + observation (0.48), syntax + observation (0.62), and full information (0.85). I next performed post hoc pairwise comparisons on the cell means from both the subjects ANOVA and the items ANOVA. The subject comparisons yielded the following ordering of conditions: full information > syntax + observation > co-occurrence + observation ≅ observa-

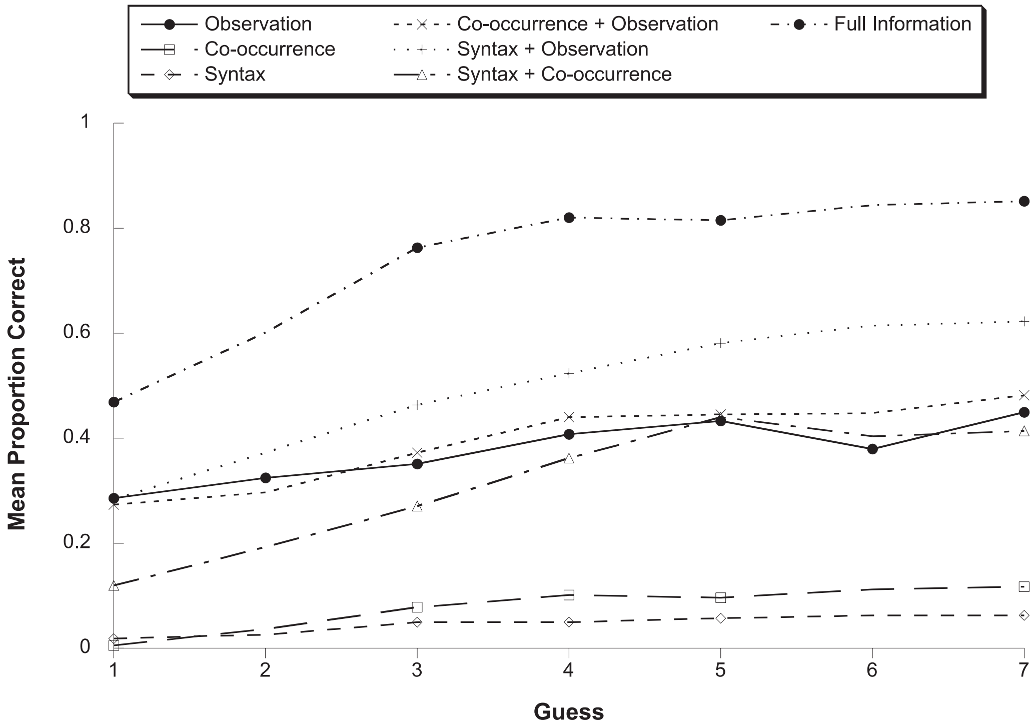

Fig. 1. Accuracy by guess in each of the seven conditions.

tion ≅ syntax + co-occurrence > co-occurrence ≅ syntax. The items comparisons yielded a nearly identical ordering: full information > syntax + observation ≅ co-occurrence + observation ≅ observation ≅ syntax + co-occurrence > co-occurrence ≅ syntax. Values from these comparisons are presented in Table 4. Thus, as predicted, syntax alone led to the worst performance, whereas full information led to the best performance. Interestingly, performance in the co-occurrence condition was statistically indistinguishable from performance in the syntax condition. Although the specifics of this pattern differ from that observed by Gillette et al. (1999), in that syntax by itself is not very informative, this results echo the same general pattern: Although observation consistently plays an integral role in word identification, the addition of linguistic context often improves success rates significantly. This finding bolsters the generality of the information-change model of word learning.

Another measure of the potency of each information source is the extent to which guesses vary from subject to subject. Following Gillette et al. (1999), I call this measure *scatter.* The more potent a source of information, the smaller this scatter should be. That is, if the information is strong and reliable, then subjects should largely agree with one another about the identity of the mystery word by the time they offer their seventh and final guess. Table 5 shows the most frequent guess on the final trial for each noun in the seven conditions, along with the percentage of subjects making that guess (with nouns listed, once again, by BLOC status). Correct guesses are marked in plain type, incorrect guesses in italics; dashes indicate that no answer was given more often than any other—that is, maximum scatter. Inspection of the table suggests that scatter generally decreased as the richness of information increased.

Table 4
Pairwise comparisons of accuracy under different information sources, ordered by magnitude

Condition	Mean % Correct	Subjects $F(1, 117)$	Items $F(1, 138)$
Syntax	6.2	—	—
Co-occurrence	11.7	2.67 *ns*	0.66 *ns*
Syntax + Co-occurrence	41.4	78.81*	19.47*
Observation	44.9	1.42 *ns*	0.28 *ns*
Co-occurrence + Observation	48.2	1.19 *ns*	0.23 *ns*
Syntax + Observation	62.2	17.68*	4.37 *ns*
Full Information	85.2	46.96*	11.60*

Note. p values are Bonferroni corrected.
$^*p < .01$.

This impression is confirmed in a quantitative analysis of scatter around the target, specifically, in the ratio of types to tokens. The more types subjects guessed—that is, the less they agreed—the greater the degree of scatter around that noun. Averaged over the 24 targets, a high type-token ratio indicates that the information source did not help subjects to identify the correct target. Table 6 presents the mean ratios for the seven conditions. A one-way repeated measures analysis confirms that the conditions do indeed differ reliably in this regard: $F(6, 138) = 54.41$, $p < .01$. Ordered by the magnitude of the type-token ratios (lowest to highest), the conditions pattern as follows: full information (0.16), observation (0.30), syntax + observation (0.30), co-occurrence + observation (0.36), syntax + co-occurrence (0.46), co-occurrence (0.70), and syntax (0.78). Post hoc pairwise comparisons reveal the following reliable differences: syntax ≅ co-occurrence > syntax + co-occurrence ≅ co-occurrence + observation ≅ observation ≅ syntax + observation > full information; values for these comparisons are presented in Table 6. Thus, syntax alone and co-occurrence alone lead to the greatest scatter, whereas full information led to the least scatter.

3.2.3. Summing up: Effects of information-richness on accuracy

The results presented previously support Prediction 1a: Accuracy does improve over successive guesses. We have also found support for Prediction 1b: Although the identification scores obtained under observation do not rise reliably when observation is supplemented just with co-occurrence or just with syntax, they do rise reliably when observation is supplemented with both co-occurrence and syntax.

3.3. BLOC labels versus non-BLOC labels

3.3.1. Prediction 2a: BLOC labels should be easier to guess from observation alone than non-BLOC labels (the BLOC privilege hypothesis)

To explore how readily BLOC labels could be guessed from different information sources, I used the three criteria laid out in the Introduction to classify each of the 24 nouns as referring either to a BLOC or to a non-BLOC. Recall that BLOC labels refer to whole objects, to situation-independent kinds, and to classes of objects that are similar in shape. Using these criteria, I classified 13 of the nouns as BLOC labels and the other 11 as non-BLOC labels. Table 3 presents mean

Table 5
Most frequent final guess by BLOC, target, and condition

Label Type and Target	Observation	Co-Occurrence	Syntax	Co-Occurrence + Observation	Syntax + Observation	Syntax + Co-Occurrence	Full Information
BLOC							
bag	bag (85.7)	—	*room* (18.8)	*box* (50.0)	bag (93.8)	bag (81.3)	bag (93.8)
ball	ball (67.9)	ball (68.6)	*door* (18.8)	ball (87.5)	ball (87.5)	ball (93.8)	ball (100.0)
camera	camera (46.4)	—	TV (12.5)	—	camera (50.0)	camera (50.0)	camera (56.3)
drum	drum (89.3)	—	*dog* (25.0)	drum (25.0)	drum (87.5)	drum (75.0)	drum (100.0)
elephant	elephant (89.3)	elephant (89.3)	—	elephant (87.5)	elephant (81.3)	elephant (93.8)	elephant (100.0)
hammer	hammer (71.4)	—	—	*tool* (43.8)	hammer (100.0)	hammer (93.8)	hammer (100.0)
hat	hat (28.6)	*box* (12.5)	hat (18.8)	hat (25.0)	hat (68.8)	hat (31.3)	hat (81.3)
peg	*nail* (25.0)	—	*birds* (18.8)	*piece* (25.0)	peg (43.8)	peg (25.0)	peg (43.8)
people	people (35.7)	*toy* (18.8)	—	*mice* (18.8)	people (62.5)	*plane* (93.8)	people (87.5)
pig	pig (89.3)	*milk* (25.0)	*cat* (18.8)	pig (31.3)	pig (87.5)	pig (81.3)	pig (100.0)
plane	plane (100)	*child* (18.8)	plane (12.5)	*boat* (25.0)	plane (93.8)	plane (93.8)	plane (93.8)
shoes	shoes/*feet* (35.8)	—	*hands* (25.0)	shoes (56.3)	shoes/*feet* (18.8)	*hands* (25.0)	shoes (81.3)
swing	swing (96.4)	—	*chair* (12.5)	swing (37.5)	swing (75.0)	swing (100.0)	swing (100.0)
Non-BLOC							
daddy	*phone* (53.6)	daddy (12.5)	daddy (25.0)	*grandpa* (56.3)	*pig* (18.8)	*phone* (43.8)	*grandpa* (43.8)
hand	*toy* (28.6)	hand (14.3)	—	hand (81.3)	hand (68.8)	hand (50.0)	hand (93.8)
hole	hole (57.1)	*balloon* (18.8)	—	hole (37.5)	hole (62.5)	hole (37.5)	hole (87.5)
kiss	*mouth* (17.9)	*money* (25.0)	—	*hug* (62.5)	kiss (50.0)	kiss (43.8)	kiss (87.5)
mommy	*ball* (42.9)	—	*daddy* (37.5)	mommy (25.0)	mommy (31.3)	*toy* (31.3)	mommy (100.0)
music	*drum* (46.4)	*game* (37.5)	*food* (25.0)	music (81.3)	music (43.8)	*drum* (87.5)	music (93.8)
nose	nose (67.9)	*trunk* (31.3)	—	nose (87.5)	nose (50.0)	nose (62.5)	nose (93.8)
pilot	*plane* (21.4)	pilot (50.0)	*dog* (31.3)	pilot (50.0)	pilot (31.3)	pilot (50.0)	pilot (68.8)
tail	tail (25.0)	tail (43.8)	tail (18.8)	tail (93.8)	tail (75.0)	tail (43.8)	tail (100.0)
thing	*toy* (39.3)	*daddy* (18.8)	—	thing/*tool* (25.0/25.0)	*toy* (93.8)	*toy* (18.8)	thing (43.8)
toy	toy (25.0)	—	toy (43.8)	toy (81.3)	toy (93.4)	*pig* (37.5)	toy (100.0)

Note. The percentage of subjects making that guess is listed in parentheses. Incorrect guesses are highlighted in italics. Note that in some cases, two answers were both the most frequently guessed. BLOC = basic-level object category.

Table 6
Mean type-token ratios for all Conditions, ordered by magnitude

Condition	Mean Type-Token Ratio	$F(1, 138)$
Syntax + Co-occurrence + Observation	0.16	—
Syntax + Observation	0.30	10.02*
Observation	0.30	0.00 *ns*
Co-occurrence + Observation	0.36	1.75 *ns*
Syntax + Co-occurrence	0.46	5.15 *ns*
Co-occurrence	0.70	32.19**
Syntax	0.78	3.00 *ns*

*$p < .05$. **$p < .01$.

accuracy rates for each of the 24 nouns in all seven conditions, by BLOC status. Mean accuracy rates by condition and by BLOC, collapsed across nouns, are presented graphically in Figure 2.

Consistent with the BLOC privilege hypothesis, Figure 2 suggests that BLOC labels were easier to identify from observation alone than from syntax alone or from co-occurrence alone. Appropriate t tests, both by subjects and by items, confirm that this was the case: Identification rates for BLOCs were better in observation than in co-occurrence, $t1(42) = 21.05, p < .01$; $t2(12) = 5.65, p < .01$, and again better in observation than in syntax, $t1(42) = 23.51, p < .01$; $t2(12) = 5.94, p < .01$.

3.3.2. *Prediction 2b: Non-BLOC labels should be easier to guess when learners have access to rich linguistic-contextual information (the information change hypothesis)*

I next explored how a noun's status as a BLOC label affected accuracy rates in all seven conditions. Similar patterns are confirmed by two repeated measures ANOVAs, one by subjects with

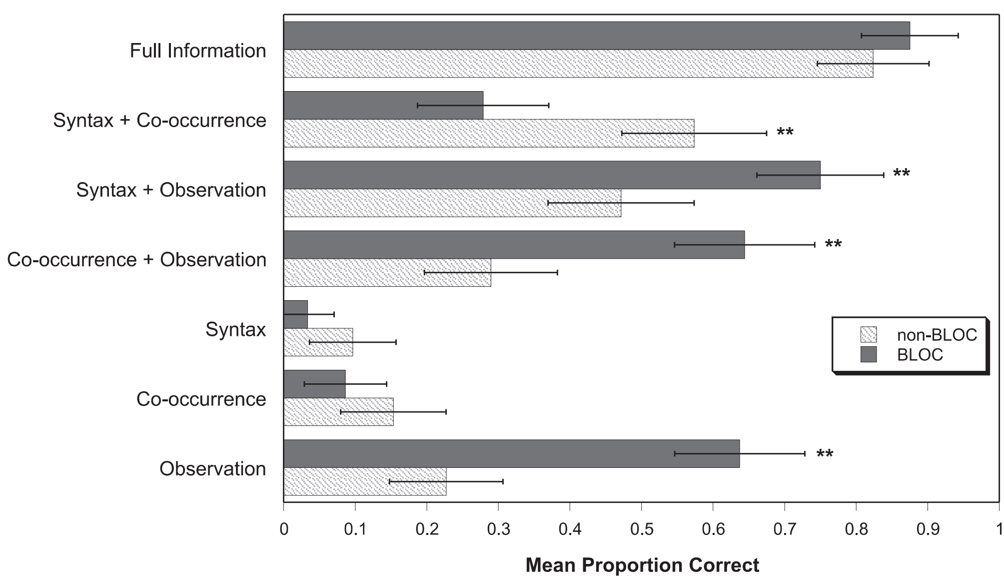

Fig. 2. Mean proportion correct (±SEM) by Condition and BLOC.

BLOC as a repeated measure, and another by items with condition as a repeated measure: There is a main effect of condition in both analyses, $F1(6, 117) = 135.39, p < .01$; $F2(6, 132) = 45.29, p < .01$. There is a main effect of BLOC only by subjects, $F1(1, 117) = 40.37, p < .01$; $F2(1, 22) = 1.91$, *ns*, but there is an interaction between condition and BLOC in both analyses, $F1(6, 117) = 48.52, p < .01$; $F2(6, 132) = 10.46, p < .01$. Thus, although BLOC labels were generally guessed more accurately than non-BLOC labels, the magnitude of this difference varied as a function of condition.

I next compared accuracy on the final guess for BLOC labels and non-BLOC labels in each of the seven conditions. In most cases where one noun type had an advantage over the other, BLOC labels were guessed more accurately than non-BLOC labels. This was true in observation, $t1(27) = 14.51, p < .01$; $t2(22) = 3.41, p < .01$; co-occurrence + observation, $t1(15) = 5.98, p < .01$; $t2(22) = 2.90, p < .01$; and syntax + observation, $t1(15) = 5.47, p < .01$; $t2(22) = 2.63, p < .05$.[10] Interestingly, the one case in which non-BLOC labels were guessed more accurately than BLOC labels was in the syntax + co-occurrence condition, $t1(15) = 8.47, p < .01$; $t2(22) = 2.32, p < .05$, which provides rich linguistic information but no perceptual information. Perhaps most important, the two noun types did not differ reliably in the full information condition, $t1(15) = 1.49$, *ns*; $t2(22) = 0.62$, *ns*, suggesting that the combination of linguistic and visual information made it equally easy to identify both types of nouns.

I also compared the mean type-token ratios for BLOC and non-BLOC labels in each of the seven conditions. These values are presented in Figure 3, which suggests a complex but interesting pattern. The non-BLOC labels produced more scatter than the BLOC labels in three conditions: observation, $t(22) = 3.71, p < .01$, co-occurrence + observation, $t(22) = 2.29, p < .05$, and syntax + observation, $t(22) = 2.75, p < .05$. The one condition in which the pattern was reversed was one that did not include observation at all, namely, syntax + co-occurrence, $t(22) = 3.70, p < .01$—also the only condition in which non-BLOCs were identified more accurately than BLOCs. More important, there was no difference in the type-token ratio of BLOC labels

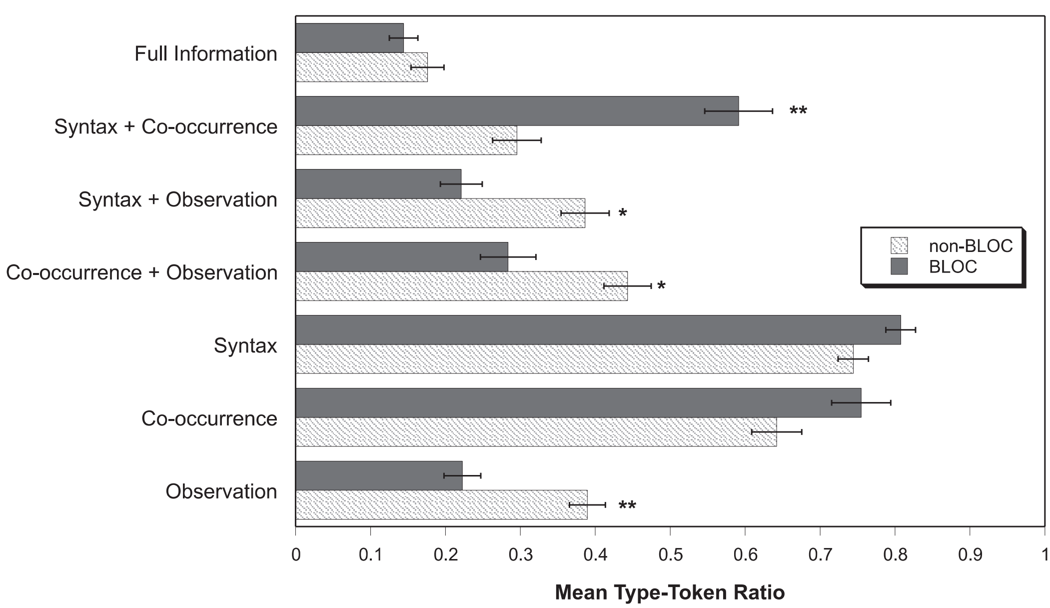

Fig. 3. Mean type-token ratios (±SEM) by Condition and BLOC.

and non-BLOC labels in the full information condition, $t(22) = 0.78$, *ns,* and in this condition scatter was low for both noun types. Once again, the combination of observational and linguistic information effectively eliminates the difference between BLOC labels and non-BLOC labels, making the former as easy to identify as the latter.

4. Discussion

The results of this research support all four of the predictions laid out in the Introduction. As predicted under the BLOC privilege hypothesis, adults who had access to observational information alone (as do children in the very early stages of vocabulary development) identified BLOC labels such as *plane* and *swing* more often than they identified non-BLOC labels such as *toy* and *music.* As predicted under the information change hypothesis, this difference decreased or even disappeared when participants had access to rich linguistic-contextual information (as do older learners, once they have built a respectable vocabulary and have mastered at least a rudimentary understanding of how their native language behaves syntactically). Consistent with the findings of Gillette et al. (1999) in their original work with the HSP, exposures to multiple instances of a word's use generally improved identification rates. Unlike the study by Gillette et al., who found that syntactic information alone was sufficient to enable accurate identification of verbs (even highly abstract verbs such as *think*), this study found a different pattern. As predicted, because nouns of all types appear in a much more limited set of syntactic contexts (which, as a consequence, carry little information about a noun's semantics), syntactic information alone did not prove very informative about the identity of the mystery noun. Rather, success on the final trial depended on participants' having access both to richer linguistic-contextual information—specifically, the syntax of the original sentence —and to other content words that co-occurred with the noun.

My general goal in the remainder of this article is to integrate both the BLOC privilege hypothesis and the information change hypothesis with research on word learning in children. I show that learners in experimental settings interpret novel nouns in ways that are consistent with the criteria laid out in the Introduction for BLOCs. I also address a shortcoming in the explanatory scope of the BLOC privilege hypothesis with respect to the learning of proper names. Turning to the information change hypothesis, I also raise some possible objections to the HSP as a model of word learning in children and argue that they are not as serious as they might at first appear. As we will see, these objections can be addressed either on logical grounds, or with evidence from studies of word learning in children.

4.1. The BLOC privilege hypothesis

4.1.1. Learners interpret new words as labels for BLOCs

4.1.1.1. Novel nouns label whole objects. A bias to assume that labels refer to whole objects was established by Markman and Wachtel (1988), who called it the *whole object assumption.* In their studies, preschoolers were presented with pairs of objects, each containing one familiar object (e.g., a banana) and one unfamiliar object (e.g., a lemon wedge press) and an unfamiliar (nonsense) label. Children rejected the novel label as a second name for the familiar object, preferring instead to treat it as the name for the unfamiliar object. Only when children were presented with a single, known object with an unfamiliar part (e.g., a car with an airfoil) did children overcome the whole object assumption, via the principle of mutual exclusivity, which encourages learners to avoid having more than one name for a known object or part. Novel word interpretations consistent with the whole object assumption (or something like it) have been documented by a number of researchers (e.g., Baldwin, 1989; Golinkoff, Mervis, & Hirsh-Pasek, 1994; Hall, Waxman, & Hurwitz, 1993; Soja, Carey, & Spelke, 1991).

4.1.1.2. Novel nouns label situation-independent kinds. Hall and Waxman (1993) attempted to teach preschoolers labels for both basic level and situation- or life-phase-restricted kinds. There were two conditions, one focused on situation and the other on life phase. In both conditions, Hall and Waxman introduced their participants to a set of four fuzzy one-eyed monsters. In the situation condition, the monsters were all the same size, but wore slightly different garments. Some were introduced riding in a car, whereas others were introduced sitting outside the car. In the life-phase condition, the monsters varied both in garment and in size (a "very young" 2 inches vs. a "grown-up" 5 inches). The experimenter introduced one of the monsters—one of the monsters in the car in the situation condition, and one of the young monsters in the life-phase condition—and then named it. The target was named either with simple ostension ("This is a murvil") or with additional information (e.g., "This is a murvil because it is riding in a car"). Shortly thereafter, the other three members of the set were brought out, and the children were asked to interact in several ways with the murvil (by tickling it, patting it, etc.); they were also asked to answer "yes" or "no" to the question, "Is this a murvil?" for all members of the basic-level kind and the two distractors. In the simple ostension condition, children were more likely to extend the meaning of the new word across context than they were in the additional information condition (to which I return shortly). Thus, learners appear biased to assume that count nouns label kinds with situation-independent identities.

The Introduction detailed one reason that situation-independent kinds might be privileged over situation-dependent kinds: The former have quantificational properties that permit consistent enumeration, not contingent on the details of a particular situation. There are two other reasons for BLOCs to be situation independent, both related to the learning of categories and, therefore, to the learning of category labels. The first has to do with the role of perceptual cues in category formation, and the second with the likelihood that induction will be correct if a learner conjectures a situation-dependent concept versus a situation-independent concept.

First, the cues necessary to infer that a category is situation dependent are often quite subtle and not directly available to perception. For example, someone is a passenger under a very wide range of circumstances: riding in the front or back seat of a car, traveling in any seat of an airplane (even the cockpit), sitting on the back of a motorcycle with arms wrapped around the driver, and so on. The property that makes someone a passenger is traveling in or on some form of transportation without participating in its operation.[11] Second, there are an enormous number of possible situation-dependent categories one could conjecture. A learner who sees a woman in a restaurant preparing meals could conjecture not only the category CHEF,[12] but also PERSON-WHEN-IN-THE-KITCHEN, PERSON-WHEN-OPERATING-A-STOVE, and so on. The profusion of possibilities renders induction nearly impossible, in part because many, if not all, of these things will be true of the woman whenever she is working as a chef (cf. Quine, 1960). A learner is much more likely to be right if he posits a basic-level category such as PERSON or WOMAN.[13] In the absence of information to the contrary (an important caveat), a bias to assume that new words refer to situation-independent kinds would significantly narrow the set of possible meanings and lead, in most cases, to successful learning.

4.1.1.3. Novel nouns label objects with respect to their shape. A number of experiments have documented that learners extend novel words based on shape, rather than on other properties. For instance, Landau et al. (1988) introduced preschoolers to a novel object—for instance, an angular *U*-shaped form made out of wood and painted blue—and named it with a novel noun, as in "This is a dax." They next showed participants a series of objects (alongside the original) that varied the shape, material, or size of the original (but keeping the other two properties constant). Participants were asked "Is this a dax?" Landau et al. (1988) found that participants tended to accept changes to size and material, although rejecting all but the most minor variations in shape. Many other experiments with preschoolers have also supported the importance of shape in the extension of newly learned words to novel exemplars (Gentner, 1978b; Landau et al., 1988, 1998; Landau & Stecker, 1990; Markman & Hutchinson, 1984; Subrahmanyam, Landau, & Gelman, 1999).[14]

4.1.2. The BLOC privilege hypothesis and the natural partitions hypothesis, revisited

As noted in the Introduction, the BLOC privilege hypothesis and the natural partitions hypothesis are similar in several ways. Both hold that concrete object labels are early learned because their referents are available to perception and physically discrete, and both allow that some concepts are inherently more complex or less likely to be entertained than others. The major difference between them has to do with what makes an object "label friendly." For the BLOC privilege hypothesis, it is, of course, belonging to a basic-level kind, according to the criteria previously discussed. For the natural partitions hypothesis, it is ease of individuation. The data presented in this article support the BLOC privilege hypothesis.

Importantly, however, the natural partitions hypothesis makes at least one prediction that the BLOC privilege hypothesis does not: namely, that proper names should be learnable from observational information, because animate objects are individuated just as easily (if not more so) than inanimate objects. And indeed, proper names are often among the earliest learned words. However, I do not believe that the failure of the BLOC privilege hypothesis in this regard is cause to reject it. First, proper names satisfy two of the four BLOC criteria: Their referents are (obviously) whole objects, and not situation dependent (because they track an individual consistently through space and time, under all circumstances). Second, the referents of proper names are likely to be much more perceptually similar from one instance to the next. *Luke* at Time 1 will closely resemble *Luke* at Time 2—even more than one instance of a BLOC will resemble another (e.g., two different tables) than are the referents of BLOCs.[15] The cross-temporal perceptual similarity of individuals (barring sudden, drastic changes in appearance) might well simplify the problem of learning proper names.

There are reasons to believe that proper names are privileged, as are BLOC labels, but for different reasons. Their privilege comes from a convergence of perceptual, conceptual, and linguistic factors. First, there is evidence, both from adults (Johansson, 1973) and from infants (Fox & McDaniel, 1982), that the human cognitive system is specialized for the detection and processing of biological motion. Things that are alive—particularly people—are quite interesting to us, and from a very early age. Second, infants as young as 9 months old attribute goal-oriented behavior to animate things: Infants who see a human hand reach for a teddy bear are not surprised when, in a subsequent event, the hand reaches to a different location, provided it still reaches for the teddy bear; infants who see a robotic arm do the same show surprise at a change of destination, but not at a change of goal (Woodward, 1998). Finally, proper names often appear in isolation or receive emphasis (P. Bloom, 2000); moreover, children in many cultures are explicitly taught proper names (e.g., Schieffelin, 1985).

The very properties that often make learning proper names straightforward in the real world may also be responsible for participants' poor performance in guessing *mommy* and *daddy* in the observation condition of the HSP. *Mommy* was frequent because the mothers referred to themselves; *daddy* was frequent because he was mentioned in absence (e.g., "Let's call Daddy on the phone"). In neither case did the adult participants (or the children who had been videotaped, for that matter) have the opportunity to use a cue such as joint attention to determine the referent of the word. What is more, participants had no way to tell whether the word had received stress or had appeared in isolation (which, in fact, neither word ever did; each consistently appeared in continuous speech).

In sum, although the BLOC privilege hypothesis fails to predict that proper names should be learnable from observational information alone—as the natural partitions hypothesis correctly predicts—it still has considerable explanatory power and can be supplemented in ways that accommodate the early learning of such names.

4.2. The information change hypothesis

Not only is observation useful for noun learning, it appears to be irreplaceable, at least for adults acting as simulated learners. No single or multiple condition for noun learning that excluded observation produced accuracy rates that exceeded those of observation alone. Indeed, neither co-occurrence alone (with a mean of 11.73% correct) nor syntax alone (with a mean of 6.26% correct) offered any real information about the identities of the mystery nouns.

Although the observational condition provided powerful cues for identification, it apparently could not support the learning of all types of nouns. We should keep in mind, however, that participants were required to identify these nouns from only 6 exposures; perhaps after 12 or 50 or 100 exposures, such as real children might get, they would have been uniformly correct for all 24 nouns.[16] Although observational evidence is very informative—when it is good, it is very good—it still cannot serve as a complete solution to the identification problem. For one thing, it can lead to false conjectures. In fact, about 55% of the time, participants were not just incorrect and unsystematic in their guesses on the final trial. It was much worse than this: By the final guess, they had often converged on the same wrong response (see Table 5). Even for BLOCs, scatter in the observational condition was not zero (i.e., not all participants agreed on their answers), and the modal response was not always the correct one.

The findings in Table 3 point to a solution of a different sort. It is not that participants required an accumulation of more evidence of the same kind (further instances of world-to-word, or world-to-beep, observations) to identify the mystery nouns. Rather, they needed collateral evidence of a different kind—particularly, evidence as to how these nouns behaved in their sentences of origin. When participants had access to the linguistic contexts in which words were used, they reached a virtual ceiling after only six exposures (at mean of 85.4% correct). In other words, additional cues further constrained the possible identities of the mystery nouns. Consider the syntax + co-occurrence condition. Participants who knew only that the mystery word *chipe* co-occurred with the words *I, play,* and *you* could divine little about its meaning. But participants who were exposed to it in one of its original contexts—"Can you play me some pretty *chipe?*"—could infer a great deal about its meaning, both from the quantifier *some* (which indicates that the noun is a mass noun and likely refers to a kind of portion), and from its position as the object of the verb *play* (which indicates that it is probably a kind of abstract portion). Together, these cues provide information that is more than their simple sum. That is, the cues combine synergistically to permit efficient identification.

The words that were hard to identify in the observational condition were not hard because their referents were imperceptible. Tails and toys and pilots—unlike acts of thinking—are easy to see (and whereas music cannot be seen, it can certainly be heard). What accounts for ease or difficulty in the observation condition is the level at which the word meaning represents the world. Consider the identification rates for BLOCs and non-BLOCs as presented in Figure 2. Inspection of this figure shows that the observation condition carried almost all the identification load for BLOCs, whereas the co-occurrence and syntax condition provided almost no information about the identities of these words. Similarly, for the multiple cues, whenever these included observational evidence, BLOCs had a clear advantage. For non-BLOCs the advantage evident in the observation condition was eradicated (in the full information condition) or even reversed (non-BLOCs were identified reliably more accurately from linguistic evidence in the syntax + co-occurrence condition than in the observation condition). Inspection of Table 3 shows this trade-off for the specific noun items. Although there is plenty of item variance, the overall pattern of findings is clear. BLOC labels such as *pig* and *bag* and *plane* were identified almost perfectly from observations of their use in context.

In clear contrast, superordinates, such as *thing,* or labels for situation-dependent kinds, such as *pilot,* and proper names, such as *mommy,* were identified quite poorly in the observation condition—a dismal 3.6%; part labels such as *tail* achieved an only slightly higher success rate of 25%. For these non-BLOC items, the linguistic cues provide a tremendous boost in accuracy. Notice again that for the BLOC and non-BLOC nouns studied here, the factor of "imageability" or "concreteness" fails to account for identification rates, as it seemed to do in the case of learning verbs such as *go* versus *think.* Things and tails and pilots and mommies are not invisible; they are not abstract; they are not unimageable. Their identification from observation alone is presumably difficult because these terms are not at the basic level of representation that is favored in lexicalization. *Tail* is hard to learn only because the dog that is wagging it comes more readily to mind.

4.3. Possible objections to the HSP as a model of word learning

4.3.1. The conditions vary in their ecological validity

A central aspect of the information change model of word learning is that later stages of vocabulary growth differ qualitatively from the earliest stages, in that early word learning provides the scaffolding for changes to the very nature of subsequent learning. The observation condition, of course, models the beginning of word learning, when the child builds an initial stock of words from observation of the world. The co-occurrence condition models a stage when the child's vocabulary has reached a reasonable size; at that point, he or she can use the meanings of words he or she already knows, perhaps along with cues to clausal structure (see, e.g., Fisher & Tokura, 1996), to infer the meaning of a new word from the meanings of the other words that accompany it. The conditions that combine information sources model later stages, when the learner has mastered two or more informational resources. Learners start the job of vocabulary building with the capacity to observe the situation in which a word is used (the observation condition); later on, they can recognize the words they have learned as they co-occur with words that are new to them (the co-occurrence condition). Taken together, these evidentiary sources are modeled as the co-occurrence + observation condition in this experiment. Similarly, there comes a point when the child has a decent-sized vocabulary, has mastered the rudiments of grammar, and understands at least the basic principles of compositionality. These evidentiary sources together are modeled as the syntax + co-occurrence condition; when observation is added to the mix, the result is the full information condition.

But it must be said that these conditions vary in their ecological validity. There is no period in the young child's life when he has mastered the linguistic properties of adult speech but *never* has the chance to observe the situations in which words are used (as in the syntax alone, co-occurrence alone, and syntax + co-occurrence conditions). But four of the conditions—observation, co-occurrence + observation, syntax + observation, and full information—plausibly represent stages in language development. The observation condition simulates the situation of a child who is just beginning to learn language, and who cannot make use of linguistic context until he or she has learned at least a few words. The co-occurrence + observation condition simulates the situation of a child who knows some vocabulary and can observe the world, but who knows little or nothing about the grammar of his or her native language. The syntax + co-occurrence and full information conditions simulate the typical circumstances of a mature learner who has acquired both a sizable number of words and knowledge of the rules in his or her native language for assembling those words into sentences. Moreover, the syntax + co-occurrence condition embodies a situation in which all language users, learners and competent adults alike, often find themselves: encountering sentences in contexts where the referents are absent or out of sight. After all, we can overhear conversations, and eventually read. Moreover, from early life children hear many conversations about absent things and events ("Let's go to the zoo and see the white tigers").

Despite their relative lack of ecological validity, the remaining conditions—syntax (only) and co-occurrence (only) are still experimentally important. First, they reveal how potent these sources of information are on their own. More important, we can compare results from these conditions with the results from the more ecologically valid conditions in which these information sources are combined with others. As we have seen, the increase in potency is quite dramatic.

4.3.2. Adults are told they are guessing nouns

One might object that telling adults they are guessing nouns—rather than leaving open the possibility that the mystery words come from multiple grammatical categories—gives them an unfair advantage. After all, young language learners get no such explicit information (which they could not comprehend even if one tried to give it to them). However, telling adults that the mystery words are nouns does not, in fact, appear to be unfair. Echols (1991, 1992) presented evidence that infants assume that a novel word refers to an object, regardless of whether it is presented as a verb or as a noun. On the other hand, recent evidence from Waxman (1999) suggested that even 13-month-olds can distinguish between count nouns and adjectives in fluent, infant-directed speech. For our purposes, however, it does not matter whether infants can tell nouns apart from words belonging to other grammatical categories, whether they can tell them apart only from some other kinds of words, or whether they cannot distinguish any kind of word from any other kind of word. What matters is that word-learning infants and adults in the HSP accomplish their respective tasks by searching similar conceptual spaces—the set of concepts that could be named by nouns.[17]

4.3.3. The linguistic-contextual information available in the HSP may be less common in real input than it would have to be for children to use it

One might wonder whether the dialogues between mothers and children originally recorded by Gillette et al. (1999) are typical of exchanges between caregivers and children. If they were not, the information change hypothesis would have little chance of holding true in general. However, a number of studies using different methods have shown that parents provide information to their children that signals that a word does not refer to a BLOC.

Important data on mother–child interactions were provided by Ninio (1980), who recorded mothers interacting with their roughly 18-month-old children as they looked at picture books. Mothers used simple ostension (e.g., "This is X") when labeling whole objects, but elaborated their word usage when labeling attributes, states, and parts of objects. For instance, instead of saying, simply, "eyes," mothers said things like, "These are the girl's eyes," providing the possessive *girl's* to signal that the word did not refer to the girl as a whole.[18] Shipley, Kuhn, and Madden (1983) asked mothers to identify a series of pictures to their children (who ranged in age from 1 year 9 months to 4 years 9 months). BLOC labels were the most commonly used type overall, but when mothers used superordinates or subordinates, they provided additional information about the nature of the label. In particular, they almost always mentioned *both* the BLOC label *and* the non-BLOC label in quick succession. Similar findings were reported by Hall (1994) for the teaching of situation-restricted count nouns such as *passenger* to preschoolers. Although mothers uniformly used simple ostension to introduce BLOC labels, they regularly augmented their descriptions of situation-restricted labels, often providing explanatory information: "A passenger is a person when he is driving in a car." Language users, then, seem to understand (on Gricean principles) that if you want to convey that you are referring to a non-BLOC representation of some referent in view, you have to supply additional, linguistic information to warn your listener off the BLOC interpretation.

4.3.4. Adults are biased to use BLOC labels

As indicated previously, adults prefer to use BLOC labels rather than non-BLOC labels, at least when they are speaking to children. Adults in the HSP know that the words they are guessing come from the stock of nouns that caregivers are likely to use with children. Thus, the HSP may produce a kind of response bias that overestimates the privileged status of BLOCs: Under conditions of limited information, participants in the HSP might tend to guess BLOC labels because they imagine that the mothers in the videotapes are likely, on the whole, to use such labels with their children. This amounts to a potential problem of perspective: To some extent, participants might be acting more like simulated caregivers than like simulated learners. Real learners might readily conjecture non-BLOC concepts—or, at least, more readily than adult responses in the HSP would suggest.

Although this objection cannot be dismissed lightly, I do not believe it seriously compromises the integrity of the data produced by the HSP. Adults may be inclined to use BLOC labels when they speak to children because they know (almost certainly implicitly) that children will find it easier to learn such labels. And, indeed, the research I have reviewed in this article suggests that BLOC labels *are* easier to learn. In other words, the caregiver's perspective aligns nicely with the child's perspective; consequently, the perspective of participants in the HSP aligns with the perspective of the learners they are meant to simulate. Still, adults may sometimes "err" in providing BLOC labels when children might be willing (in fact, might prefer) to entertain non-BLOC concepts.[19] It is difficult to assess the impact of such a bias on the results I have reported and, therefore, its impact on the status of the BLOC privilege hypothesis. Although it is important to keep the possibility of such a bias in mind, the close alignment between the perspective of the caregiver and the perspective of the learner suggests that the data, and the conclusions I have drawn from them, remain fundamentally sound.

4.3.5. Children may be unable to use the information that adults use in the HSP

Ultimately, it is not enough that caregivers make available the rich linguistic-contextual information that adults find helpful in the HSP. For the information change hypothesis to be a viable model of word learning, it must also be the case that children can make use of the same kinds of information. In fact, a number of experiments have demonstrated that preschoolers are sensitive to the linguistic context in which a word appears and that they use such information to determine the appropriate reference for a newly encountered noun. Katz, Baker, and Macnamara (1974) found that 17-month-old girls (but not boys) took a novel noun to label a specific individual when it was presented in proper name syntax ("This is Zav") but not when it was presented in count noun syntax ("This is a zav"). (This gender effect was perhaps not surprising because the relevant props were dolls.) Taylor and Gelman (1984) later replicated this finding for children of both sexes, although their participants were several months older; Hall, Lee, and Bélanger (2001) found that children showed sensitivity to proper name syntax starting at about 20 months.

Soja (1992) asked whether children at 2 and 2.5 years could use the difference between count syntax and mass syntax to shift their construal of entity away from an object kind to a substance kind, or vice versa. In earlier work, Soja et al. (1991) had shown that 2-year-olds extended a novel word applied to a rigid object (e.g., a crescent shape made out of orange wax) to other entities with the same shape, regardless of material, whereas they extended a novel word applied to a nonrigid substance (e.g., a backward *S* made out of Dippity-Do) to other entities made of the same substance, regardless of shape. In some cases, Soja used "matching" syntax, labeling rigid objects with count syntax ("This is a dax") and nonrigid entities with mass syntax ("This is some dax"); in other cases, she pitted syntax against ontology, labeling nonrigid entities with count syntax and rigid entities with mass syntax. As in the prior research, children were then shown variations of the original entity that preserved its shape but not its substance, or vice versa. For the object trials, mass syntax had a minor effect on participants' choices; but for the substance trials, count syntax shifted participants' choices away from substance-based construals, albeit not completely. Thus, although syntax did not override children's perceptual biases, it did at least suppress them and alter their hypotheses about what the new word might mean. Gordon (1985) documented that the effects of count-mass syntax were even more powerful for older children.

As noted previously, Hall and Waxman (1993) attempted to teach preschoolers labels for both basic level and situation- or life-phase-restricted kinds. When the target creature was introduced with simple ostension ("This is a murvil"), preschoolers were much more likely to give the word a situation-independent interpretation than they were to give it a situation-dependent interpretation. However, if they were provided with additional information ("This is a murvil because it is riding in a car"), they were much more likely to interpret the word as a label for situation-dependent kinds. Thus, learners appear biased to assume that count nouns label kinds with situation-independent identities—unless they have access to information that would lead them to think otherwise.

To sum up, the evidence indicates that adult performance in the HSP does provide a good model of word learning in children, despite the myriad differences between the two populations. These similarities give further suasion to the information change hypothesis and, by extension, to the BLOC privilege hypothesis.

5. Final thoughts

Based on the data reported in this article, I have argued that the course of noun learning can be understood as a consequence, in part, of changes to the informational database that learners have available to them. To account for the late learning of *thing* compared to *dog,* one might, but need not, allude to relative concreteness or conceptual complexity. It is enough to say that learners enter the world with a bias to classify the things in it at the conceptually privileged basic level. Words that represent meaning at this level, BLOC labels, are easy to learn from observing the contexts of their use. Such words are very common in early vocabularies and also provide the scaffolding for the acquisition of a vocabulary that is both larger and more conceptually varied.

I conclude by addressing what might appear to be a paradox: Although early vocabularies are dominated by BLOC labels, many non-BLOC labels are also learned very early (L. Bloom et al., 1993; Nelson et al., 1993). How can this be, when early learners show little mastery of syntax, and observational information restricts learners to a narrow, privileged set of object concepts? The answer that I propose echoes a claim made (albeit in somewhat different forms) by Nelson et al. (1993) and by P. Bloom (1994b): At least when it comes to learning nouns (and possibly when it comes to learning words from other grammatical categories as well), children are likely to be sensitive to linguistic context when they are very young indeed—younger, perhaps, than we have yet been able to measure in the laboratory. A significant challenge for future research on word learning will be to document precisely when infants become sensitive to such cues, such that, shortly after beginning their lifelong journey into speech, they can talk not only of dogs and of balls, but also of noses, money, beaches, doctors, parties, and music.

Notes

1. For instance, languages vary in the degree to which they allow the dropping of arguments (where these are pragmatically recoverable); this changes the noun–verb ratio in parental speech. This input difference has predictable effects, shrinking, although not eradicating, the noun advantage in such “verb-friendly” languages as Korean, Mandarin Chinese, and Japanese (Fernald & Morikowa, 1993; Gelman & Tardif, 1998; Gopnik & Choi, 1995; Tardif, 1996; Tardif, Gelman, & Xu, 1999; Tardif, Shatz, & Naigles, 1997).
2. A note on typographic conventions: Concepts will appear in capital letters, words in italics, and members of a given category (e.g., dogs, chairs) in plain type.
3. It should be noted that there is some controversy about the specificity of early infant representations. Most notably, Mandler and her colleagues (Mandler & Bauer, 1988; Mandler & McDonough, 1993) have argued that infants first make very global distinctions, such as between artifacts and animals, and distinguish among basic-level categories only for some kinds of artifacts, but not for natural kinds (*contra* the evidence from Eimas & Quinn, 1994). Murphy (2002) suggested that the contradiction may be more apparent than real, hinging to a great degree on the differences in stimuli (photographs for the Quinn–Eimas studies, toys for the Mandler studies) and dependent measures (habituation and dishabituation for Quinn–Eimas, touching for Mandler).
4. With some exceptions: Parts of an artifact can appear in isolation before they are assembled in the factory, or after the artifact breaks. And (somewhat gruesomely) the parts of animate things can come apart after accident or injury.
5. Gillette et al. (1999) asked their subjects to rate imageability on a 7-point scale, with the following instructions: “Any word which, in your estimation, arouses a mental image (i.e., a mental picture, or sound, or other sensory experience) very quickly and easily should be given a HIGH imagery rating; any word that arouses a mental image with difficulty (or not at all) should be given a LOW imagery rating.” The adjective *sweet* and the preposition *above* were given as examples of high imagery items; the words *ambitious* and *of* were given as examples of low imagery items.
6. I later argue that the notion of imageability does not fully explain the noun identification data and should be replaced with the notion of BLOC-hood. I focus for now on the original findings of Gillette et al. (1999)—and their interpretation of those findings—so as to make the logic of their experimentation clear.
7. Of course, the syntax of a verb phrase will not tell you what the verb’s precise meaning is, no matter how many different syntactic frames you encounter the verb in (there is, for instance, no set of syntactic frames that uniquely points to the concept SWIM). But the syntactic frames of verbs carve up the conceptual space of events and states in a much finer way. See Gleitman et al. (2005), for some discussion of these issues.
8. An exposure window of this length was chosen after pilot testing by Gillette et al. (1999) revealed that participants needed about 40 sec (with the beep occurring at the position described) to get a sense of what was going on in the scene. Windows of less than 40 sec produced confusion about the nature of the activity during which the word was uttered; windows of more than 40 sec did not increase accuracy and led to a cumulative increase in the length of the procedure that left participants fatigued.

9. Note that target words were not excluded when the referent was invisible both to the child observer and to the adult subjects, as this situation holds quite often. After all, one of the great advantages of language is that it can refer to absent things and events. This also presents a significant challenge to the learner, whether child or adult. Eliminating cases in which the referent was not visible to the child or to our adult subjects would have seriously compromised the integrity of the simulation. However, it was essential to eliminate the (rare) cases in which the referent was visible to the child but not to the adult participant because the former would not have had access to the same information as the latter.
10. These *p* values are not corrected for multiple tests, because the omnibus ANOVA that includes BLOC as a factor was significant, and because these comparisons were planned in advance (Rosenthal & Rosnow, 1991).
11. Intriguingly, the properties of passengerhood are even more nuanced than the ones mentioned here. For instance, passengers can have the capacity to become the person who is driving, piloting, and so forth, but it is not necessary. Moreover, it seems that passengers must exist in a particular relationship with the vehicle and the person or persons operating it—they must have some choice in the matter. Thus, it seems odd to say that an arrested man is a passenger in a police car, or that the men and women on a Navy battleship are passengers aboard the vessel.
12. I set aside, for this discussion, the undeniable fact that one would need to know something about the preparation of food and about restaurants before one could conjecture CHEF in the first place.
13. It may seem contradictory to say that both PERSON and WOMAN (MAN) are BLOCs, as WOMAN and MAN are arguably subordinates of PERSON. To my knowledge, no one has investigated the issue of which category deserves the status of BLOC, although some experimental work has assumed that person is a BLOC (e.g., Hall, 1993). Certainly neither *woman* nor *man* is synonymous with *person,* and women and men are each types of people. But because gender is such a salient property in the way we categorize people, it is arguably the case that the basic level includes more than one tier in the hierarchy (cf. Berlin, Breedlove, & Raven, 1973).
14. I here reiterate a point made in the Introduction, namely, that function, in addition to shape, also plays an important role in our object concepts (Kemler Nelson, 1995; Kemler Nelson et al., 2000; Nelson, 1973, 1974). The question is not, ultimately, whether our object concepts are "all shape" or "all function," but to what extent shape and function each contribute to those concepts, whether and how those contributions vary with context, and how the two are linked.
15. I thank Dedre Gentner for calling my attention to this fact.
16. In fact, additional exposures do not appear to be of much help. Lederer, Gleitman, and Gleitman (1995) conducted a version of the observation condition, again using the most frequent items uttered by mothers to their children. In that version, the number of exposures ranged from 4 to 84; crucially, the number of instances did not predict identification accuracy. In other words, more was not better.
17. We cannot say whether they search the same space of concepts without knowing whether the set of concepts available to adults is identical to the set available to children,

which it might not be. But as far as the utility of the HSP is concerned, it is enough that those spaces be similar.

18. Interestingly, Ninio found that mothers also augmented their descriptions when labeling articles of clothing (e.g., “Here is a girl. Here are her shoes.”) I have classified SHOE as a BLOC because it meets the criteria outlined in the Introduction. But the problem that arises with inalienable parts (eyes, tails) can hold with similar force for things, such as clothing, that often (if not always) co-occur with their owners. Indeed, subjects guessed *shoes* only about 4% of the time in the observation condition, but 94% of the time in both the syntax + observation and the full information conditions. A similar situation held for *hat,* which was guessed by 29% of subjects in observation and by 81% of subjects in full information. It would appear, then, that a BLOC that behaves like a non-BLOC is no easier than real non-BLOCS to learn from observation alone.
19. Indeed, such a bias, played out in the HSP, could help to explain why subjects rarely guess proper names in many of the conditions, even though proper names are consistently learned quite early.

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