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Brief article

Principles that are invoked in the acquisition of words, but not facts

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Abstract

A controversial question is whether language acquisition is the result of domain-general or domain-specific principles. Focusing on word-learning, Markson and Bloom (Nature 385(6619) (1997) 813) recently argued that the ability to learn and retain new words (count nouns) is the result of abilities that are not specific to language. In the current experiment, we replicate their empirical finding, but challenge their domain-general interpretation by highlighting a crucial distinction between the principles involved in learning a count noun, as compared to learning a fact. The current results confirm that learning count nouns and facts involve (at least) two common components: establishing a mapping to a designated individual, and retaining this mapping over time. However, these results go further to document that the processes invoked in the acquisition of words differ from those invoked in the acquisition of facts. Children spontaneously and systematically extended a novel count noun exclusively to other members of the same category, but revealed no such systematicity when extending a fact. This illustrates that there are principles that are invoked in learning a novel count noun that are not invoked in learning a fact. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

The notion that the human language capacity may be a 'special' capacity has perhaps been most intensely argued within the arena of acquisition. Despite the enormous complexity of the system, infants acquire their native languages naturally

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and rapidly. Language acquisition appears to unfold within a biologically-tuned critical period (Newport, 1990), even in the face of vastly impoverished input from the environment (Bickerton, 1999; Gleitman & Newport, 1995; Goldin-Meadow & Mylander, 1998; Senghas, 1996). Observations like these have contributed to the view that language acquisition is supported by powerful principles of organization within the learner.

There is, however, considerable controversy concerning the specificity of these principles. Some have argued for principles that are specific to language (Chomsky, 1965, 1981; Fodor, 1983). Others have argued that domain-general cognitive principles provide a sufficient account for acquisition (Bates & Elman, 1996; Seidenberg, 1997; Smith, 1999).

The recent argument by Markson and Bloom (1997) against a dedicated system for word-learning in children can be seen as an example of this more recent, domain-general account. Word-learning, like phonology or syntax, is a fundamental building block of language, and children's remarkable talents in this arena have been well-documented. When young children hear a novel word applied to an individual object, they spontaneously map the word to the designated individual and retain that mapping for weeks (Carey & Bartlett, 1978; Waxman, Phillippe, & Branning, 1998). This ability to map a word to an object, even after only a limited number of exposures, has been called 'fast mapping'.

Markson and Bloom (1997) asked whether fast mapping is supported by a dedicated system for word-learning, or by more general cognitive processes. They taught preschool-aged children either a novel word (e.g. 'This is a koba') or a novel fact (e.g. 'My uncle gave this to me') for an unfamiliar target object. The children were resoundingly successful at mapping either the word or fact to the target, and retaining these mappings over 1 month's time. Based on this evidence, the authors concluded that fast mapping is not limited to word-learning. However, the authors went beyond this conclusion to argue that learning and retaining new words is the result of abilities that are not specific to language. Highlighting this latter point, they claimed to have uncovered "…evidence against a dedicated system for word-learning in children".

In our view, there is insufficient support for this latter claim. Demonstrating that (at least) one component (fast mapping) is invoked in the acquisition of both novel words and facts is noteworthy. However, this in itself does not constitute evidence that these tasks share other components as well, or that acquisition of words and facts draw upon precisely the same set of underlying principles.

Put in this light, the question is whether there are principles invoked in learning words that are not invoked in learning facts (or vice versa). At the very heart of this question is the crucial distinction between what it means to learn a fact versus a word. To be more precise, consider the acquisition of a count noun (e.g. a dog or, following Markson and Bloom, a koba). There is no doubt that mapping to a designated individual is essential, but acquiring a word entails much more. In particular, novel count nouns are spontaneously and systematically extended beyond the designated individual to include other members of the same object category (Brown, 1957; Waxman, 1998). This principled pattern of extension for count nouns is

available by 14 months of age in infants just beginning to produce words on their own (Waxman, 1999; Waxman & Booth, 2000, submitted; Waxman & Markow, 1995).

In sharp contrast, there appear to be no clear principles governing the extension of facts. Instead, the extension of any given fact appears to depend upon knowledge about the fact itself, and knowledge about the individual to which it has been applied (Gelman, 1988; Goodman, 1955/1983; Shipley, 1993; Waxman, Lynch, Casey, & Baer, 1997). We return to this point in Section 4.

To summarize, learning words and facts both involve (a) mapping to a designated individual, and (b) retaining that mapping over time. However, this observation does not constitute evidence against a dedicated system for word-learning. It remains to be seen whether there are other principles that are invoked in learning words, but not facts.

The current experiment addresses precisely this issue. We introduced preschool-aged children to an unfamiliar target object (a carpenter's level), applying to it either a novel count noun ('This is a koba') or a novel fact ('My uncle gave this to me'). We then examined children's ability to (a) establish a mapping to the designated individual, (b) retain this mapping over time, and (c) extend the information beyond the designated individual. If the acquisition of words and facts draws upon the same set of domain-general cognitive processes, then performance should be identical in the two conditions. If there are processes that are invoked in the extension of words, but not facts, then performance on the extension task should differ as a function of condition. Children learning the word (presented as a count noun) should make systematic extensions of the word to other members of the same object category, but not to any other type of object; children learning novel facts should reveal no such principled patterns of extension.

2. Method

2.1. Participants

Forty-eight 4-year-olds (28 females, 20 males) with a mean age of 53 months (range 48.1–56.6 months) participated. All were enrolled in preschools serving middle- to upper-middle-class suburbs of Chicago, IL and were acquiring English as their native language. Three additional children were eliminated because they failed to select the target object at the end of the training period (see below).

2.2. Stimuli

Twenty-two small, lightweight objects were organized into a training and an extension set. The training set included ten objects: four were familiar (dog, bowl, hammer, butterfly); six were unfamiliar (e.g. carpenter's level, rack) (see Fig. 1). One unfamiliar object (the orange carpenter's level) served as the target object. The extension set included 13 objects: the original target (from the training

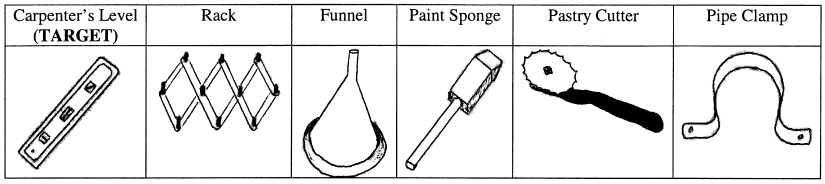

Fig. 1. Illustration of each unfamiliar training object.

set) and two novel exemplars of each unfamiliar object category. These exemplars differed from the original training objects in color, patterning, texture and/or size.

2.3. Procedure

Children were tested individually within their preschools. They were randomly assigned to either a Word or Fact condition. The word and fact were presented in sentence frames that were structurally identical (see below). The procedure included a training and a test phase, each lasting approximately 7 min. For half of the children in each condition, testing was conducted immediately after training (Immediate test); for the remaining children, testing was conducted a full week after training (Delayed test).

2.3.1. Training phase

The experimenter presented a pail containing the ten training objects. She picked up the target (orange carpenter's level) saying, 'Look at this one. This one is SO special to me. And you know what?' At this point, she applied either a word ('It is called a koba') or a fact ('My uncle gave it to me') to the target. She then placed the target back into the pail, and introduced each training object, one at a time.[1] She demonstrated an arbitrary action with each (e.g. spinning the bowl), and then offered it to the child for a few seconds. The familiar objects were referred to with their familiar basic-level names (e.g. 'dog'). The unfamiliar non-target objects were referred to as 'this one'.

To close the training phase, the experimenter assessed whether the child had established a mapping to the target, asking 'Can you hand me the one that is a koba?' (Word condition) or 'Can you hand me the one that my uncle gave to me?' (Fact condition).

2.3.2. Test phase

All children completed three tests.

2.3.2.1. Identifying the original target. The experimenter presented the ten original training objects, and asked the child to identify the target, asking 'Can you hand me

[1] Training objects were presented in the following fixed order: bowl, funnel, sponge-brush, dog, rack, carpenter's level, hammer, pipe-clamp, pastry-cutter, butterfly.

the one that is a koba?' (Word condition) or '…the one that my uncle gave to me?' (Fact condition). The training objects were then removed.

2.3.2.2. Extensions beyond the original target. Each child then completed both the Yes/No and Choice extension tasks (presented in counterbalanced order). These tasks were designed to reveal whether and how children would extend the word or fact when faced with a new set of objects, including the original target and two new exemplars of each of the unfamiliar objects presented during training.

With the Yes/No task, the experimenter presented each object individually,[2] asking 'Is this one a koba?' (Word condition) or 'Is this one that my uncle gave me?' (Fact condition). 'Yes' responses received a score of 1; 'no' responses received a score of 0.

With the Choice task, the experimenter displayed all of the extension objects at once, asking 'Can you show me one that is a koba?' (Word condition) or '…one that my uncle gave me?' (Fact condition). Once a choice was made, the experimenter removed that object and continued, saying 'Are there any other ones that are kobas?' (Word condition) or 'Are there any other ones that my uncle gave me?' (Fact condition). This was repeated until the child said 'no' or until all objects had been chosen. Each object received a score of 1 (chosen) or 0 (not chosen).

3. Results and discussion

Children successfully (a) mapped either a word or a fact to the designated individual, and (b) retained this mapping over a week's delay. There was, however, a frank difference in children's extensions. Children spontaneously extended the novel word to other members of the same object category as the target, but revealed no such systematicity when extending the fact.

3.1. Identifying the original target

All children in all conditions correctly identified the target among the training objects. This replicates the finding by Markson and Bloom (1997) that children readily map novel words and facts to an individual, and retain these mappings over time.

3.2. Extending beyond the original target

Children's overall tendency to extend words and facts beyond the designated target was comparable (Tables 1 and 3). There was, however, a striking difference in the pattern and systematicity of extensions in the two conditions.

[2] Objects were presented randomly, respecting the following contingencies: (1) the first three objects presented were not members of the target category; (2) the original target object was always presented fourth; and (3) the two additional exemplars of the target category were never presented within two positions of each other.

Table 1
Yes/No task: rates of extension to (a) objects from the target category (carpenter's levels), (b) objects from the non-target categories, and (c) all objects combined, as a function of condition

	Target category	Non-target categories	Overall
Word			
Immediate	100	0	16.67
Delay	100	0	16.67
Fact			
Immediate	66.67	21.67	29.17
Delay	50.00	22.50	27.08

3.2.1. Yes/No extension

Table 1 depicts the proportion of 'yes' responses in each condition. An ANOVA, using Condition (2) and Delay (2) as between-participants factors, and Object-type (6) as a within-participants factor, revealed a main effect for Object-type ($F(5,40) = 45.97$, $P < 0.0001$). Children in both conditions were more likely to say 'yes' to objects from the target category than to any of the other types of objects. This was qualified by a Condition by Object-type interaction ($F(5,40) = 7.57$, $P < 0.001$). Children extended the word to members of the target category at a rate of 100%, and never extended it to any other object. In contrast, children's extension of the fact was much less systematic. Although they were more likely to extend the fact to members of the target category than to any other type of object (all $P < 0.05$, Helmert contrasts), their extension to members of the target category did not differ from chance performance. Thus, children spontaneously extended words on the basis of category membership, but honored no such principled extension for novel facts.

A careful examination of each individual child's performance strengthened this interpretation. We established three primary response patterns (Table 2). Children credited with a 'category extension' pattern selected both exemplars of the target category, but no other test objects.[3] Children credited with a 'no extension' pattern selected only the original target. Children credited with an 'unrestricted extension' pattern selected all test objects. Children who failed to conform to one of these primary patterns were labeled 'inconsistent'. In the Word condition, all children (100%) extended the novel word to all and only the members of the target category. In the Fact condition, performance was distributed more evenly across the response patterns. Children's tendency to display either a Category extension or another type

[3] In assigning children to these patterns, we allowed for one error of omission. For example, a child would be credited with a 'Category Only' extension pattern if he/she extended the word or fact (a) to both carpenter's levels, but to no other objects (this constitutes the perfect pattern), or (b) to one of the carpenter's levels, but to no other objects (this constitutes an error of omission). In reality, there were only two errors of omission in the entire sample. These occurred in the Category Only pattern, with one omission made by a child in the Word condition (Choice task) and the other made by a child in the Fact condition (Yes/No task).

Table 2
Choice task: number of children in each condition producing each of four patterns of extension

	Category only	Extend to none	Extend to all	Inconsistent
Word				
Immediate	10	2	0	0
Delay	12	0	0	0
Fact				
Immediate	6	2	4	0
Delay	4	4	4	0

of extension pattern (combined) varied significantly as a function of condition ($\chi^2(1, N = 48) = 21.62$, $P < 0.0001$).

3.2.2. Choice extension

This task revealed the same striking difference between children's extension of the word as compared to the fact (Table 3). An ANOVA revealed a marginal condition effect ($F(1, 40) = 4.03$, $P = 0.051$), which was qualified by a cross-over Condition by Object-type interaction ($F(5, 40) = 16.25$, $P < 0.001$). Children extended the novel word to other members of the target category at a rate of 90%, but never to any other type of object. Children's extension of the fact was less systematic. Although they were more likely to select members of the target category than any other type of object (all $P < 0.05$), none of their extensions (including extensions to the target category) differed from chance performance.

This difference between children's extension of a novel word versus fact is echoed in the patterns displayed by individual subjects (Table 4). In the Word condition, 22 out of 24 children (92%) selected all and only the objects from the target category. In the Fact condition, performance was distributed more evenly across response patterns. The proportion of children displaying either a Category extension or another type of extension pattern (combined) varied significantly as a function of condition ($\chi^2(1, N = 48) = 13.5$, $P < 0.0005$).

Table 3
Choice task: rates of extension to (a) objects from the target category (carpenter's levels), (b) objects from the non-target categories, and (c) all objects combined, as a function of condition

	Target category	Non-target categories	Overall
Word			
Immediate	79.17	0	13.19
Delay	100	0	16.67
Fact			
Immediate	66.67	16.67	24.31
Delay	66.67	33.33	38.89

Table 4
Yes/No task: number of children in each condition producing each of four patterns of extension

	Category only	Extend to none	Extend to all	Inconsistent
Word				
Immediate	12	0	0	0
Delay	12	0	0	0
Fact				
Immediate	5	3	1	3
Delay	4	3	2	3

3.2.3. Integrating the two measures

Finally, we tabulated the number of children in each condition who displayed a Category extension pattern on both the Yes/No and Choice tasks (Table 5). The clear difference between children's extensions of words versus facts held up on this very stringent analysis ($\chi^2(1, N = 48) = 19.43$, $P < 0.0001$).

4. General discussion

The current results confirm that acquiring novel words and facts both involve (a) establishing a mapping to a designated individual, and (b) retaining this mapping over time. More importantly, these results underscore a crucial distinction between the principles involved in learning a word as compared to a fact. Children spontaneously extended the novel count noun, applied to an individual object, to other members of the same category as the target. Children revealed no such systematicity when extending the fact. This illustrates one important way in which the principles invoked in the acquisition of words differ from those invoked in the acquisition of facts (also see Kleinknecht, Behrend, & Scofield, 1999).

A review of the existing literature reveals several other relevant observations. It is now well-documented that the extension of a given novel word varies regularly as a function of its grammatical form. As we have pointed out, novel count nouns (e.g.

Table 5
Number of children in each condition producing Category Only response patterns on both the Yes/No and Choice tasks

	Category only	Other patterns
Word		
Immediate	10	2
Delay	12	0
Fact		
Immediate	4	8
Delay	3	9

'This is a koba') are mapped to the designated individual and are extended systematically to other members of its kind. However, this pattern of extension appears to be specific to count nouns. Novel proper nouns (e.g. 'This is Mr. Koba') are mapped to the designated individual, but are extended no further. Novel adjectives (e.g. 'This is very koba') are mapped to a property of the designated individual (e.g. color, texture) and are extended to other objects sharing that property. These links between particular grammatical forms and their extensions are available by 2.5–3 years of age (Waxman, 1998). Moreover, the link between count nouns and object categories emerges in 14-month-old infants who have just begun to produce words (Waxman, 1999; Waxman & Booth, 2000, submitted; Waxman & Markow, 1995).

These observations underscore the following points. The extension pattern for a novel word can be (roughly) ascertained on the basis of grammatical form and does not depend upon previous exposure to the particular word or upon previous knowledge about the object to which the word has been applied. Throughout development, count nouns support stable extensions from a designated individual to other members of its kind. This stable pattern of extension appears to be tied to the semantics of count nouns. A count noun supplies a criterion of identity for an individual, providing a logical means for tracing the identity of that individual within a kind (Gupta, 1980; Macnamara, 1986).

A review of the evidence concerning the acquisition of facts paints a very different picture. Some facts represent transient characteristics that are only temporarily applicable to the designated individual (e.g. is sleepy; just stubbed its toe). Others represent enduring characteristics that correctly apply to that individual over time (e.g. has an aorta; was given to me by my uncle). Among these enduring facts, only some can be extended beyond the designated individual. Therefore, in the process of acquisition, children must discover which facts represent enduring characteristics of an individual, and among these, which can be generalized on the basis of category membership (e.g. has an aorta) and which cannot (e.g. was given to me by my uncle). Moreover, this is not simply a matter of cataloguing the range of extension for various facts and kinds of facts, but also requires some knowledge about the kinds of individuals to which the fact has been applied. For example, facts about the 'insides' of a natural kind (e.g. 'This dog has an aorta inside') can be generalized to other members of the same object category.[4] Yet facts about the 'insides' of an artifact (e.g. 'This pillow has goose down inside') cannot necessarily be so generalized. Unlike novel words, the extension of a novel fact depends critically on knowledge about the kind of fact and the kind of individual to which it has been applied. In future work, it will be important to identify how children acquire the requisite knowledge to extend various kinds of facts to various kinds of individuals (see

[4] Studies of inductive inference are predicated on this observation. In tests of inductive inference, subjects' willingness to extend a fact (e.g. has an aorta inside) from one individual (e.g. a dog) to another (e.g. a tiger, an insect, a bird) serves as a proxy for that subject's underlying category representation (Coley, 1995; Coley, Medin, Proffitt, Lynch, & Atran, 1999; Goodman, 1955/1983; Osherson, Smith, Wilkie, Lopez, & Shafir, 1990; Rips, 1975; Shipley, 1993; Sloman, 1994; Waxman et al., 1997).

Gelman, 1988; Shipley, 1993; Waxman et al., 1997). This is likely accomplished via domain-general cognitive mechanisms.

Discovering which principles are unique to word-learning and which are shared more generally with other cognitive tasks is an important issue that will require careful attention. Although acquisition of novel words and facts share some important components, there are crucial distinctions between them. The current experiment highlights one such distinction. Children spontaneously extend a novel count noun, applied to an individual object, to other members of the same category. They reveal no such principled pattern of extension for novel facts. Clearly, there are principles invoked in word-learning that are not invoked when learning novel facts. This indicates that arguments against a dedicated system for word-learning are premature.

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