PAPER

They call it like they see it: spontaneous naming and attention to shape

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Abstract

Two experiments explore children's spontaneous labeling of novel objects as a method to study early lexical access. The experiments also provide new evidence on children's attention to object shape when labeling objects. In Experiment 1, the spontaneous productions of 21 23- to 28-month-olds (mean 26;28) shown a set of novel, unnamed objects were analyzed both in terms of the specific words said and, via adult judgments, their likely perceptual basis. We found that children's spontaneous names were cued by the perceptual feature of shape. Experiment 2 examines the relation between spontaneous productions, name generalizations in a structured task, and vocabulary development in a group of children between 17 and 24 months of age (mean 21;6). Results indicate that object shape plays an important role in both spontaneous productions and novel noun generalization, but contrary to current hypotheses, children may name objects by shape from the earliest points of productive vocabulary development and this tendency may not be lexically specific.

The starting point for these studies is a spontaneous behavior that we have repeatedly observed in the laboratory but never systematically studied. When children are presented with a novel unnamed object, they often spontaneously offer an English noun as a label for that object. For example, shown a piece of irregularly shaped hardened clay painted purple (object 5 in Figure 1), one child was observed to say 'dinosaur'. In the present paper, our interest is in the perceptual properties of the named object that activated the child's lexical category of dinosaur. Although it is unlikely that the child really thought that the piece of clay was a dinosaur, it is also the case that something about the appearance of that lump of clay must have reminded the child of a dinosaur. Thus, children's spontaneous naming of novel objects may provide a useful new method for studying the perceptual properties children attend to when accessing lexical categories. The principle purpose of this paper is to explore this method. In so doing, we also provide new data relevant to current discussions about the role of shape in children's object name learning.

Perceptual cues, names and categories

In an early examination of diary records, Eve Clark (1973) noted that many reported instances of young language learners' spontaneous over-extensions appeared to be based on the perceptual similarity of the named object and instances of that category (see also Anglin, 1978; Gershkoff-Stowe & Smith, 1997; Mervis, 1987; Rescorla, 1980). Clark classified 45 examples of over-extensions in terms of the feature that appeared to underlie the child's usage of the selected word and found that the feature that occurred most often was shape (Clark, 1973; see also Gershkoff-Stowe & Smith, 2004). These observations suggest that the processes that connect a seen object to a lexical category often rely on shape, an idea that fits the adult literature on object recognition (e.g. Hummel & Biederman, 1992).

However, further evidence is needed before we accept this conclusion in children's naming. The over-extensions studied by Clark are primarily cases in which the child did not yet know the name for the referent but was highly familiar with the kind of thing named and with related categories. That is, these were misnamings of objects that are common to the experiences of young children (fruit, dogs, outside things, etc.) and that are members of categories richly structured by many properties other than shape, including many conceptual features (Gelman, 2003; Gelman & Bloom, 2000; Yoshida & Smith, 2003). For example, one instance Clark classified as a shape-based over-extension consisted of a child

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calling a cat 'dog'. Although cats and dogs are similar in shape, they also share a number of other properties and are conceptually related in many ways (see also Gelman, 2003). Thus, the over-extensions Clark examined may not have been based on shape *per se*. A complete understanding of the development of processes of lexical access requires an independent assessment of conceptual and perceptual contributions. The study of children's spontaneous labeling of novel objects may therefore provide new insights precisely because these objects lack the conceptual richness of common object categories.

Other evidence on the potential importance of shape in children's object naming stems from experimental studies of children's performances in novel noun generalization tasks. In these tasks, children are typically shown a novel object, told its name and then, in a forced-choice procedure, asked to indicate which one of two (or three) test objects is also called by the same name. A number of controversies surround the bias to attend to shape children typically demonstrate in this task: whether this 'shape bias' is somehow specific to this task and thus not relevant to real word learning, whether it is a perceptual or conceptual bias, whether it is a learned consequence of learning object names, and whether it is lexically specific (e.g. Bloom, 2000; Booth & Waxman, 2002; Diesendruck & Bloom, 2003; Gelman, 2003; Gelman & Ebeling, 1998). The study of how children spontaneously label nonce objects may also provide insight on some of these issues. For example, if children spontaneously name objects by their shape, then it would appear that the shape bias is not specific to one particular experimental task but rather reflects the general importance of shape as a perceptual cue for children's object name retrieval.

Likewise, the study of spontaneous naming may yield new insights into the *development* of children's attention to shape – whether the shape bias precedes or is a product of learning object names. Smith and colleagues have reported that the shape bias in novel noun generalization tasks emerges after children have already learned some nouns (specifically, after they have more than 50 nouns in their productive vocabulary, Gershkoff-Stowe & Smith, 2004). This fact is consistent with the idea that the shape bias is a relatively late, learned consequence of learning object names and fits with recent findings that children as old as 18 months often do not attend to overall shape when categorizing objects but instead focus on parts and features (e.g. the heads of animals and the wheels of vehicles; Quinn, Eimas & Tarr, 2001; Rakison & Butterworth, 1998). Other recent studies, however, do not support this conclusion. Specifically, studies by Waxman and colleagues (Booth & Waxman, 2002; Waxman & Booth, 2003; Waxman & Booth, 2001)

suggest that young children generalize novel names systematically as early as 11 to 14 months of age, well before they have many names in their productive vocabularies. In these studies, infants systematically and correctly extend common object categories to new instances when objects are named with count nouns but not when they are named with adjectives. These results indicate that count nouns direct even very young word learners to category-relevant similarities. However, because these experiments used common object categories that are richly organized by many properties, they do not unambiguously show that 11- to 14-month-old infants use shape to form object categories. For example, it is possible that children attend to specific parts such as legs or wheels, or a more global level of overall similarity (including shape, color, texture, parts, etc.), rather than just overall shape, when generalizing names in this task. Nevertheless, these studies raise the possibility that children at the earliest stages of lexical learning attend to shape in the context of naming objects.

One possible explanation for the difference between the results of Smith and colleagues and Waxman and colleagues concerns the supportive nature of the task used with infants, compared to the novel noun generalization task used with older children (see Samuelson, 2002). Specifically, the task used with infants involves repeated presentations of objects from familiar categories, explicit comparison of category members to nonmembers, and practice extending the novel name to a previously named example of the named category. In contrast, children in the novel noun generalization task are shown only one instance of a completely novel object that is named one time before they are asked to generalize the novel name to other completely novel instances. By this view, the correlation between vocabulary development and the shape bias is only found in studies using the novel noun generalization task because this task is harder and requires more knowledge of how names link to categories. If this explanation is correct, we might see early knowledge of the importance of shape in lexical categories when we look at children's spontaneous naming of novel objects with English names, because in this situation, as in the supportive noun generalization task, children are able to use more of their existing category knowledge to support noun generalization.

Finally, examination of children's spontaneous naming of novel objects will inform the current debate on the cues that elicit children's attention to shape. Many studies suggest that naming invites children to form categories and to attend to category-relevant information (Gelman, 2003; Smith, 2000; Waxman, 1999). But how specific to the context of naming is children's attention to shape and on what kind of mechanism does this selective attention

depend? In early papers, Smith and colleagues suggested that young children require the *explicit* cue of hearing the experimenter name the object in order to attend selectively to shape. By this hypothesis, the use of a count noun syntactic frame (e.g. 'this is a _____') in the novel noun generalization task serves as a explicit cue that *triggers* attention to shape (Landau, Smith & Jones, 1988; Smith, Jones & Landau, 1996). This idea was recently challenged by Diesendruck and Bloom (2003), who argue that the link between count nouns and attention to shape is not based on direct association. Rather, Diesendruck and Bloom (2003; see also Bloom, 2000; Samuelson, Horst, Schutte & Dobbertin, under review; Smith, Yoshida, Colunga, Jones & Drake, 2003) suggest the link exists because children think count nouns refer to object kinds, and know that shape is a good cue to an object's kind. According to this view, then, children should not only demonstrate a shape bias in tasks in which the experimenter explicitly names objects, but also in any task in which children are likely to categorize objects by kind. To the extent that the names children spontaneously produce for novel objects are kind terms, the experiments that follow provide evidence on this issue by examining the relation between children's spontaneous naming and their categorizations in a task that is free of experimenter-provided lexical cues.

The present experiments

In sum, our casual observations of children interacting with nonce objects suggest that they often name them with known English nouns. The main goal of the research reported here is to explore the usefulness of this behavior as a method for studying how perceptual properties cue early lexical access. Thus, unlike previous studies of children's spontaneous productions, we attempt to elicit spontaneous naming with novel made-up objects. One approach to studying such spontaneous productions might be to invent nonce objects that bear selective similarities to known categories as a way of determining which of those similarities matter. However, because these studies are our first attempt to examine children's spontaneous naming of novel objects, we wanted to gather a large enough corpus of productions to examine the usefulness of this method. Thus, we did not systematically manipulate the similarity of our stimuli to known noun categories. Rather, we selected nonce objects that had generated much spontaneous naming by young children in prior experiments. We sought evidence on the properties that elicited the spontaneously produced labels offered by the children by determining whether adults could match the child-produced label

with the objects that elicited them, given just one object property (shape, material or color) at a time. If a particular property, say shape, strongly determined children's spontaneous labels, then adults should be able to match the label to the object given just the shape information. Experiment 1 uses this method to examine a corpus of names children spontaneously produced in reference to a set of nonce objects. Experiment 2 replicates the basic result of Experiment 1 and goes a step further. This experiment also asks how the names children spontaneously produce for novel objects are related to their developing noun vocabulary and to their categorizations in tasks with and without experimenter-provided naming cues.

Experiment 1

This experiment provides support for the idea that looking at the names young children spontaneously produce in reference to novel objects gives insight into the processes of lexical access. We analyzed a corpus of spontaneous utterances produced by a group of children who were between 23 and 28 months of age. The experimental context was free of any biasing information or naming prior to the point when the children saw the objects and named them. The children were given 5 minutes to play freely with a set of five novel objects. The experimenter, who was the only adult present during this experiment, did not name the objects prior to or during the free play time. A total of 48 *spontaneous* utterances were produced by 21 different children in the free play task. The point of our analysis is not the frequency of this phenomena of spontaneous naming, but rather, given that it occurs, what it can tell us about the perceptual properties that activate children's lexical categories. Thus, we first present a description of the corpus of names children produced. We then explore the perceptual basis of children's spontaneous naming via adult judgments.

Method

The corpus

The spontaneous productions are from 21 23- to 28-month-olds (range = 23;16–28;12, *M* = 26;28), 12 males and nine females. The utterances emerged during 5 minutes of free play time prior to participation in another experiment. During this free play time children were given all of the objects to explore and manipulate on their own. No other stimuli or toys were present. An adult experimenter was present while the children played with the objects but did not interact with the child and

did not offer any names or ask the children to name any of the objects. The experimenter also never responded to a child's naming bid or question about an object. Nevertheless, children sometimes spontaneously named the objects. The spontaneous names provided by the children were transcribed from videotape by the experimenter. A spontaneous utterance was taken as referring to an object if it was said while the child looked or pointed at the object, or if the child held the object up in a 'show' posture while they said the word.

Each child played with four nonce objects selected from the set of five objects pictured in Figure 1. Object 1 was a cardboard cone, painted with green sandstone paint, approximately 15.5 cm tall and 7.0 cm wide at the base with a diagonal cut at the apex. Object 2 was a plastic cup, 9.0 cm tall and 6.0 cm wide at the base, which was cut along one side and the bottom removed. The cup was covered with cotton batting and spray painted yellow. Object 3 was a 14.0 cm wooden rod connected to a wooden ball with a diameter of 3.0 cm. It was painted with lumpy purple paint and glitter, and had a purple tassel glued to one end of the rod. Object 4 was an irregularly shaped piece of wood painted orange with plastic orange mesh glued to all sides. It was approximately 14.0 cm long, 2.5 cm thick and 7.0 cm wide at the widest part. Object 5 was an irregular shape made of hardened Super Sculpey. It was approximately 10.5 cm × 2.5 cm × 12.0 cm and painted a light purple. Only four objects were shown to the children at any one time, with Object 5 replacing Object 3 for half of the children. No other toys or objects were present.

Adult judgments

To investigate the perceptual basis of children's spontaneous references, we gave adults either the exact objects children saw when they produced the spontaneous labels, or information about only the shape, color or texture of the stimuli and asked them match the children's spontaneous productions to the correct referents. These perceptual dimensions were chosen because they were some of the most prevalent perceptual dimensions in Clark's (1973) prior analysis, and because they are the dimensions most often examined in tests of young children's word learning (e.g. Booth & Waxman, 2003; Smith, Jones & Landau, 1992). Adults participated in one of four conditions determined by the stimulus information they were given about each named object.

Participants

Forty-nine undergraduates enrolled in an elementary psychology course at a large midwestern university served as participants in the adult matching task. Twelve participants were randomly assigned to each of the four conditions: Whole Object, Shape Only, Color Only, or Texture Only. Data from one participant was excluded from the analysis because he failed to complete the task. All adult participants received course credit for participation.

Stimuli

Four sets of stimuli were constructed for the adult judgment task. Each stimulus set contained five objects. Stimuli for the Whole Object condition consisted of the five stimulus objects used to elicit spontaneous productions from children. Each of the five stimuli in the Shape Only condition matched one of the objects shown to children exactly in shape, but not in color or material. These three-dimensional objects were constructed by tracing the two-dimensional planes of the original stimuli on cardboard, taping the pieces together, and painting the finished objects with black matte paint. Stimuli in the Color Only condition matched the colors of the original stimuli but not the shapes or materials. They consisted of five cardboard circles, 10 cm in diameter, each painted to match exactly the color of one of the objects shown to the children. Each of the five stimuli in the Texture Only condition matched one of the original objects exactly in texture, but not in shape or color. The texture match for Object 1 was created by painting a 10 cm cardboard circle with the same sandstone paint in gray. The texture match for Object 2 was created by gluing cotton batting to 10 cm cardboard circle and painting it with gray spray paint. The texture of Object 3 was recreated by applying Elmer's school glue to a 10 cm wooden circle to create the lumpy surface, and then painting it with gray paint and glitter. The texture match for Object 4 was a 10 cm wooden circle painted gray and covered with gray mesh. The fifth stimulus was a 10 cm circle of hardened Super Sculpey painted the same gray color as the other stimuli in this set.

Procedure

Adults were tested in small groups of four or five participants. Each participant was given one of three randomized lists of the children's spontaneous utterances. The five stimulus objects for the particular condition (Whole Object, Shape Only, Color Only, or Texture Only) were placed in the center of the table on white sheets of paper that had large numbers (1–5) printed in the diagonal corners for identification. Which identification numbers were assigned to which stimulus objects was predetermined and counterbalanced across the groups of participants. The experimenter then read the

instructions aloud to the group. The participants were instructed to decide which of the five numbered objects on the table was referred to by each word or phrase in the list and write the number for that object in the space next to the word or phrase. Participants were told that if they could not tell which object a particular word referred to they should pick the best alternative. Before the participants began, the five stimulus items were passed around the table so that each participant had the chance to examine each one. The participants were also told that they could touch and handle the objects at any time during the experiment if they wished. The experimenter then asked if there were any questions and if there were no questions the participants were instructed to begin. A shortened version of the instructions was also printed at the top of the matching task form. Adults were not told where the words on the list came from or anything about the production context until after the matching task was completed.

Results

Spontaneous productions by children

A total of 48 spontaneous referential acts, including 44 different types, were recorded. The number of references to each object, and the complete list of utterances are given in Figure 1. Because previous research suggests that young children attend to different features of objects in the context of nouns and adjectives (Booth & Waxman, 2003; Smith *et al.*, 1992), each spontaneous production was coded as either a noun or 'other' word. An utterance was counted as a noun only if it could not be construed as any other part of speech. Thus, color terms, and diminutive terms that could be adjectives (e.g. 'fishy') were classified as 'other'. Overall, the majority of children's productions were nouns (29). Fifteen utterances were classified as 'other' words, including 10 spontaneous utterances that consisted of more than one word. Most of these descriptive phrases were two words, a noun and an adjective; however, two of these phrases were three or more words long. Of the remaining five 'other' utterances, one was an adjective ('soft'), one was neither a noun nor an adjective ('mine'), and three could be classified as either a noun or another part of speech (adjective or quantifier: 'fishy', 'orange' and 'three'). The percentages of nouns and other words children produced in reference to each of the five stimulus objects are listed in Figure 1.

At first glance, these spontaneous productions seem idiosyncratic. Only eight of the recorded tokens were instances of different children using the same, or similar, words to refer to the same object. Two different children said 'ball' in reference to Object 3, three children used

'sucker' or 'lollipop' to refer to Object 3, and three children used 'fish', 'fishy', or 'fishes' to refer to Object 4. Only four of these tokens were instances of different children using the same or similar words to refer to different objects. Specifically, 'dinosaur' was used by one child to refer to Object 3 and by another child to refer to Object 1 (this same child also called Object 1 'T-rex'). Likewise, 'horsie' was used by one child to refer to Object 4 and 'horse' by another child to refer to Object 5.

If, however, we consider a more inclusive grouping of the labels children produced – whether they referred to the novel objects with names for animate or inanimate things – we see more systematicity. The productions were classified as referring to animate things if they included the name of a living being, referred to a feature of a living being ('three paws', 'it's got hair'), or described an action ('it bites'). Of the 29 nouns children produced, 14 referred to inanimate objects (e.g. 'hat', 'house' and 'teepee'), and 15 to animate beings (e.g. 'camel', 'Tigger' and 'frog'). Eight of the descriptive phrases referred to animate beings (e.g. 'one paw', 'it bites' and 'sharp teeth') and two to inanimate objects ('green tree' and 'purple one'). The different kinds of words offered for the different objects suggest that the utterances were driven by the perceptual properties of the objects. Specifically, objects 1, 4 and 5 were more often labeled with animate terms than objects 2 or 3 (see Figure 1), χ^2 (4, n = 46) = 10.93, p = .03. This suggests that these objects somehow present properties that remind children of animate rather than inanimate things. The analysis of adult's mapping of labels to objects also suggests that children's productions are systematically related to the perceptual properties of the objects.

Adult matching task

If the specific perceptual properties of the stimuli systematically cue children's spontaneous naming, then adults shown the same stimuli should be able to match children's utterances to the correct object. Further, if it is particular perceptual properties, like shape, that elicit the specific *names* children produce, then adults given only information about shape should also be able to match the utterances to the correct stimuli. Data from the adult judgment task suggest that, of the three perceptual cues tested here, the names offered by children were driven by shape. Responses in the matching task were scored as correct if adults picked as the match the correct object the child had referred to when the utterance was produced. In cases where children used the same word to refer to two different objects, the selection of either object by an adult was taken as correct. Figure 2 presents the proportion of correct responses in each of
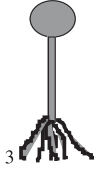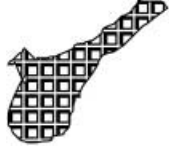
	Cardboard painted with green sandstone paint		Plastic covered with cotton batting spray painted yellow		Wood painted with lumpy purple paint and glitter, and purple tassel		Wood painted orange covered with orange mesh		Light purple hardened Super Sculpey	
Total	11		6		7		18		6	
	Nouns	Others	Nouns	Others	Nouns	Others	Nouns	Others	Nouns	Others
%	82	18	67	33	86	14	67	33	17	83
Inanimates	bridge tee-pee rectangle hat train	green tree three	football sponge house	soft	ball (2) lollipop sucker (2)	purple one	block cookie banana	orange		mine
Animates	frog T-Rex dinosaur monster		chicken	it's got hair	dinosaur		camel doggie Tigger horsie hand fish Winnie the Pooh fishes duck	one paw it will bite my finger fishy sharp teeth like papa's	horse	bad guy it bites 3 paws fishy

Figure 1 *Stimulus objects presented to children in Experiment 1 and the children's spontaneous productions to each object. The productions are classified as nouns and other words, and by whether they referred to animate or inanimate things. The total number of references as well as the per cent of references to each object that were classified as nouns and other words are also given.*

the four conditions for nouns and other words. The data were submitted to a Condition (Whole Object, Shape Only, Color Only, Texture Only) × Word Class (Nouns, Others) repeated measures ANOVA. This analysis revealed a significant main effect of Condition, $F(3, 44) = 32.15$, $p < .0001$, and a significant interaction between Word Class and Condition, $F(3, 44) = 5.025$, $p < .01$. The main effect of Word Class was not significant. As can be seen in Figure 2, adults were just as good at matching *nouns* to the correct referent when given only information about shape as they were when they saw the exact same objects children saw. This conclusion was confirmed by Tukey's HSD tests ($p < .05$) on the noun data, which revealed no significant differences between performance in the Whole Object and Shape Only conditions or between the Color Only and Texture Only conditions, but significant differences between all other pairings of conditions. This suggests that the perceptual property of shape is mainly responsible for eliciting children's spontaneous names.

It is also evident in Figure 2 that adults were better at matching *other* words to the correct referents in the Whole Object Condition than they were in any of the three partial information conditions. Tukey's HSD tests ($p < .05$) revealed significant differences between performance in the Whole Object condition and each of the other three conditions, but no significant differences between any pairing of the partial information conditions. This probably reflects the fact that the 'other' word category included a more diverse set of words, from adjectives such as 'orange', to actions like 'it bites', and idiosyncratic phrases such as 'like papa's', and thus no single property was critical to eliciting all of the 'other' productions. However, the fact that adults were successful at matching the other words to the correct referents 50% of the time suggests that the 'other' productions were related to the perceptual features of the stimuli, and that properties beyond shape are important for eliciting children's spontaneous productions of adjectives and descriptive phrases.
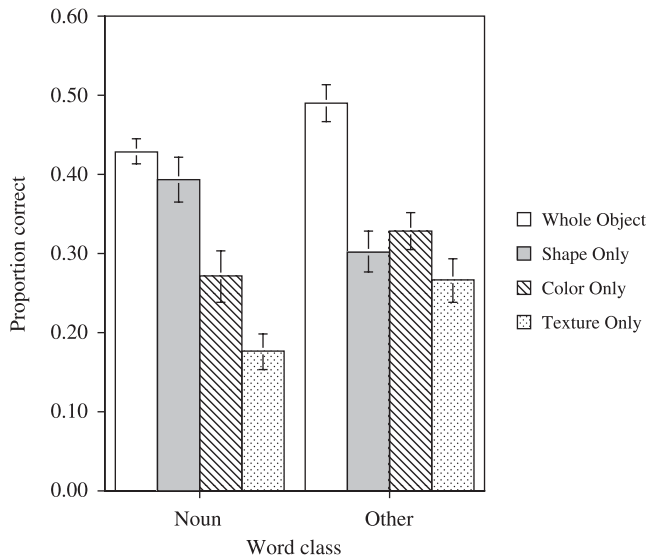
Figure 2 *Results of Experiment 1 adult matching task. The proportion of correct matches of children's spontaneous productions that were nouns or other words to referents in each of the four information conditions.*

Discussion

This study confirms the potential value of using children's spontaneous naming as a means to study lexical access. The adult data suggest that, as Clark (1973) originally concluded, children's spontaneous productions – at least the names – appear to be elicited by perceptual information about shape. Moreover, because the objects were relatively impoverished made-up things, we can be confident that it was the perceptual properties of the objects, rather than other knowledge about them, that drove children's lexical retrievals. The fact that these productions were spontaneous and not specifically elicited by the experimenter further suggests that children's attention to shape does not require an explicit external cue as a trigger. This is only one corpus of productions and one set of stimuli, however, and because we did not analyze this corpus by age or vocabulary level, these data do not address the issue of when children begin attending to shape when naming objects. Thus, in Experiment 2 we examine a second corpus of spontaneous productions with particular attention to the relation between children's spontaneous productions, their attention to shape in tasks with and without explicit cues to naming, and vocabulary development.

Experiment 2

In this experiment, we collected a new corpus of spontaneous productions from children given free play time with a new set of novel objects, and analyzed these in the same way as Experiment 1. Children also participated in either a noun generalization task, in which the experimenter explicitly labeled the object providing a clear 'triggering' cue, or in a similarity judgment task, in which the experimenter did not name any object and thus provided no explicit cue as to the relevance of shape. Finally, we also examined children's spontaneous naming and their categorizations in these two tasks as a function of the number of object names in their productive vocabularies, providing evidence on the developmental relation between attention to shape and knowledge of object names.

Method

### Child data

Participants

Eighty children, 40 boys and 40 girls, between the ages of 17 and 24 months, participated ($M = 21;6$). Children were recruited from birth announcements in the local newspaper and from parenting clubs. Children were from a small midwestern town and were primarily from middle class, European American households. Children were tested in the laboratory and received a small toy in return for their participation. Half of the boys and half of the girls were randomly assigned to the Explicit-Naming condition; the remaining children participated in a No-Naming condition. In each condition, children were divided into four developmental levels based on the number of nouns in their productive vocabulary according to parental report: 0–25 nouns, 26–50 nouns, 51–75 nouns, 76 or more nouns. These levels were chosen to correspond to those used in previous studies that reported a relation between productive vocabulary and the development of the shape-bias (Smith, 2000). Table 1 provides information about the number of children in each group, their ages, and their productive vocabulary.

Stimuli

Four sets of nonce objects were constructed. These are illustrated in Figure 3. Each set consisted of an exemplar and three test objects, and is designated by the name used for the exemplar in the Explicit-Naming condition. In each set, one test object matched the exemplar in shape only, one in color only, and one in texture only. All objects were three-dimensional things, each approximately as thick as it was wide and tall (approximately 15 cm³ in volume). For example, the actual object depicted by the two-dimensional representation of the 'zup' exemplar in Figure 3 was a sphere with four protruding blocks.

Table 1 *Numbers, ages and productive vocabulary of the children participating in Experiment 2. Children in each condition are partitioned into four groups according to number of total nouns in their productive vocabulary by parent report*

Vocabulary group	0–25		26–50		51–75		76+	
Condition	Explicit-Naming	No-Naming	Explicit-Naming	No-Naming	Explicit-Naming	No-Naming	Explicit-Naming	No-Naming
Number	13	9	9	9	11	9	7	13
Mean age	18;12	18;19	20;4	19;11	22;30	19;13	24;6	23;0
Range	17;16–24;9	17;23–23;5	17;23–24;13	17;10–24;10	18;1–24;21	17;19–24;24	23;20–24;24	17;28–24;15
Mean nouns	12.8	12.8	38.3	41.6	65.8	67.7	89.0	88.1
Range	1–24	5–24	29–49	29–49	51–75	54–74	77–106	76–108
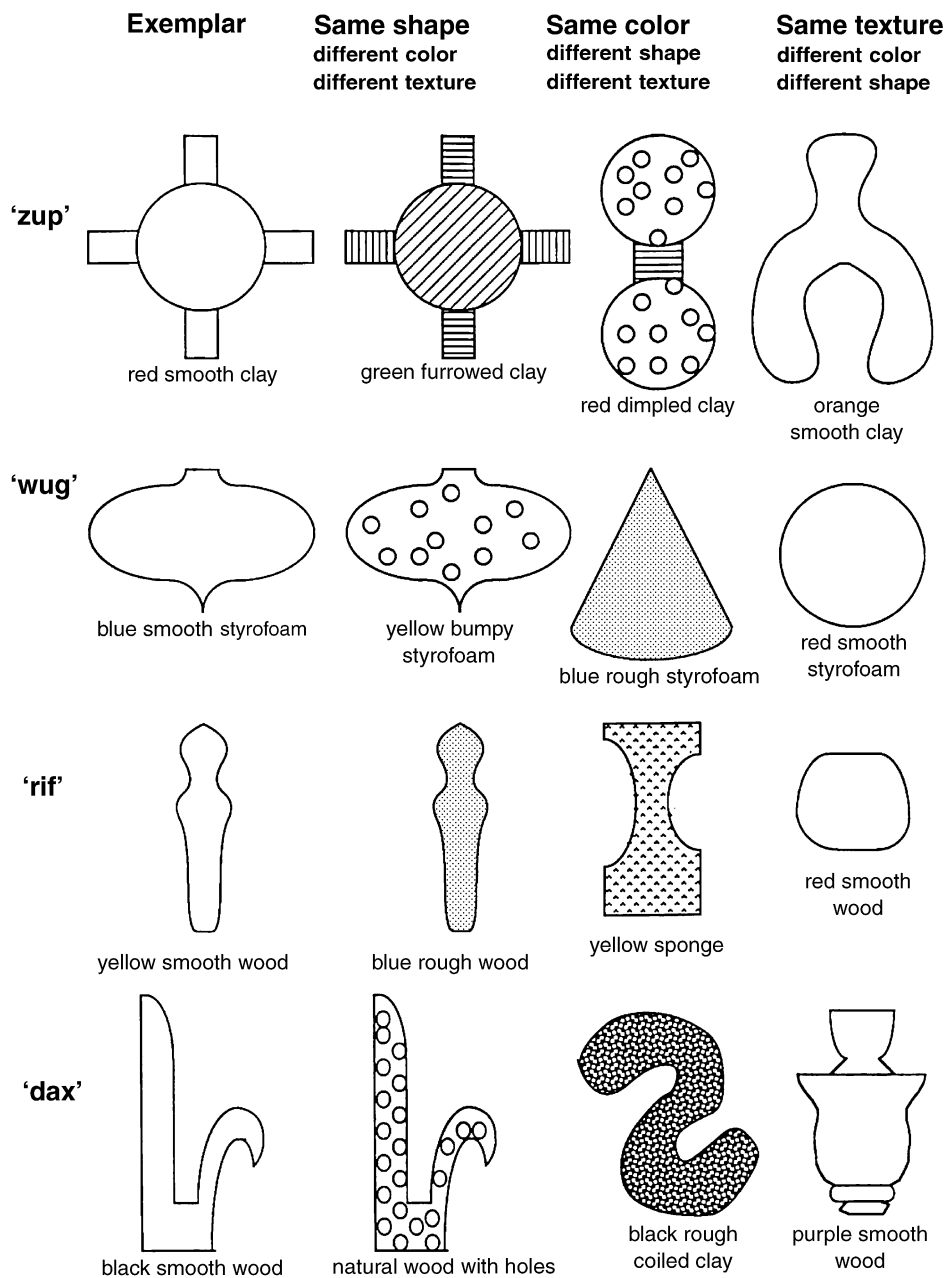
Figure 3 *The four sets of stimuli used in the tasks with children in Experiment 2.*

Procedure

At the beginning of the session, the parent completed a vocabulary assessment while the experimenter played with the child. Parents were asked to recall and list all the object names their children used. Because we wanted to document any idiosyncratic names the children might know and use to name our novel stimuli, we gave parents an abbreviated checklist based on the MacArthur Communicative Development Inventory (MCDI) (Fenson *et al.*, 1994) and invited them to write in the words their children produced. This method has been previously used by Resnick (1994) and also Rescorla (1989; see also Fenson *et al.*, 2000). The checklist included the following major categories: people, pets, toys, household objects, tools, clothing, outdoors, vehicles, animals, places, food, furniture and body parts. Under each category heading, five to 10 common examples of the category were listed and space was provided for the parent to write in other words. The parent was asked to try to think about words and objects in each category that their child used and to write that word on the form. They were told to report a word as being in their child's vocabulary if they could remember a specific instance in which they had heard their child say that word.

After completion of the vocabulary assessment, the experimenter, child, and parent moved to the testing room. The parent and child sat side-by-side on a small couch across the table from the experimenter. The experimenter took the four objects from one test set, for example, the 'zup' exemplar and its three test objects, and placed them on the table, saying only 'Look at these'. Then, while the parent and experimenter talked quietly, the child was allowed to touch, play with, and explore the stimuli for 1 minute. The purpose of this period was to elicit spontaneous naming of the novel stimuli.

After this play period, the procedure in the Explicit-Naming condition was as follows. The experimenter picked up the exemplar and said, 'Look, look at this. This is a _____. It's a _____.' Then holding the exemplar in one hand and with the other hand outstretched palm up, asked 'Where's another _____. Get me a _____.' The experimenter waited 30 seconds for a response. Then the exemplar and any of the test objects handed over by the child were placed back on the table and the child was allowed to play with them for another minute. The child was presented with four trials in this manner, one for the 'zup' set, one for the 'wug' set, one for the 'rif' set, and one for the 'dax' set. The order of presentation of the four sets was counterbalanced across children and the order in which test objects were placed on the table was randomly determined for each set.

The procedure for the No-Naming condition was identical to that in the Explicit-Naming condition except that children participated in similarity judgment rather than a noun generalization task. When the experimenter held up the exemplar she said, 'Look at this. Look at this one.' She then asked the child 'Where is another one? Get me one like this.' Thus, for children in the No-Naming condition, none of the objects was ever named.

Coding

All child experimental task sessions were videotaped for later coding. Children's performance was coded in terms of two behaviors – spontaneous utterances and choices. Spontaneous utterances included any spontaneous words produced during the 1 minute of free play with the objects prior to the noun generalization or similarity judgment task. As in Experiment 1, an utterance was taken as referring to an object if it was said while the child looked or pointed at the object, or if the child held the object up in a 'show' posture while saying the word. Choices were the objects indicated or handed over when the experimenter made a request during the noun generalization or similarity judgment task. Two coders unaware of the purpose of the experiment coded all videotaped sessions for these behaviors. Data from 15 children were coded independently by both coders and yielded 86% agreement on the use of an English word to refer to a test object, and 98% agreement on responses to the experimenter's request. All disagreements were resolved by joint review of the videotapes.

Adult data

Participants

Thirty-six adults served as participants in the adult matching task. Adults were recruited in a small midwestern town and were primarily middle class European Americans. Twelve adults were randomly assigned to each condition: Shape Only, Color Only, or Texture Only. All adult participants received monetary compensation at the rate of $7.00/hour in return for their participation.

Stimuli

Three sets of stimuli were constructed for the adult matching task. Each stimulus set contained 12 objects, each of which matched one of the perceptual features (shape, color, or texture) of one of the test objects children had seen and thus also the exemplar. As in Experiment 1, the stimuli for each condition were constructed

to exactly represent only one perceptual feature of the stimuli presented to children. Thus, the stimuli for the Shape Only condition, for example, matched the objects presented to children exactly in shape, but provided no information about the colors or textures of those objects.

Procedure

The procedure for the adult matching task was identical to that of Experiment 1 with the exception that the stimuli and list of words were divided into four sets corresponding to the four sets of objects presented to children. As in Experiment 1, participants were instructed to decide which of the numbered objects for each set was the referent of each name on in the list, and that if they could not tell which object a particular name referred to they should pick the best alternative. Adults were not told where the names on the list came from or anything about the production context until after the matching task was completed.

Results

Spontaneous naming

Fifty-one of the 80 children spontaneously volunteered English words for the stimulus objects during the free play time. Six of these children referred to the objects only with 'that' or 'this'. Of the 29 children who did not spontaneously offer English words for the nonce objects, seven had uncodeable audio data due to microphone or tape difficulties, 14 referred to the objects with non-English babble, and eight did not talk during the experiment. Since the children were never asked to name or comment on the objects, it is not surprising that some of them did not. The children who did not offer English names for the stimuli were approximately equally divided between the Explicit-Naming and No-Naming conditions.

Utterances were counted as nouns only if they could not be construed as any other part of speech. The great majority of the utterances were single nouns (rather than multi-word phrases); however, 11 multi-word phrases were recorded. Of these, six contained a noun (e.g. 'Where's the ball?'), and five were descriptive phrases (e.g. 'That blue one'). Only three isolated non-nouns were recorded; two sound effects ('hoot' and 'ssssss') and one color term ('purple'). Because we were specifically interested in the relationship between children's spontaneous naming by shape and the shape-bias seen in novel noun generalization tasks, the list of nouns (independent of the linguistic context in which they occurred) serve as the main data. Figure 4 provides a complete list of the nouns children spontaneously pro-

duced and the number of children (greater than one) offering each name for each object. A total of 100 spontaneous names were recorded. Of these, 37 were unique types. Most of the names children produced referred to inanimate things – only nine of the utterances were names for animates. However, as in Experiment 1, the likelihood of a child referring to an object with an animate name appears to be related to the perceptual features of the object. Specifically, two of the objects were more likely to be labeled with an animate label (the texture match from the 'zup' set, and the shape match from the 'wug' set), χ^2 (11, $n = 100$) = 28.55, $p = .02$. Thus, the perceptual properties of some of the stimuli reminded the children of animate rather than inanimate things.

Figure 5 shows the mean number of spontaneous productions as a function of vocabulary level. As is evident in the figure, attempts to name the novel stimulus objects with English object names increased steadily as a function of the number of nouns in productive vocabulary for children in both the Explicit-Naming and No-Naming conditions. A Vocabulary Level (0–25, 26–50, 51–75, 75+) × Condition (Explicit-Naming, No-Naming) analysis of variance revealed a significant effect of noun vocabulary level, $F(3, 72) = 3.953$, $p = .01$, but no other significant main effects or interactions. As children knew more object names, they were (at least in the age range examined here) increasingly likely to use those names to refer to the novel objects. Considered in isolation, this result is not surprising – it is necessary to know a number of names to be able to spontaneously use those names for the novel stimuli.

As in Experiment 1, the spontaneous English names offered appeared to be predominantly based on shape. Objects with side protrusions that could be wings were called 'airplane', coiled clay was called 'snake' and many children called rounded objects 'ball'. This observation is also supported by the fact that children often spontaneously named the shape-matching test object with the same name they used to refer to the exemplar. Specifically, of the 17 times children used the same word to refer to an exemplar and a test object, 11 times it was for the shape-matching test object. Interestingly, however, some of the spontaneous productions elicited in this experiment appear to be influenced by the conjunction of another property with shape. Most notably, color seems to matter. Children called red round things 'apple' and a yellow and plausibly winged thing 'bee'. The relative importance of shape, color and texture in eliciting children's spontaneous names was again examined in an adult matching task.

Adult matching data were scored as correct if adults said a given word referred to the same object that the children initially referred to when producing the spontaneous
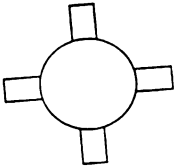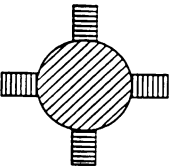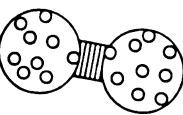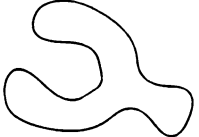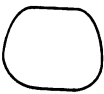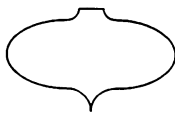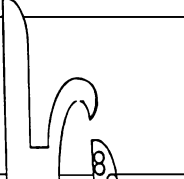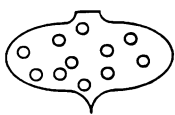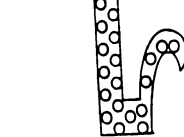
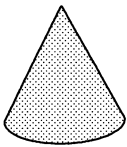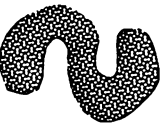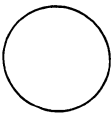|			
	ball (2) A playdough star plane		ball sucker stick (2)
	ball (3) A playdough star plane		ball sucker stick (2) drumstick
	ball (9) apple baseball balls dog		food
	boy Y foot		ball (7) apple (6) toy
	ball egg mountain water airplane		duck 'ABC' rock car
	fish egg football bee		duck 'ABC' gun (2)
	house hat (3) mountain ball		ball anchor rock snake
	ball (10) apple (3) nose		horn light (3) man lamp

Figure 4   *Spontaneous English names produced by children in Experiment 2 for each of the 12 stimulus objects.*

reference. Figure 6 shows the mean proportion of correct responses in each of the three conditions. As is apparent, adults were much better at matching children's spontaneous productions to the correct object in the Shape Only condition than they were in the Color Only or Texture Only conditions. This conclusion was confirmed by a one-way analysis of variance with condition (Shape Only, Color Only, Texture Only) as a between-subjects factor. This analysis revealed a significant effect of condition, $F(2, 33) = 22.91$, $p < .0001$. Thus, it again appears that shape plays a primary role in eliciting the particular *spontaneous* names children produced.
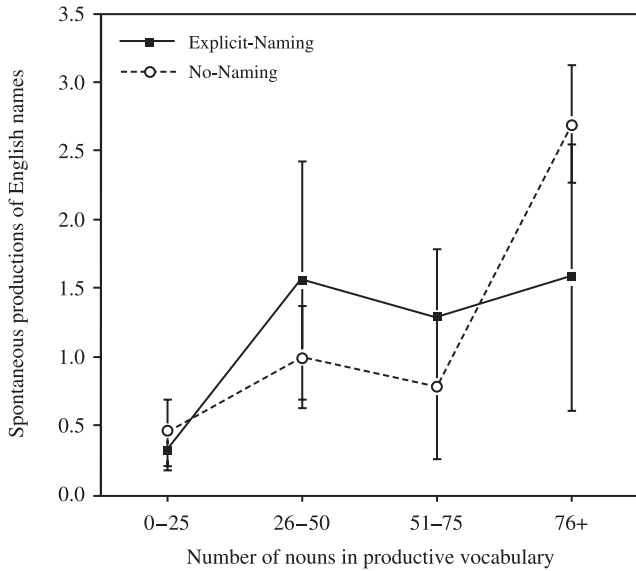
Figure 5 *Mean number of over-extensions of English nouns by noun vocabulary group for children in the Explicit-Naming and No-Naming conditions of Experiment 2. Vertical bars represent standard error.*
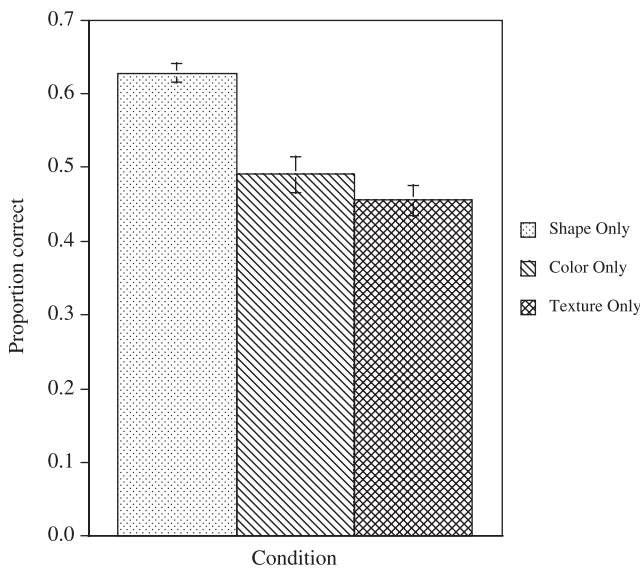

Figure 6 *Results of Experiment 2 adult matching task. The proportion of correct matches of children's spontaneous over-extensions of English words to the correct referent in the Shape Only, Color Only and Texture Only conditions. Vertical bars represent standard error.*

Figure 7 *The proportion of choices of the same shape test object at each of the four productive noun vocabulary levels for children in the Explicit-Naming and No-Naming conditions of Experiment 2. Chance performance was .33. Vertical lines represent standard error.*

Figure 7 shows children's performance in the two experimental tasks: their choices of the same shape test object in response to the experimenter's request, both when the experimenter provided explicit cues that it was a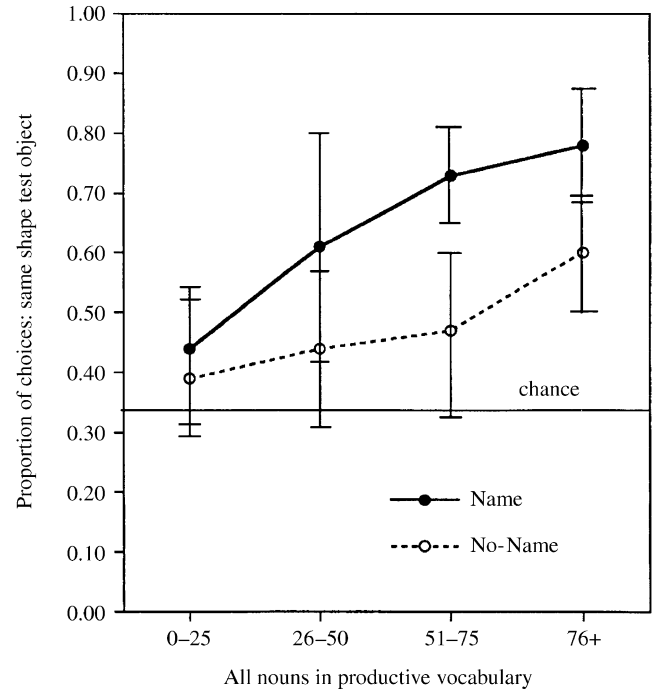 naming task and when the experimenter did not. As is apparent, children's attention to shape in both tasks – with and without experimenter-provided naming cues – increased as a function of the number of nouns in their productive vocabulary. Children in the Explicit-Naming condition who had more than 50 nouns in their productive vocabulary systematically extended the experimenter-provided name to new instances by shape over 70% of the time. Children in the No-Naming condition who had more than 76 nouns in their productive noun vocabulary systematically picked the test object that matched the exemplar in shape as being 'like' the exemplar 60% of the time. The results were analyzed by a Vocabulary Level (0–25, 26–50, 51–75, 75+) × Condition (Explicit-Naming, No-Naming) ANOVA. This analysis revealed a significant main effect of both Condition, $F(1, 72) = 7.00$, $p = .01$, and Vocabulary Level, $F(3, 72) = 4.31$, $p < .01$, but no interaction. The main effect of condition indicates that children in the Explicit-Naming condition picked the shape-matching test object significantly more than children in the No-Naming condition. This suggests that an experimenter-supplied cue of naming the object does increase attention to shape. However, such an experimenter-supplied explicit cue is clearly not necessary. Follow-up Tukey's HSD tests ($p < .05$) on the

Vocabulary main effect revealed that children with 51–75, and 76 or more nouns in their productive vocabulary picked the shape-matching test object significantly more than children with 0–25 nouns in their productive vocabulary. Further, one sample t-tests against chance (.33) revealed that the choice of the shape-matching test object was significantly higher than what would be expected by chance for all but the lowest vocabulary group: 26–50 $t(17) = 3.05$, 51–75 $t(19) = 4.70$, 76+ $t(19) = 6.26$; all p's < .05. Note that the data from the No-Naming condition challenge some previous accounts of the shape bias. In this similarity judgment task, children were able to organize their attention to focus on the object properties that matter in the absence of a cue provided by the experimenter. Thus, children's attention to shape does not require the externally generated triggering cue of hearing an object being named. Importantly, however, attention to shape in both the similarity judgment and name generalization tasks does appear to increase as a function of vocabulary development.

Note also that the fact that there are developmental trends in the experimental tasks of both the Explicit-Naming and the No-Naming conditions strongly suggests that the shape-matching test objects were not simply more perceptually salient than the other choices. If they were, one would expect all children – regardless of vocabulary level – to select the shape matches. Rather, in both conditions, shape matches increase as vocabulary increases. This pattern thus fits the idea that attention to shape becomes stronger with development, and perhaps specifically as children know more and more object names.

How does the shape bias seen in the experimental tasks fit with children's attention to shape when spontaneously labeling these stimuli? To address this question we classified each spontaneous utterance children produced as shape-based if adults in the Shape Only condition were able to correctly match the utterance to the right stimulus object over 50% of the time. A chi-square test of independence examined whether the number of shape-based spontaneous productions was independent of vocabulary level. This analysis was not significant, χ^2 (3, $n = 100$) = 1.70, $p = .63$, suggesting that children with very few nouns in their productive vocabulary attend to shape when spontaneously naming our novel stimuli at the same level as children with many more nouns in their vocabulary. This result must be qualified, however, by the fact that the children with more limited productive vocabularies did not produce as many spontaneous names as children with more extensive vocabularies (see Figure 4). Nevertheless, it is interesting that when they did spontaneously name our stimuli, the children with smaller noun vocabularies, like those with more extensive noun vocabularies, attended to shape. Thus, we do not see the same developmental trend towards *increased* attention to shape with larger vocabulary in spontaneous naming as we do in the experimental tasks.

Importantly, however, children's tendency to overextend the words they knew to the novel objects *was* related to their performance in the similarity judgment task. The number of shape choices by individual children in the No-Naming condition was correlated with the total number of spontaneous naming attempts by that child, $r(36) = .65$, $p < .05$ (two children who had uncodeable audio data are not included in this analysis). Taken together then, the data suggest an earlier role for attention to shape in children's spontaneous productions compared to their choices in the experimental task. Nevertheless, the two behaviors appear to be related; the more individual children name objects, the more they attend to shape when judging their similarity.

Discussion

As in Experiment 1, young children spontaneously named our nonce objects and the names they selected appear to principally reflect the shape of the thing they were referring to. These spontaneous productions, together with the results of the experimental tasks, suggest that this attention to shape is internally generated by the child, and does not require explicit cueing by an adult partner. In addition, while children with the most limited productive vocabularies do not systematically attend to shape when generalizing novel names or making similarity judgments, their spontaneous productions do suggest an early reliance on shape in lexical retrieval. These results challenge some prior proposals about the shape bias and in so doing highlight the value of adding new methods to the experimental repertoire.

General discussion

The principle goal of these experiments was to explore the use of children's spontaneous labeling of nonce objects as a method for studying lexical retrieval. The strength of the method is that it builds on spontaneous behavior and is therefore likely to reflect processes that the child naturally brings to bear on the world, rather than the demand characteristics of an experimental task. The two experiments used adult judgments to assess the object properties that elicited the particular names children offered. The results suggest that the spontaneous names young children produce are cued by object shape, and that the development of this behavior is related to the development of both early categorization behaviors and the productive noun vocabulary. Of course, the

experiments presented here represent only an initial test of the usefulness of this method for examining lexical retrieval. Thus, several important aspects of the method and results need to be explored further. In particular, we discuss below the relation between the stimuli used in the present experiments and the results we obtained, and the relevance of these findings for object name learning outside of the laboratory. These issues notwithstanding, the relevance of the current findings to issues in children's attention to shape in object naming, also discussed below, suggests that this method has much potential value.

Stimulus features, vocabulary, context and over-extensions

One potential limitation of the method used in these experiments is that it is based on spontaneous behavior and thus some children, as in Experiment 2, may not contribute data. In some sense this is also a strength; the regularities in children's productions were generated by the children, not by an explicit naming cue provided by the experimenter. A second potential limitation of the present work is that only a relatively small set of novel objects were used to elicit the spontaneous productions. Thus it is possible that the particular results obtained – that children's spontaneous productions are cued by shape – are due to the particulars of these stimuli. Perhaps the children focused on the shapes of our novel objects when naming them because the textures or colors were hard to name. It is important to note, however, that young children typically learn very few names for textures early in vocabulary development (there are only three texture terms on the MCDI; 'hard', 'soft', and 'sticky') and that children's acquisition of color terms is typically slow and full of errors (Sandhofer & Smith, 2001). Thus, the relative lack of texture and color terms in our corpora of spontaneous utterances fits with the fact that the early noun vocabulary is dominated by names for categories organized by similarity in shape (Samuelson & Smith, 1999).

Nevertheless, if our method accurately reflects the process of lexical access, it should be possible to find cases where children's spontaneous utterances are tied to features other than shape. For example, we would expect that more of children's spontaneous names would be cued by features other than shape in cultures where noun categories are organized by features other than, or in addition to, shape. Lucy (1992) has reported that in Yucatec Mayan, common nouns refer to categories organized by material substance. To the extent that material substance is a better cue to object kind than object shape for the Mayans, and children learn to name

these material-based categories early, children's spontaneous names should be cued by the material nonce objects are made of, rather than their shape.

Further, it may also be possible to influence the cues that children attend to when spontaneously naming novel objects by altering the specifics of the experimental context. For instance, the material substance of stimuli may be more salient in the context of a highchair because children are used to eating in this context and material is more important than shape for distinguishing whether a mass of white substance is mashed bananas or rice cereal. Similarly, children might have been more likely to call the green cone-shaped object in Figure 1 'frog' if they had previously seen it moving up and down in a bouncing motion (e.g. Smith, in press). Studies with adults suggest that contextual factors, such as the experimental setting and prior knowledge about object categories (such as the fact that frogs hop), influence lexical access (e.g. Barsalou, 1987). Importantly, however, the fact that children's spontaneous productions are likely to be influenced by the experimental context in these ways can be viewed as a strength of the method we employed. Nevertheless, future work that systematically manipulates the properties presented by the stimulus objects and the particulars of the experimental context will likely provide valuable insight into how specific aspects of shape, color and texture cue lexical access in children.

Over-extensions, lexical gaps and shape

Previous studies investigated children's spontaneous 'overgeneralizations' or 'over-extensions' in naming for insights into both the nature of children's early categories (e.g. Anglin, 1978; Clark, 1973; Hoek, Ingram & Gibson, 1986) and the processes of language development (e.g. Barrett, 1986; Bloom, 1973; Kay & Anglin, 1982; Nelson, 1973; Rescorla, 1980). Over-extensions are cases in which a child uses a word to refer to a broader range of referents than is conventional in adult usage (Anglin, 1978; Bloom, 1973; Clark, 1973). Thus, like the spontaneous productions studied here, over-extensions are instances in which a child uses an already known word to refer to an unnamed object. However, the original interest in children's over-extensions was in what they could tell us about the structure of children's concepts – are they illogical?

More recent work suggests that these over-extensions of known names for common things often reflect a lexical gap – the child chooses a name for some similar thing as a way to refer to something for which they do not have a name. Although the similarities that the child uses in response to these lexical gaps may not be the similarities that *define* categories, they do indicate the

similarities relevant to lexical retrieval and potentially to object recognition. Clark's earlier analyses of children's over-extensions implicated shape as a key perceptual cue. The use of nonce objects in the present experiments provides stronger support for this conclusion. These impoverished objects present very little category-relevant information, but when children want to refer to them they select a name that is – at least according to adult judgment – related by shape.

An early shape bias in children's spontaneous names

Previous studies of the development of the shape bias have suggested that children do not systematically attend to shape when naming novel stimuli until they already have many names for shape-based categories in their productive vocabularies (Gershkoff-Stowe & Smith, 2004; Samuelson & Smith, 1999). In contrast, the data from Experiment 2 suggest that children's spontaneous productions of English names for our novel stimuli were elicited by shape cues from the earliest points of productive noun vocabulary development. This, of course, does not mean that the shape bias is not learned as a consequence of object name learning, but it does mean that if it is learned, it has an earlier beginning than is evident in novel noun generalization tasks. The fact that attention to shape was evident earlier in spontaneous naming than in either similarity judgment or noun generalization reminds us that there is probably no 'shape bias' in the sense of a unitary skill that comes on-line all at once. Rather, attention to shape in the context of naming and categorizing objects is more likely a continuously increasing propensity that becomes stronger and more robust with development.

Is the shape bias lexically specific?

In their previous work, Smith and colleagues argued that the shape bias is a product of learning object names that refer to things in categories organized by similarity in shape, and that attention to shape is cued by linguistic cues regularly associated with naming objects (Landau *et al.*, 1988; Smith *et al.*, 1996). Two results from the present experiments are relevant to this proposal. First, we found that children spontaneously named objects by shape even in tasks that did not include overt naming cues – the experimenter did not name any of the stimuli, nor did she prompt the children to name the objects. Thus, children's bias to attend to shape in these studies was not cued by the explicit task of extending a novel count noun. Second, we found that children were biased to attend to shape when asked to select 'another one like this'. Since associative learners such as connectionist

nets can generalize broadly and do not typically require an explicit cue to do so, these results do not necessarily contradict an associative learning account of the origins of the shape bias. Nevertheless, both the fact that children spontaneously named our novel stimuli by shape without being prompted by the experimenter, and the link between spontaneous naming by shape and shape-based similarity judgments, suggest a shape bias that is earlier, broader, and less task-constrained than attention to shape in the context of the specific lexical cue of 'this is a _____.'

Spontaneous naming, the shape bias and object categories

The two studies presented here clearly suggest that children's spontaneous productions of the English names they know are related to their generalizations of novel names and that information about object shape plays a key role in each. One possible form this relationship could take is that spontaneous naming may actually foster the development of object categories and in so doing also help to refine the shape bias. Students of word acquisition generally agree that children typically receive only positive evidence and not negative evidence about category membership (Brown & Hanlon, 1970; Sokolov & Snow, 1994). Put simply, parents tell children what things are ('this is a grapefruit') and they do not tell them what things are not ('this is not the moon'). The apparent lack of negative evidence has been theoretically important and contentious because without such evidence there are no limitations on the scope and direction of generalizations from known examples. Importantly, however, parents *do* provide negative evidence when the child makes a naming mistake (see Brown & Hanlon, 1970; Chouinard & Clark, 2001; Ninio & Bruner, 1978, for examples). Thus, for example, a child finds out that grapefruits are not called *moon* by calling a grapefruit a *moon* and then being corrected.

This suggests the possibility that the dawn of productive language and spontaneous over-extensions in naming may play a crucial role in teaching category extensions. This idea puts children's attempts to use English nouns to refer to our made-for-the-experiment objects in a different context – in the real world, such naming attempts invite feedback about category extension. By adult judgments, the nonce objects used in these experiments are globally similar in shape to instances of the categories indicated by the children. But they are only globally similar; they are not exactly the right kind of shapes and we suspect few adults would offer these names – even metaphorically – for these objects. Thus, if feedback had been provided in the present experiments,

the child would have been told that the labels did not apply, and that the sphere with the protrusions was not, in fact, a plane or a bee. Recently, Smith (2003; see also Nelson, 1973) has suggested that children learn how to perceive object shape as a product of category learning and, moreover, learn the proper range of shapes within object categories in the process. For example, although we as adults see all chairs as similarly shaped and chair-shaped (Rosch & Mervis, 1975; Samuelson & Smith, 1999), the fact is that real chairs – from kitchen to desk to living room – are not really the exact same shape. Chairs are all similarly shaped only under some abstract description of object shape. The suggestion is that children learn this abstract and category relevant description of shape as a product of learning early object categories. A possible interpretation of the results of the present experiments is that the 18- to 24-month-olds in these studies have not yet learned these category-relevant descriptions of shape. Instead, the range of accepted shapes within a category appears broad and somewhat idiosyncratic. In this way, then, the perception of object shape may not only serve as a cue to elicit spontaneous names, but the act of spontaneous naming – and the corrections it engenders – may play a crucial role in fine-tuning the perception of shape.

Conclusion

Children's spontaneous labeling of nonce objects may provide a useful new method to study lexical access in children, one that builds on children's self-generated behaviors and thus has the potential to yield new insights about how children learn words outside of the laboratory. The present examination of spontaneous productions suggests that children understand the importance of shape in object categorization earlier than previously suggested and that their attention to this category cue does not require the explicit support of a naming task. We would argue further that because spontaneous productions are a likely causative force in development – eliciting feedback from the adult partner – understanding perceptual properties and task contexts that elicit these spontaneous productions are important in their own right.

References

Anglin, J.M. (1978). From reference to meaning. *Child Development*, **47**, 969–976.

Barrett, M.D. (1986). Early semantic representations and early word usage. In S.A. Kuczaj & M.D. Barrett (Eds.), *The development of word meaning: Progress in cognitive development research* (pp. 41–67). New York: Springer-Verlag.

Barsalou, L. (1987). The instability of graded structure: implications for the nature of concepts. In U. Neisser (Ed.), *Concepts and conceptual development* (pp. 101–140). Cambridge: Cambridge University Press.

Bloom, L. (1973). *One word at a time: The use of single word utterances before syntax*. The Hague: Mouton.

Bloom, P. (2000). *How children learn the meanings of words*. Cambridge, MA: MIT Press.

Booth, A.E., & Waxman, S.R. (2002). Object names and functions serve as cues to categories for infants. *Developmental Psychology*, **38** (6), 948–957.

Booth, A.E., & Waxman, S.R. (2003). Mapping words to the world in infancy: infants' expectations for count nouns and adjectives. *Journal of Cognition and Development*, **4** (3), 357–381.

Brown, R., & Hanlon, C. (1970). Derivational complexity and order of acquisition in child speech. In J. Hayes (Ed.), *Cognition and the development of language* (pp. 11–54). London: Academic Press.

Chouinard, M.M., & Clark, E.V. (2001). Adult reformations of child errors: Negative evidence during language acquisition. Poster session presented at the biennial meeting of the Society for Research in Child Development, Minneapolis, USA.

Clark, E.V. (1973). What's in a word? On the child's acquisition of semantics in his first language. In T.E. Moore (Ed.), *Cognitive development and the acquisition of language* (pp. 65–110). New York: Academic Press.

Diesendruck, G., & Bloom, P. (2003). How specific is the shape bias? *Child Development*, **74** (1), 168–178.

Fenson, L., Dale, P.S., Reznick, J.S., Bates, E., Thal, D., & Pethick, S. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development*, **59** (5), no. 242.

Fenson, L., Pethick, S., Renda, C., Cox, J.L., Dale, P.S., & Reznick, J.S. (2000). Short-form versions of the MacArthur Communicative Development Inventories. *Applied Psycholinguistics*, **21** (1), 95–115.

Gelman, S. (2003). *The essential child: Origins of essentialism in everyday thought*. New York: Oxford University Press.

Gelman, S., & Bloom, P. (2000). Young children are sensitive to how an object was created when deciding what to name it. *Cognition*, **76** (2), 91–103.

Gelman, S.A., & Ebeling, K.S. (1998). Shape and representational status in children's early naming. *Cognition*, **66**, B35–B47.

Gershkoff-Stowe, L., & Smith, L.B. (1997). A curvilinear trend in naming errors as a function of early vocabulary growth. *Cognitive Psychology*, **34**, 37–71.

Gershkoff-Stowe, L., & Smith, L.B. (2004). Shape and the first hundred nouns. *Child Development*, **74** (4), 1098–1114.

Hoek, D., Ingram, D., & Gibson, D. (1986). Some possible causes of children's early word overextensions. *Journal of Child Language*, **13**, 477–494.

Hummel, J.E., & Biederman, I. (1992). Dynamic binding in a neural network for shape recognition. *Psychological Review*, **99**, 480–517.

Kay, D.A., & Anglin, J.M. (1982). Overextension and underextension in the child's expressive and receptive speech. *Journal of Child Language*, **9**, 83–98.

Landau, B., Smith, L.B., & Jones, S.S. (1988). The importance of shape in early lexical learning. *Cognitive Development*, **3**, 299–321.

Lucy, J.A. (1992). *Grammatical categories and cognition: A case study of the linguistic relativity hypothesis*. Cambridge, MA: Cambridge University Press.

Mervis, C.B. (1987). Child-basic object categories and early lexical development. In U. Neisser (Ed.), *Concepts and conceptual development: Ecological and intellectual factors in categorization* (pp. 201–233). Cambridge: Cambridge University Press.

Nelson, K. (1973). Structure and strategy in learning to talk. *Monographs of the Society for Research in Child Development*, **38** (1–2), no. 149.

Ninio, A., & Bruner, J. (1978). The achievement and antecedents of labeling. *Journal of Child Language*, **5**, 1–15.

Quinn, P., Eimas, P.D., & Tarr, M.J. (2001). Perceptual categorization of cat and dog silhouettes by 3- to 4-month-old infants. *Journal of Experimental Child Psychology*, **79** (1), 78–94.

Rakison, D.H., & Butterworth, G.E. (1998). Infants' use of object parts in early categorization. *Developmental Psychology*, **34** (1), 49–62.

Rescorla, L.A. (1980). Overextension in early language development. *Journal of Child Language*, **7**, 321–335.

Rescorla, L.A. (1989). The language development survey: a screening tool for delayed language in toddlers. *Journal of Speech and Hearing Disorders*, **54** (4), 587–599.

Reznick, J.S., & Goldfield, B.A. (1994). Diary vs. representative checklist assessment of productive vocabulary. *Journal of Child Language*, **21** (2), 465–472.

Rosch, E., & Mervis, C.B. (1975). Family resemblances: studies in the internal structure of categories. *Cognitive Psychology*, **7**, 573–605.

Sandhofer, C.M., & Smith, L.B. (2001). Why children learn color and size words so differently: evidence from adults' learning of artificial terms. *Journal of Experimental Psychology: General*, **130** (4), 600–620.

Samuelson, L.K. (2002). Statistical regularities in vocabulary guide language acquisition in connectionist models and 15–20-month-olds. *Developmental Psychology*, **38** (6), 1016–1037.

Samuelson, L.K., & Smith, L.B. (1999). Early noun vocabularies: do ontology, category organization and syntax correspond? *Cognition*, **73** (1), 1–33.

Samuelson, L.K., Horst, J.S., Schutte, A.R., & Dobbertin, B. (under review). From correlation to conceptualization: the effects of syntax on an overgeneralized shape bias.

Smith, L.B. (2000). Learning how to learn words: an associative crane. In R.M. Golinkoff & K. Hersh-Pasek (Eds.), *Becoming a word learner. A debate on lexical acquisition* (pp. 51–80). New York: Oxford University Press.

Smith, L.B. (2003). Learning to recognize objects. *Psychological Science*, **14** (3), 244–250.

Smith, L.B. (in press). Shape: a developmental product. In L. Carlson and E. van der Zee (Eds.), *Functional features in language and space: Insights from perception, categorization and development*. Oxford: Oxford University Press.

Smith, L.B., Jones, S.S., & Landau, B. (1992). Count nouns, adjectives, and perceptual properties in children's novel word interpretations. *Developmental Psychology*, **28** (2), 273–286.

Smith, L.B., Jones, S.S., & Landau, B. (1996). Naming in young children: a dumb attentional mechanism? *Cognition*, **60**, 143–171.

Smith, L.B., Yoshida, H., Colunga, E., Jones, S., & Drake, C. (2003). Whose DAM account? Attentional learning explains Booth and Waxman. *Cognition*, **87**, 209–213.

Sokolov, J.L., & Snow, C.E. (1994). The changing role of negative evidence in theories of language development. In C. Gallaway (Ed.), *Input and interaction in language acquisition* (pp. 38–55). New York: Cambridge University Press.

Waxman, S.R. (1999). Specifying the scope of 13-month-olds' expectations for novel words. *Cognition*, **70**, B35–B50.

Waxman, S.R., & Booth, A.E. (2001). Seeing pink elephants: fourteen-month-olds' interpretations of novel nouns and adjectives. *Cognitive Psychology*, **43**, 217–242.

Waxman, S., & Booth, A. (2003). The origins and evolution of links between word learning and conceptual organization: new evidence from 11-month-olds. *Developmental Science*, **6** (2), 128–135.

Yoshida, H., & Smith, L. (2003). Known and novel noun extensions: attention at two levels of abstraction. *Child Development*, **74** (2), 30–34.