Competition between linguistic cues and perceptual cues in children's categorization: English- and Japanese-speaking children

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Abstract

Past research on children's categorizations has centered on the question of whether categorization is based primarily and /or strictly on perceptual properties or on more conceptual notions of kinds. This paper reports new data pertinent to this issue by examining the influence of linguistic cues and perceptual cues. The results showed that the linguistic cues strongly influenced English-and Japanese-speaking children's judgments in systematic manner. This suggest that for both language groups, linguistic cues activated different conceptual understanding that direct children's attention to different properties. Nevertheless, the linguistic cues had their effect only given named things with ambiguous properties.

Introduction

Children categorize the world systematically. The systematicity of early categories has been well documented by many researchers (Mandler, Bauer and McDonough, 1991; Landau, Smith and Jones, 1998a, 1998b; Samuelson & Smith 1999; Soja, Carey & Spelke1991; Markman, 1991; Bauer & Mandler, 1989.) Yet the mechanisms responsible for this systematicity in performance are not yet specified. The research reported in this paper seeks insights into these mechanisms and is motivated by both contemporary and traditional ideas about the nature of categories. The first idea is the more modern one of emergent categories that reflects momentary goals as well as long term knowledge. The second idea is the more traditional one of stable categories that reflects regularities in experience. Considered jointly these two ideas suggest a new way of thinking about how language influences children's category formation and fosters cultural differences.

Contemporary Idea

Barsalou (1983) introduced the idea of an ad hoc category, a category formed in the moment in the service of solving a specific problem, for example one might from a category of "all the objects on my desk I can use to draw a straight line" or "all the things I can eat in this restaurant that I can afford." Our ability to form coherent ad hoc categories clearly depends on long-term knowledge of objects, their properties, and goals. The idea, however, is that specific bits of knowledge and the current input are melded to form a category adaptively fit to the moment. "Ad hoc categories should come to mind only when primed by current goals. Laurence W. Barsalou, 1983, (p. 223)"

Traditional Idea

The traditional idea of categories contrasts with the on-line flexibility of Barsalou's ad hoc categories. Traditionally, categories have been seen as fixed, mental structures that one either has or does not. It is this traditional idea about categories that make Whorf's (1956) claims about the role of language in categorization so contentious. Whorf argued that concepts are the product of language and so speakers of different languages "have" different concepts. But viewed through a more modern lens, Whorf's ideas present another possibility. "… all observers are not led by the same physical evidence to the same picture of the universe, unless their linguistic backgrounds are similar."(1956:214)—(p. 6 Gumperz & Levinson, 1996) Here is the idea: Language operates both as a contextual and long-term force an on-line category formation, causing speakers of different languages to attend to different properties in the task and thus to create different ad hoc categories. We test this idea in a study of English- and Japanese-speaking children's attention to cues distinguishing animates and inanimates.

Animates and inanimates

All languages distinguish between animates and inanimates and do so in a variety of ways. However, English and Japanese differ in their systems for individuating objects, and specifically in whether they treat animates as special discrete kinds. English treats both animate and inanimate objects as discrete and countable, that is, names for animate and inanimate objects are count nouns that take the plural. Substances,

in contrast, are named by mass nouns and not pluralized but instead take continuous quantifiers. In contrast, Japanese treats only animates as discrete. Nouns in Japanese are not pluralized, but names for animates can take an optional plural form. Further, the classifier system used for counting distinguishes animates from inanimate objects, but does not distinguish substances from inanimate objects. If Whorf is right, these linguistic differences might lead Japanese speakers more than English speakers to attend to properties relevant to animal categories. If instead Barsalou is right about the online creation of categories, cues suggesting the relevance of animacy properties should make speakers of both languages attend to properties relevant for animal categories. Finally, if both Whorf and Barsalou are right, speakers of both languages may be differentially sensitive to these cues and thus form different categories online.

Task

One task commonly used to examine children's category formation is the novel noun generalization task (e.g., Landau, Smith & Jones, 1988.) In this task, children are presented with a novel object, told its name, and then asked what other objects have the same name. Since both the objects and names are novel, this task measures category creation. Research has shown that children smartly use information about the objects and information from linguistics in the category formation (See, Smith, 1995, for a review). Critical to the present research are well replicated findings showing that when the named novel object has the properties of an artifact (solid, angular, complex shapes), children from categories based on shape but when the named novel object has properties of animals (e.g., eyes), children form categories based on a joint similarity in shape and texture (Jones et. al, 1991). We use this task and children's creation of shape-based versus shape plus texture based categories as a measure of the role of language history and on-line linguistic cues in children's category formation. More specifically, the experiments examine the interaction of the immediate linguistic cues, the individual's history of using those linguistic cues, and perceptual properties of the to-be-classified objects.

Experiment 1

The first experiment examined Japanese-speaking children's use of both linguistic cues and perceptual cues in category formation. The design crosses two levels of linguistic cues, one clearly marking the object as animate, one clearly marking the object as inanimate—with three different perceptual cues, cues that strongly suggest an animate thing, cues that weakly suggest an animate thing and cues that strongly suggest an inanimate thing.

The linguistic cues are *aru* and *iru* . In locative constructions (e.g., There is a cup) *aru* is obligatorily used with inanimate objects and *iru* is obligatorily used with animate objects. This is a highly salient and pervasive lexical contrast in Japanese. Figure 1 illustrates the 3 kinds of perceptual cues: rounded objects with eyes, rounded objects with appendages that might be viewed as legs, and angular objects with no properties suggestive of animate things. We ask: How do Japanese-speaking children combine these perceptual and linguistic cues when forming a new category?

Method

Participants Sixty monolingual Japanese-speaking children who were 21.06 to 45.7 months old participated. Participants' mean age was 34.51 months. All the participants were recruited from Niigata, Japan. All children participated with their parents.

Stimuli, materials and procedure Children participated in one of the six conditions that resulted from crossing the two linguistic cues (*iru/aru*) with the three levels of perceptual cues. In each condition children were tested in two blocks of 12 trials. In each block, a unique exemplar was named with a novel name and the child was asked whether that name also labeled each of 6 test objects. These six test objects were each queried twice in a randomly determined order. Three of these were control objects designed so that children should respond the same way regardless of whether they perceived the named object as depicting an animate or inanimate. One control object matched the exemplar in all features thus all children should say "yes" the name of the exemplar applies to this object. Two control objects differed from the exemplar in both shape and texture (or shape and color), thus all children should say "no" the name of the exemplar does not apply to these objects. The three diagnostic test objects matched the exemplar in shape and texture, shape and color, or only shape. If children perceive the exemplar as an animate, they should say the name applies only to the shape-and –texture matching object. If children perceive the exemplar as an artifact, they should say " yes" the name of the exemplar applies to all three diagnostic objects.

The sentence frames used in the experiment were presented in the following in the Iru and Aru conditions, respectively: "*Kokoni ____ ga iru yo*" and "*Kokoni ___ ga aru yo*." Test objects were queried as follows in the Iru and Aru conditions respectively: "*Kokoni ____ga iru kana*?" and "*Kokoni _____ ga aru kana*?"

The objects used in this experiment are, illustrated in Figure 1. The 3 control objects and 3 diagnostic test objects for the two test sets were constructed in the same way and are labeled in Figure 1 by the properties on which they match the named exemplar. All objects

were 3-dimensional, approximately 7cm x 7cm x 7cm, in size. The sample set illustrated in Figure 1 is stimuli with suggestive of animate cues: all objects in the pre-training set, the keppuru set, and tema set had appendages made of pipe cleaners.

Results

When the exemplar had eyes, a clear cue indicating the depiction of an animate, children generalized the name to new instances that matched in both shape and texture. The linguistic cues of *iru* and *aru* had no effect on performance. When the exemplar was angularly shaped and presented no cues suggesting an animate thing, children generalized the name to all test objects matching in shape. The linguistic cues of *iru* and *aru* had no effect on performance. However, when the exemplar presented weak perceptual cues suggesting an animate thing, the linguistic cues had a dramatic effect. The children generalized the name in the context of *iru* (the animate form) only to test objects that matched the exemplar in shape and texture just as they did when the exemplar had eyes. However, in the context of *aru* (the inanimate form) , the children generalized the name to all objects that matched the exemplar in shape just as they did when the exemplar was clearly an artifact. These conclusions were confirmed by analyses of "yes" responses (the name applies) on the diagnostic trials.

Children's proportions of "yes" responses on these trials were submitted to analysis of variance for a 2 (Linguistic cues) X 3(perceptual cues) mixed design. The analysis revealed the main effect of Linguistic cues, $F\ (1,54) = 15.834$, $p < .001$, the main effect of perceptual cues, $F\ (2,54) = 14.132$, and the interaction between perceptual cues and linguistic cues, $F\ (2,54) = 9.073$, $p < .001$. The "yes" responses for these diagnostic test objects in the 6 conditions are shown in Figure 2. These results show: (1) clear effects of perceptual cues on category formation. (2) clear effects of linguistic cues, and (3) the dominance of perceptual over linguistic cues, at least for these children in this task context.

Experiment 2

Experiment 1 showed Japanese-speaking children's sensitivity to linguistic cues in category formation, when the perceptual cues were not strongly pointing in some other direction. The goal of Experiment 2 was to replicate this finding with English-speaking children. Specifically, children were provided with stimulus objects that presented weak cues suggestive of animacy, appendages that could be seen as legs. The exemplar was named in one of two sentence frames that used different verbs; one using a verb suggesting an animate kind, the other using a neutral verb. The verbs used were "wants" and "goes": The exemplar was named saying, "*This mobit wants to stay here."* or *"This mobit goes here"*

Method

Participants Twenty monolingual English-speaking children between the ages of 23 to 43 months participated. The mean age was 31.7 months. The experimental sessions were held in Bloomington, IN. Participation of children was voluntary.

Stimuli, materials, design and procedure All aspects of the stimuli, procedure and design were identical to Experiment 1 with the exceptions of the type of stimuli and the sentence frames in which the novel names were presented. We used only one perceptual level for stimuli: ambiguous objects (see Figure. 1). The sentence frames used in English were non-locative constructions that had plausible animate/inanimate distinction "wants" for animate and "goes" for inanimate or neutral. The novel words employed to name the exemplars in the Experiment 2 were slightly altered to sound natural in English (e.g., *mobito*/mobit; keppuru/kipple; tema/teema).

Results

As shown in Figure 3, the English-speaking children generalized the names for these objects in the same way in both linguistic conditions, to all test objects that matched the exemplar in shape. This suggests children saw the objects as artifacts. The key result, however, is that they were unaffected by the linguistic cues. This contrasts with the Japanese-speaking children of Experiment 1 who categorized these same ambiguous objects differently in the two linguistic contexts.

Experiment 3

Are English-speaking children just less sensitive to linguistic cues? Perhaps "wants" is not as strong a cue suggesting animacy in English as "*iru* " is in Japanese. In Experiment 3, we used a sentence context containing personal pronouns (he/she) in an attempt to encourage children to form animal-like categories.

Method

Participants Twenty monolingual English-speaking children between the ages of 24 to 43 months participated. The mean age was 32.95 months. The experimental sessions were held in Bloomington, IN. Participation of children was voluntary.

Stimuli, materials, design and procedure All aspects of the stimuli, procedure and design were identical to Experiment 2 with the exception of the sentence frames in which the novel names were presented. The sentence frames used in English had either pronoun "she/he" or neutral subject "it" to refer the object

Results

English-speaking children showed clear (and reliable) effect of linguistic cue. As is evident in Figure 4, in the context of "he/she," children generalized the name to test objects matching the exemplar in shape and texture. In the context of "it," children generalized the name to new instances the same shape as the exemplar. Thus, we see clear on-line effects of linguistic cues on category formation in English-speaking as well as Japanese-speaking children.

The analysis revealed that the number of 'yes' responses to the shape matching test objects for the two groups of children differed reliably, $t=3.851$, $p<.005$. Given objects with features suggestive of animal limbs, English-speaking children provided with pronoun *"she/he*" were significantly more likely to form a narrower category based on both shape and texture than children with the neutral subject "*it*" only new instances that matched in shape alone.

Clearly, these pronouns activated different conceptual understanding that directed children's attention to different properties.

Experiment 4

The evidence thus far fits the contemporary vision of systematic categories created on-line and in-the-moment from the combination of perceptual cues and linguistic cues. But what of the long-term effects of learning particular language with a particular structure on on-line category formation. Although both English and Japanese have many linguistic devices and contrasts organized around animacy, the Japanese language through its system of individuation is arguably more concerned with animacy than English. Are linguistic cues suggesting animacy thus stronger for Japanese-speaking children than English-speaking children? To test this, we presented both English- and Japanese-speaking children with a novel angular artifact with no cues even remotely suggestive of animate thing. We named the object with a novel name in a linguistic context loaded with multiple cues indicating the conceptualization of the object as an animate.: for English *"See, who do you think this is? He is a Mobit! Isn't this mobit cute? There might be some more mobits that came to play with us!"* and for Japanese, *"Hora, koko ni dare ga iru to omou? Kokoni iru nowa mobito kun. Mobito kuntte kawaii desyo? Hoka nimo motto ippai mobito ga asobini kiteirukamo shirenaiyo!*"

Method

Participants Ten monolingual English-speaking children who were 25 to 45 months old and 10 Japanese-speaking children who are 27.4 to 38 months old participated. English-speaking children's mean age at this study was 35.5 months, and Japanese-speaking children's mean age was 33.82 months. The English-speaking children were recruited from Bloomington, IN. The Japanese-speaking children were recruited from Niigata, Japan. All children participated with their volunteer parents.

Stimuli, materials, design and procedure All aspects of the stimuli, procedure and design were identical to Experiment 2 & 3 with the exceptions of the sentence frames in which the novel names were presented.

Results

As is evident in Figure 5, Japanese-speaking children generalized the name to all test objects that matched the exemplar in shape and texture, the pattern typical of animate things. In contrast, English-speaking children generalized the name to all instances like the exemplar in shape, the pattern typical of artifacts. The numbers of 'yes' response to the shape matching test objects for the two groups of children differ reliably, $t=7.577$, $p<.001$.

Apparently English-and Japanese-speaking children see these objects differently. English-speaking children form categories based on the perceptual cues, Japanese-speaking children follow the linguistic cues. It appears that different histories of using language lead children to make different use of on-line information, and thus, in-the-moment-of the task, form different categories.

General discussion

The Whorfian question is often conceptualized as asking whether speakers of different languages "have" different categories. This question does not make sense if categories are momentary creation. Certainly, children's categorizations in the novel noun generalization task used here are momentary creations, formed *de nouveau* from learning a single novel object named with a novel name. But both English- and Japanese-speaking 3 year olds readily and coherently create categories in this task using perceptual and linguistic information in the task as the basis for categorizing new instances. But how in-task, in-the-moment, information is used will also depend on the life time histories in using those cues in other contexts. In this way, we may see direct effects of the language one knows, not on the categories and concepts one has, but on the categories and concepts one creates to solve a specific task.

Figures

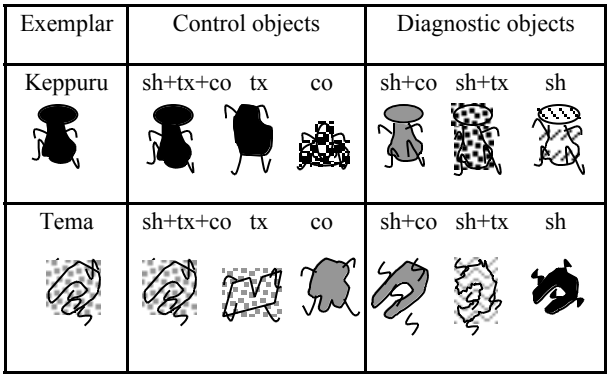

Figure 1: Test set stimuli with suggestive animacy features.

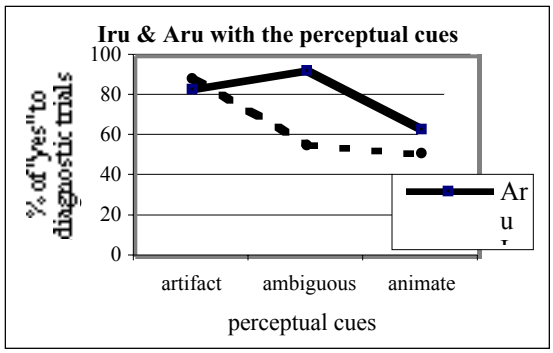

Figure 2: Proportion of "yes" responses by Japanese-speaking children with two different linguistic cues to test objects that matched the exemplar by shape. On the x-axis, objects are labeled by three perceptual cues.

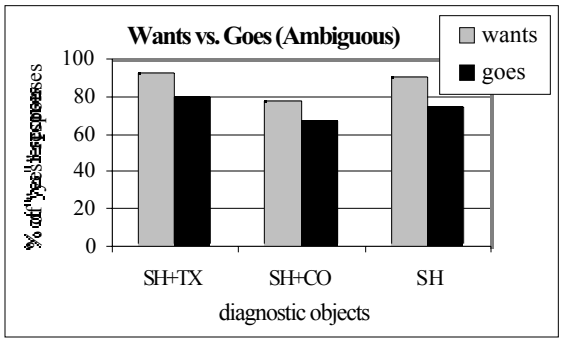

Figure 3. Proportion of "yes" responses by English-speaking children with two different linguistic cues to test objects. On the x-axis, objects are labeled by the properties matched to the exemplar.

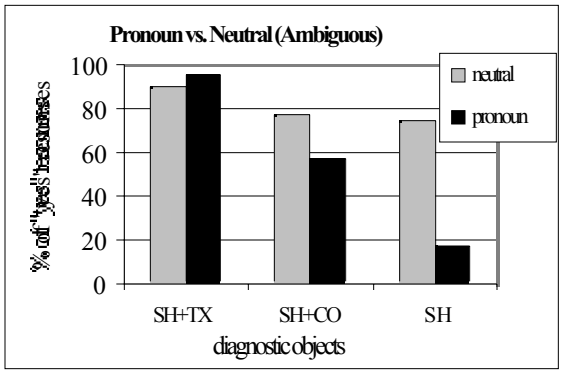

Figure 4. Proportion of "yes" responses by English-speaking children with two different linguistic cues to test objects. On the x-axis, objects are labeled by the properties matched to the exemplar.

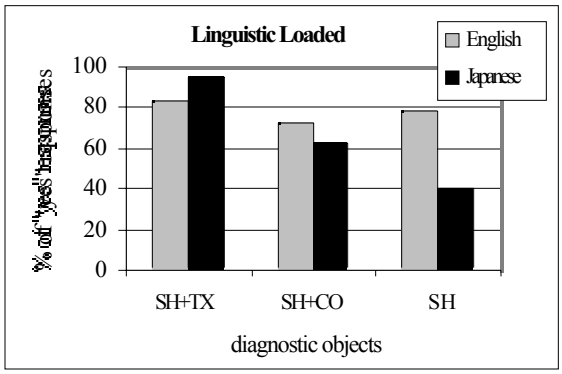

Figure 5. Proportion of "yes" responses by Japanese- and English-speaking children with a maximum linguistic cues to test objects that are clearly artifacts. On the x-axis, objects are labeled by the properties matched to the exemplar.

References

Barsalou, L. W. (1983). Ad Hoc categories. *Memory and Cognition*, *3*, 211-227

Bauer, P.J. & Mandler, J.M. (1989) Taxonomies and triads: Conceptual organization in one- to two-year olds. *Cognitive Psychology, 21*, 156-184.

Gumperz, J. J., & Levinson, S. C. (1996) Introduction; Linguistic relativity.re-examined. In J. J. Gumperz & S. C. Levinson (Eds.), Rethinking linguistic relativity (pp-1-18). Cambridge: Cambridge University Press

Jones, S., Smith, L., & Landau, B. (1991). Object properties and knowledge in early lexical learning. *Child Development, 62,* 499-516.

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

Landau, B., Smith, L. B., & Jones, S. (1998a) Object shape, object function, and object name. Journal of *Memory and Language, 38*, 1-27.

Landau, B., Smith, L. & Jones, S. (1998b) Object perception and object naming in early development. *Trends in cognitive science, 2*, 19-24.

Mandler, J., M., Bauer, P. J., and McDonough, L. (1991) Separating the sheep from the goats; Differentiating global categories. *Cognitive Development*, *3*, 247-264

Markman, E. M. (1991). The whole object, taxonomic, and mutual exclusivity assumptions as initial constraints on word meanings. In J. P. Byrnes & S. A. Gelman (Eds.), Perspectives on language and cognition: Interrelations in development (pp-72-106). Cambridge: Cambridge University Press

Samuelson, L. & Smith, L. B. (1999) Early noun vocabularies: Do ontology, category structure, and syntax correspond? *Cognition*. *73,* 1-33

Smith, L. B. (1995). Self-organizing processes in learning to learn words: Development is not induction. The Minnesota Symposia on Child Psychology. Volume 28. Basic and applied perspectives on learning, cognition, and development (pp. 1-32). Mahwah, NJ: Lawrence Erlbaum Associates.

Soja, N., Carey, S., & Spelke, E. (1991). Ontological categories guide young children's inductions of word meanings: Object terms and substance terms. *Cognition, 38,* 179-211.

Whorf, B. (1956). Language, thought and reality: Selected writings of Benjamin Lee Whorf (J.B. Carroll, Ed.). Cambridge, MA: MIT Press.