What makes a word?

Eliana Colunga (ecolunga@cs.indiana.edu)
Department of Psychology; 1101 East 10th Street
Bloomington, IN 47405-7007 USA

Linda B. Smith (smith4@indiana.edu)
Department of Psychology; 1101 East 10th Street
Bloomington, IN 47405-7007 USA

Abstract

Words seem to have a special status among perceptual signals. The developmental evidence, however, suggests that words *become* special. Woodward and Hoyne (1999) showed that 13-month-olds readily associate both words coming from the experimenter's mouth and non-linguistic sounds coming from a hand-held noisemaker, with object categories. In contrast, 20-month-olds associate words but not non-linguistic sounds with object categories. Woodward and Hoyne suggest that words become privileged as possible names; that the forms a name can take are open at the beginning and become more restricted with development. Are children learning what forms count as words? If so, just what defining features are they learning? This paper presents an associationist account of this developmental trend and tests this explanation in two experiments with 20-26-month-old children.

Introduction

Words seem to have a special status among perceptual signals. Having a label for an object changes the way it is categorized for both adults and children. For example, when asked to generalize an object name to new instances, children and adults generalize by shape. However, when asked to find an object that "goes with" another, they choose by overall similarity (Landau, Smith & Jones, 1988; Imai & Gentner, 1997). A label also makes children's choices shift from thematic to taxonomic (Waxman, 1997) and from surface to more conceptual similarities (Keil, 1989) . As Waxman said, words work like invitations to form categories; words are category names. But what makes a word? How do children know whether a particular sound is a category label?

One finding critical to this issues was reported by Woodward and Hoyne (1999) . They presented children with two novel objects and labeled one of them (the target object). In the Word condition they paired the target object with a word ("this is a toma"); in the Sound condition they paired the target object with a non-linguistic sound, such as a tone. Children were then asked to "get the toma" or "get the $<$ *tone* $>$" to test whether they had associated the "label" (toma or $<$ *tone* $>$) with the object. They asked: Do children treat only words as possible names or do they also accept tones as possible names? Their results indicate that the answer to this question depends on the developmental level of the child. Thirteen month-old infants will associate both a word and a non-linguistic sound with a target object. In contrast, 20-month-old children will associate a word to a target object, but not a non-linguistic sound. Namy & Waxman (1998) have similar results for 18- and 26-month-olds contrasting words and gestures. While the younger children will associate both a novel word and a novel gesture with a target object (object category) the older children will only associate the word to the object, and not the gesture.

Both teams of researchers suggest that older children do not associate non-words with the objects because older children know that non-words are not possible names. The idea is that words become privileged as possible names; that the forms a name can take are open at the beginning and become more restricted with development. But how do words become names and thus privileged? What determines what counts as a name?

In this paper we attempt to answer these questions. First we offer a mechanistic explanation of this developmental trend. Then we present two experiments that test our explanation.

An associationist account

We propose that words become privileged as category names because of the special way in which they correlate with object categories. In the experience of a child, many events may co-occur with attention to objects. For example, objects may co-occur with expressions such as "look!", gestures such as pointing, words related or unrelated to the object, noises, actions related or unrelated to the nature of the object, and so on. However, of all these events, words (as object names) correlate in a way that makes them especially good predictors for category membership.

By our account, there are two properties that make words good candidates for becoming privileged as names. The first property is predictiveness or cue validity. There is one name (more or less) that goes with one category (more or less). Thus, the name of

a category is a feature that all members of the category have in common, while at the same time the name is a feature that distinguishes instances of the named category from members of other categories. This is illustrated in Figure 1. The word "ball" typically co-occurs with members of the category BALL, but not with members of the category DOG. Similarly, the word "dog" co-occurs with members of the category DOG, but not with members of the category BALL. In contrast, events like pointing and hearing "look!" will just as likely co-occur with both balls and dogs. Thus, it is the object names that are predictive of object category, and not events like pointing or the word "look!".

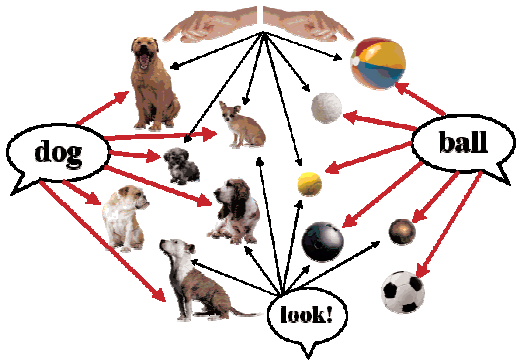

Figure 1: Object names systematically correlate with object categories

Predictiveness, however, is not enough by itself. After all, even 3-4 month-old infants can distinguish pictures of dogs from, for example, cars. Whether infants have the category or concept of DOG or CAR or not, the fact remains that there is something about dogs and cars perceptually that allows them to distinguish members of the two categories. Why isn't the feature "dogness"(or "carness") which is predictive of category membership for the category DOG (or CAR) not something that can be taken as a name, like a word? We propose that the answer to this question lies in a second statistical property: systematicity. That is, words *as a domain* are predictive of object category membership. Put another way, if there were just one word that correlated with a category, words in general would not get an advantage. The fact that there are many words that co-occur with many object categories is what helps children generalize this expectation to novel words.

The mechanism we propose also says something about the nature of words as names. According to our account, a name is simply the bundle of signals that systematically co-occurs with categories. These could be properties such as being a speech sound with particular spectral and prosodic forms, being produced by people, coming out of mouths, or co-occurring with pointing and eye gaze to the object. Thus, these may be the properties that, through language learning, come to define what counts as a name for children.

In sum, in our account what makes words privileged as names is that they co-occur systematically with object categories. Conversely, a name is whatever features systematically co-occur with object categories, even beyond what we usually think of as words (or names).

Thus, we make the following two predictions:

1. Events that co-occur systematically with object categories come to refer — to be usable as names. According to our account, any event domain that systematically predicts category membership will be taken as a name as well. Fortunately for the experiment we report here, children's experiences include a domain in which something other than words co-occurs systematically with categories — the domain of animals. Animal category correlates with animal sound: dogs bark, cats meow, elephants trumpet and so on. Thus our first prediction is that animal sounds should be taken as names for animals.

2. What defines a name is the cluster of features that systematically co-occurs with categories. This means that any strongly correlated feature of a name, even beyond what we think of as a word, will become an integral part of what is a name. For young children who rely on spoken language, words emanating from mouths is a highly systematic property of names. Therefore children should take coming-from-a-mouth as one of the defining features of being a name. Thus, our second prediction is that if a word comes out of a place other than a mouth, young children will not take it as a name. Conversely, young children may take a non-word as a name if it emerges from a mouth.

In the next experiment we tested these predictions in the domain of animals. We selected children to participate who by Woodward & Hoyne's and Namy and Waxman's studies should already treat words as the only privileged naming events. To test the first prediction (that animal sounds can be used as names for animals) we labeled animal toys with different kinds of sounds: a word, an animal sound, and a motor sound. To test the second prediction (that emanating from the mouth was a defining feature of being a name) we made the names emanate from different sources: from the experimenter's mouth or from a nearby object.

The design for Experiment 1 is shown in Figure 2. Note that from Woodward and Hoyne's study we know what will happen in the Word-Mouth cell and in the ArbitrarySound-Noisemaker cell. Children should take the word as a name in the first case and reject the sound as a name in the second case. The questions are: will they accept the animal sound as a

name? Will they accept any kind of sound emanating from the mouth as a name? Will they accept the word as a name regardless of where it comes from, or will the source matter?

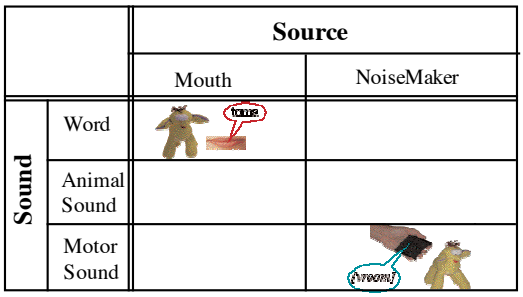

Figure 2: The experiment had three different kinds of sound (Word, Animal Sound, Arbitrary Sound) as within-subject conditions and two different sources (Mouth, Noisemaker) as between-subject conditions

Experiment 1

Methods

Subjects. 24 20-26 month-old children participated in the experiment.

Design. We used a 2x3 mixed design with the two different sources (mouth, noisemaker) as a between-subject variable and the three different sounds (word, animal sound, arbitrary sound) as a within-subject variable.

Stimuli. The stimuli consisted of two sets of six novel toy animals. The animals in the two sets were the same in all respects except in color, and one was used as the generalization of the other. The sounds used as names were the word "toma", a frog sound as the animal sound, and a motor sound as the arbitrary sound.

Procedure. The experiment was preceded by a training phase. The goal of the training phase was to make sure that the child understood the task and could make clear choices. In this phase we presented the child with a familiar object (a ball, a spoon, a flower) and asked the child to "get the ball" (or spoon or flower). Once the child had done this, we put two familiar objects on the tray and asked the child to get one of them. The training was considered successful if the child retrieved the correct object twice from the tray with a distracter.

Each child heard three different kinds of names (Word, Animal Sound, Motor Sound) in three blocks. Each block consisted of a Familiarization phase and a Test phase.

In the Familiarization phase the child was shown two different toy animals and a name was supplied for one of them – the target object. The two objects were presented twice, one toy animal at a time. First the target animal was presented and named, and then the distracter animal was presented with the same phrases but without a name. Then the target animal was presented and named again followed by the distracter animal.

In the Mouth condition, children heard the three kinds of label coming from the experimenter's mouth. When presenting the target object, the experimenter named it saying, "Look at this toma. Wow! See this toma? Look! Toma." in the Word condition, imitated the animal sound in the Animal Sound condition ("look at this $<$ $frog-likeclucking$ $>$") and imitated the mechanical sound in the Motor Sound condition ("look at this $<$ $motor-likesound$ $>$"). In the Noisemaker condition the three kinds of sounds came from cloth-covered recorders that were held close to the toy animal being named. The distracter objects were always presented with the same phrases as the target objects, but without the name: "Look at this! Wow! See this? Look!"

In the Test phase the child was presented with two choices on a tray and asked to retrieve the target object. The test question was asked in the same manner as the naming in each condition – from the mouth in the Mouth condition and from the Noisemaker in the Noisemaker condition. There were four test trials for each kind of sound; two test trials used the same animals as the ones used in the Familiarization phase and the other two were generalization trials, using the animals that matched the familiar ones in all aspects except for their color. Each child got a total of 12 trials. The toys were randomly assigned to each condition for each child. The order of the two sound type conditions was counterbalanced.

Results

We coded children's choices as the first object they touched or took from the tray. Figures 3 and 4 show the number of children who successfully mapped the name to the object category in the Word, Animal Sound and Motor Sound conditions. We classified children as Successfully Mapping if they picked the target object when asked on three or more of the four trials.

Figure 3 shows children's performance. In the Word condition, most children (9 out of 12) successfully mapped the word to the animal category when the word came from the experimenter's mouth. The number of children that successfully mapped the word to the animal category in the Mouth condition was reliably more than would be expected by chance ($p < .01$). In contrast, the number of Successfully Mapping children in the Noisemaker condition was almost reliably below what would be expected by

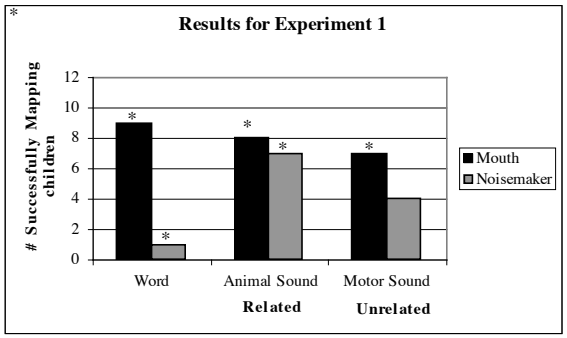

Figure 3: Results of Experiment 1. Any sound emanating from the mouth is taken as a name and animal sounds are taken as names regardless of its source

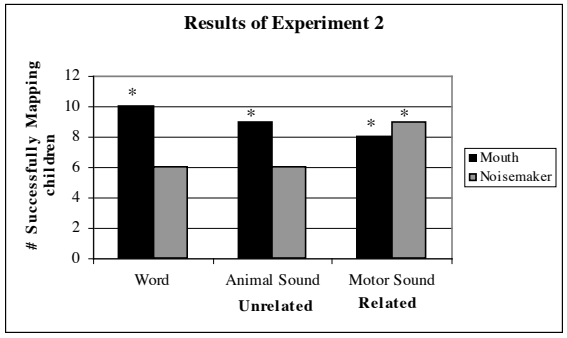

Figure 4: Results of Experiment 2. Any sound emanating from the mouth is taken as a name and motor sounds are taken as names regardless of its source

chance ($p = .06$). In fact, only one child consistently retrieved the target object when the name was a word coming from a handheld noisemaker. Thus, it appears that children *only* accept the word as the name of an animal category when the word emanates from the mouth of the experimenter.

In the Animal Sound condition, the number of the Successfully Mapping children exceeded what would be expected by chance in both source conditions (Mouth: $p = .01$, Noisemaker: $p = .03$). That is, children successfully mapped the animal sound to the animal category regardless of the source of the sound. They did so whether the sound came from the experimenter's mouth or from a handheld noisemaker. So, children always accept the animal sound as the name of an animal category, regardless of the source from which the animal sound emanates.

In the Motor Sound condition – when the sound used was an unrelated sound – the number of children successfully mapping the sound to the animal category only exceeded what would be expected by chance in the Mouth condition ($p < .05$). The number of children that successfully mapped the mechanical sound with the animal category when the sound came from the Noisemaker did not reliably exceed chance ($p > .2$). That is, motor sounds are only accepted as names when they emanate from a mouth.

In short, any sound emanating from the mouth is taken as a name and animal sounds are taken as names regardless of its source.

Discussion

Our results replicate Woodard and Hoyne's study: words emanating from mouths are associated with object categories and arbitrary sounds emanating from handheld noisemakers are not associated with object categories. In addition to that, however, we have shown two things. First, that words are only accepted as names when they come from the speaker's mouth, and not when they come from other sources, such as a hand-held noisemaker. Second, that even non-linguistic sounds, such as the buzz of a motor or the croak of a frog, will be taken as a name if they are produced by a human mouth. Therefore, our results suggest that for children at this age it is not words that are taken as the privileged form of naming, but rather sounds produced by a human mouth, that is, source matters.

One difference in our results between words and animal sounds is that the source of the name matters for the word, but not for the animal sound. This also fits with our associationist account: in children's experience, animal sounds are not specific to a source. They emanate from the mouths of real animals, from the inside of stuffed animal toys, and from mouths of people imitating animals. In contrast, words – as object names – are typically produced by human mouths. Therefore the source will be part of what defines a word as a name, but not of what defines an animal sound as a name for an animal category.

Why are sounds emanating from mouths always taken as names? According to our account, this is because emanating from a mouth is one of the most systematically correlating features of naming situations. Another possibility that needs to be explored is that perhaps when produced by a human mouth even an imitation of a mechanical sound stops being arbitrary. Being made by a mouth may make any sound word-like (or animal sound-like).

More importantly for our proposal, however, our results showed that animal sounds – which are systematically correlated with animal categories in the real world – will be accepted as labels for animal categories regardless of their source. Thus, our predictions were confirmed.

Why are animal sounds taken as names for animal categories? According to our proposal, this is because animal sounds correlate with animal categories in much the same way as words correlate with object categories in general: one animal sound corresponds to one animal category, and animals typically

are associated with a sound they make. However, an alternative explanation is that there is something in the acoustic features of the animal sound used that makes it word-like. That is, it may be that it is not the special way in which animal sounds correlate with animal categories which makes animal sounds good potential labels *for animal categories*, but that there is something about animal sounds (perhaps they are closer to linguistic sounds in some similarity space), that makes them good potential labels *for any category*. Conversely, it could be that motor sounds are just not word-like enough to serve as a label. Thus, to support our propsal we have to show that animal sounds are good *only* for animal categories (and not vehicle categories), and that motor sounds are good *only* for vehicle categories (and not animal categories). Accordingly, in the next experiment we test this alternative explanation by replicating Experiment 1 using toy vehicles instead of toy animals as stimuli.

We reasoned that vehicle sounds correlate with vehicle categories much in the same way as animal sounds correlate with animal categories. Thus, if our account is right, and it is the systematicity of correlations that makes a word, we predict that contrary to what was found in Experiment 1, the motor sound (now related) will be accepted as a name for toy vehicles, but the animal sound (now unrelated) will not. However, if it is something specific about the animal sound we used that made it work as a name, the same animal sound should be accepted as a name for vehicle categories as well.

Experiment 2

Subjects. 24 20-26 month-old children participated in the experiment.

Design. As in Experiment 1, we used a 2x3 mixed design with the two different sources (mouth, noisemaker) as a between-subject variable and the three different sounds (word, animal sound, motor sound) as a within-subject variable.

Stimuli. The stimuli consisted of two sets of six novel toy vehicles. We used the same sounds as in Experiment 1, that is the word "toma", a frog sound, and a motor sound.

Procedure. The procedure is the same as in Experiment 1.

Results

Children's choices were coded as in Experiment 1. Children were classified as Successfully Mapping according to the same criterion as in Experiment 1 – when they chose the target object correctly in at least 3 of the 4 trials. The results of Experiment 2 are analogous to the results of Experiment 1. Children map the motor sound to vehicle categories, but fail to map the animal sound – the unrelated sound.

Figure 4 shows children's performance in Experiment 2. In the Word condition, most children (10 out of 12) successfully mapped the word to the animal category when the word came from the experimenter's mouth. The number of children that successfully mapped the word to the animal category in the Mouth condition was reliably more than would be expected by chance ($p < .01$). In contrast, the number of Successfully Mapping children in the Noisemaker condition was not different from chance ($p > .2$). Thus, as in Experiment 1, children accept the word as the name of a vehicle category only when the word emanates from the mouth of the experimenter.

In the Animal Sound condition, when the sound used as name was a unrelated to the vehicle categories, the number of children successfully mapping the sound to the animal category only exceeded what would be expected by chance in the Mouth condition ($p < .05$). The number of children that successfully mapped the animal sound with the vehicle category when the sound came from the Noisemaker did not reliably exceed chance ($p > .2$). That is, animal sounds are only accepted as names for vehicle categories when they emanate from a mouth.

In the Motor Sound condition, when the sound was systematically related to vehicle categories, the number of the Successfully Mapping children exceeded what would be expected by chance in both conditions (Mouth: $p = .01$, Noisemaker: $p = .03$). That is, children successfully associated the motor sound to the vehicle category regardless of the source of the sound. So, children seem to accept the motor sound as the name of an vehicle category, regardless of the source from which the motor sound emanates.

In short, as in Experiment 1, any sound emanating from the mouth is taken as a name and related sounds (in this case motor sounds) are taken as names regardless of their source.

Discussion

In Experiment 1, the pattern of results could be explained away by suggesting that there was something special about the animal sound used in the experiment, or animal sounds in general, that made it more word-like. By using the same sounds as in Experiment 1, but showing the opposite pattern of results (Animal sound not taken as a label; Motor sound taken as a label), we showed this is not the case. Which non-linguistic sound will be more readily associated with an object category depends on the kind of object categories being associated: if the categories are from the domain of animals, then the animal sound will have the advantage; if the categories are from the domain of vehicles, then the motor sound will have the advantage.

Furthermore, Experiment 2 provided converging evidence from a different domain for the idea that systematically correlating cues become good candidates for label-hood. The results of this experiment agree with the results of Experiment 1. That is, children in Experiment 2, like children in Experiment 1, were likely to map the related non-linguistic sound to the object categories, but not the unrelated non-linguistic sound.

Conclusions

The results of the two experiments showed the same pattern: Words, as well as non-linguistic sounds that systematically correlate with the relevant domain of categories, are accepted as labels. In contrast, non-linguistic sounds that are unrelated to the domain in question are not accepted as labels. Furthermore, words are only accepted as labels when they are produced by a mouth. Why this pattern? We believe that this pattern reflects the systematicity with which events correlate with categories in the world. Sounds from mouths typically name things, so they are taken as names even when they have unusual properties such as the imitation of a mechanical sound does. Animal sounds systematically correlate with animal categories, so these kinds of sound – from mouths or from noisemakers – are accepted as names for animal categories. Analogously, motor sounds systematically correlate with vehicle categories, so these kinds of sound – regardless of their source – are accepted as names for vehicle categories.

Perhaps, before language learning, there is nothing special about words as names and there is nothing special about reference. All that a word is is a bundle of highly correlating features. All that reference is, is the association between a name –the bundle of highly correlating features – and a category. Maybe children learn what is reference as they learn names, and they learn names as they experience words referring to object categories.

With more learning, what counts as a name should get more and more abstract, to the point in which emanating from a mouth may no longer be a crucial feature. However, this may be where it starts; in the systematicity with which events, such as spoken words or animal sounds, refer to categories.

References

Imai, M. and Gentner, D. (1997). A cross-linguistic study of early word meaning: Universal ontology and linguistic influence. *Cognition*, 62:169–200.

Keil, F. C. (1989). *Concepts, kinds, and cognitive development*. MIT Press, Cambridge, MA.

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

Namy, L. L. and Waxman, S. R. (1998). Words and gestures: Infants' interpretations of different forms of symbolic reference. *Child Development*, 69:295–308.

Woodward, A. L. and Hoyne, K. L. (1999). Infants' learning about words and sounds in relation to objects. *Child Development*, 70:65–72.