The Relation of Similarity to Naming: Chinese versus American Conceptions of Bottles and Jars

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Abstract

We distinguish two forms of categorization: recognizing objects and choosing a name for them. Understanding the relation between similarity -- which we take to underlie recognition -- and naming is therefore fundamental. Two sources of complexity in naming are described that distinguish recognition from naming. We distinguish the tasks empirically by comparing linguistic category boundaries and perceived similarity for speakers of Chinese and English for sixty common containers. Although the two groups have different linguistic catgegory boundaries, their similarity judgments are largely convergent.

Introduction

Consider the object in Figure 1. Although you have not encountered that particular object before, it does not seem unfamiliar. Its familiarity is a result of the fact that you are perceiving it not as an isolated instance, but as a member of a category, a category that is highly familiar.

Figure 1. A typical bottle.

What does it mean to categorize? In the real world, at least two different acts are appropriately called categorization. First, people recognize objects as members of familiar categories and encode the objects in an internal representation system. Second, people connect objects with words, both in producing a name for an object and in understanding an object name used by someone else. The act of naming differs from the act of recognition in at least two critical ways. First, naming is part of a communication process, whereas recognition is not. Second, the act of naming requires that boundaries between categories be observed -- i.e., between those instances that are appropriately referred to by the name and those that are not, whereas recognition does not require observing boundaries.

Therefore, although we believe that naming and recognition are closely connected, we posit that names used for objects reflect influences that are independent of the process of internal representation. To test this distinction, we investigate whether the names that people acquire for objects influence their mental representations of those objects. To measure how people structure the representational space that supports recognition, we collected judgments of similarity and investigated the relation between naming and similarity judgments. If the Whorfian hypothesis (Whorf, 1956) that language influences thought holds true, then groups of people who use different name boundaries should show differences in their perception of similarity among the objects. In contrast, if we are correct that naming and recognition are separable, then groups with different name boundaries should nevertheless provide highly comparable similarity judgments.

Previous work using related tasks provides conflicting evidence regarding our hypothesis. Experiments distinguishing "categorization" from "similarity" suggest that, as we propose, systematic differences do obtain between naming and similarity. Rips (1989; Rips &

Collins, 1993) used simple verbal descriptions (e.g., a circular object with a diameter of 3.5 inches) to show that judgments of categorization (the object is judged, on average, more likely to be a pizza than a quarter) diverge from judgments of similarity (the object is judged, on average, more similar to a quarter than a pizza). Rips's experiments suggest that people are more likely to use a rule like "if an object is a quarter, then its diameter is not much greater than an inch" in the process of categorization than similarity judgment. However, his conclusion has only limited generality. Smith and Sloman (1994) have shown that Rips's results depend on both asking subjects to think aloud while responding (and therefore presumably justifying their responses) and on using sparse descriptions of objects. When richer descriptions of stimuli were used, Smith and Sloman's subjects were willing to violate Rips's rules.

Although we have sympathy with Rips's effort to distinguish two aspects of categorization, we believe that the distinction is not between categorization *per se* and similarity, but rather between naming and similarity. Rips's categorization task did not clearly distinguish between a judgment of naming and of *kind*. The question whether an object is more likely to be an X or a Y confounds the choice of the object's name with beliefs about rules for belonging to a kind.

In contrast with Rips's demonstrations, other work has demonstrated convergence between categorization and similarity. Work on categorical perception (reviewed by Repp, 1984) has shown that the ability to discriminate perceptual stimuli like phonemes and colors is tightly coupled to how those stimuli are categorized linguistically. Discrimination is better across than within linguistic boundaries. Learning of artificial categories can also affect the ability to discriminate. Goldstone (1994) found greater perceptual discriminability for items that were learned as members of contrasting categories. Moreover, a variety of work has shown that similarity judgments are sensitive to context, framing, and level of expertise in categorization tasks (e.g., Medin, Goldstone, & Gentner, 1993). In these senses, similarity judgments indeed vary with categorical knowledge. This conclusion is inconsistent with our hypothesis. However, none of this previous work has looked at the effects of naturally occurring linguistic categories on the perceived similarity of familiar objects. Such an investigation may produce results that dissociate linguistic categories and similarity, because familiar objects may acquire names that are only loosely related to intrinsic properties of objects such as appearance and function, as we discuss below.

Theoretical framework

Drawing on the distinction between linguistic and conceptual categories and on a variety of past research, we assume a simple working model of object recognition and naming that describes linguistic categories as associated with regions in similarity space. We then describe principles that account for further complexity in naming. We propose that

- objects can be represented as points in a multi-dimensional feature space;
- representations tend to form clusters in this space;
- recognition categories correspond to clusters of points. No fixed boundaries separate these clusters, so recognition categories are only implicitly defined;
- names are associated with object representations with varying degrees of strength;
- the strength of the name generally varies in proportion to the similarity of an object to other objects in a cluster;
- activating an object representation also activates associated names;
- naming an object consists of selecting among competing names. Because names are explicitly represented, the linguistic categories are explicit, although their boundaries will be fuzzy.

Categories and classification exist at two different levels on this view: Two objects are members of the same recognition category if they are represented within the same object cluster; and they are members of the same linguistic category if they are given the same name on a particular occasion.

The relation of recognition to naming

What does this view say about what linguistic categories will be like, and what their relation is to recognition categories? The framework implies that, in general, the probability that an object is called by a given name will reflect the centrality of the object in a cluster of objects associated with the name; that is, the centrality with respect to a recognition category. However, complexity in how names are chosen for objects can arise in several ways. Some sources of complexity fall directly out of the similarity relations amongst the objects, as a result of the exemplar-based model of naming (Medin & Schaffer, 1978). Other sources, in contrast, arise as a result of experience with names for an object and pressures from communicating about objects (e.g., Clark & Marshall, 1981). We illustrate one from each source.

Chaining

First, because similarity is exemplar-based, chains of objects sharing a name may come into existence (Lakoff, 1987), where the last exemplar in the chain is at a large distance from other objects in a cluster. For example, in Figure 2, the object T may share the name of the cluster of objects with prototype P1 because of a chain of intermediate objects, despite being closer to the cluster with prototype P2. If the feature space for objects that get called "bottle" encompasses objects like rectangular shampoo bottles and Mickey Mouse-shaped water bottles, why are the objects in Figure 3 called "plastic juice box" instead of "bottle"? The answer may be that they developed from, and are linked to, the more familiar cardboard juice box shown in Figure 4,

which itself was called a box by virtue of sharing the features of shape and cardboard material with other objects in the cluster of boxes. Presumably the plastic smurf in Figure 3 is a called a juice box because of an additional link in the chain. It developed from the plastic juice box that developed from the cardboard juice box.

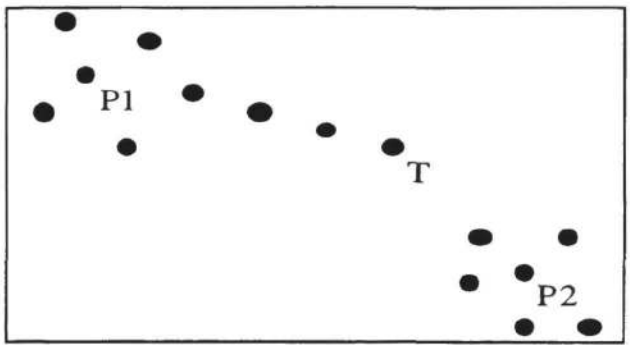

Figure 2. T might be given the same name as the cluster surrounding Prototype 1 (P1) despite being closer to the cluster around Prototype 2 (P2) because of the chain of exemplars linking T to the first cluster.

Figure 3. Juice boxes.

Figure 4. Prototypical juice box.

Convention

Another source of complexity in naming is ordinary experience. Being told that an object has a particular name can alter the strength of association of the name to the object, independent of the similarity of the object to other objects associated with the name. If the odd plastic objects in Figure 3 can be boxes, why is the rectangular cardboard object with a lid in Figure 5, which shares a lot of features with other objects that we would call "boxes", rarely called an ice cream "box", but instead an ice cream "carton" or "container"? Similarly, the other object in Figure 5 is rarely a Chinese food "box" but also a "carton" c "container." These names may well have no psychologica explanation other than convention. People recognize th place of these objects in feature space among objects that ge called boxes, but grew up hearing them called cartons and s call them cartons.

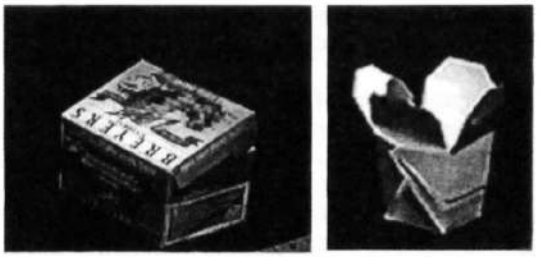

Figure 5. Carton and container, not boxes.

Motivation for these objects' names may have existed at one time. Perhaps ice cream "cartons" were not called "boxes" in order to distinguish them from other ice cream containers which were already known as "boxes." But any motivation that existed for the exclusion of these objects as boxes, or the inclusion of them as cartons, has been lost over time, and only the convention remains.

Experiment

Within this framework, the Whorfian question is whether a name, once it is acquired for an object, feeds back down to influence the perception of the similarity of that object to other objects in similarity space. So, for instance, once people learn to call the objects in Figure 3 "juice boxes", does that move them closer to other boxes in similarity space? Or does it just strengthen the name-object association while leaving the perception of similarity unchanged? Our assumption that linguistic and recognition categories are fundamentally different -- if related -- leads us to hypothesize the second of these possibilities.

To approach this issue, we examined the linguistic category memberships assigned to the same set of objects by two languages. Various examples indicate that the boundaries for linguistic categories may differ from language to language. For instance, in English, a large stuffed seat for one person is given the same name as a wooden chair, but in Chinese, it is given the same name as large stuffed seats for multiple people (things that in English would be called sofas; Gao, personal communication). So the boundary between "chair" and "sofa" as linguistic categories is not the same in Chinese as in English. Similarly, in English, paper and plastic drinking vessels are called by the same name as coffee cups (paper "cups" and plastic "cups"), but in Hebrew, they are called by the same name as things that English speakers would call "glasses" (Kronenfeld, Armstrong, & Wilmoth, 1985). So the boundary between the linguistic categories "cup" and "glass" is not the same in Hebrew as in English.

The question is whether people who have learned different linguistic category boundaries for a set of objects perceive the similarity among the objects differently. We collected

names and similarity judgments for a large set of objects, for speakers of Chinese and of English. We recognize that similarity judgments do not measure a stable, absolute relation between object representations that holds in all contexts (Medin et al., 1993). Nevertheless, they provide a fairly reliable indication of how people conceive of the relations between objects in a context almost identical to that in which the naming judgments were collected.

We can ask three specific questions:

- Does the division of objects into linguistic categories differ between the two languages for this set of objects?
- Does the perception of similarity among the objects differ between speakers of the two languages?
- If at least some differences in linguistic categorization and in perceived similarity are found, then where category membership differs between the two languages, are those differences paralleled by differences in the perceived similarity among the objects?

Method

Materials

The stimuli were a set of 60 common containers that were a mixture of objects likely to be called "bottle" or "jar" in English, along with some additional ones not likely to be called either bottle or jar but sharing one or more salient properties with bottles and jars. Figure 6 displays black-and-white images of some of the objects. These images were taken from the color photographs used in the experiment.

Figure 6. Black-and-white images of the color photographs used in the experiment.

Subjects

Seventy-five English-speaking Lehigh University students and 50 Chinese-speaking students, 10 from Lehigh and 40 from Shanghai University, carried out the tasks described here along with several related ones that will not be described.

Procedure

Forty-nine of the English-speaking group and 33 of the Chinese-speaking group made similarity judgments by sorting the objects into piles. They were told "I would like you to put into piles all the containers that you think are very similar to each other overall." They were asked to focus on all the aspects of the containers themselves, not on the substances they contained. The remaining subjects gave other types of judgments that will not be discussed here. In a subsequent phase, 28 of the English-speaking students and all 50 of the Chinese students were shown the pictures in a different random order and gave a name for each object.

The names were tallied for each object (separately for English and Chinese), and the most commonly given name was taken to indicate the object's linguistic category membership. The sorting data were used to derive a measure of the similarity between each pair of objects. Pairwise similarity was determined by counting the number of times that a pair of objects was placed in the same pile across subjects (again, separately for American and Chinese subjects). Objects that were put into the same pile by a large number of subjects will be considered highly similar, and objects that were rarely or never put into the same pile will be considered low in similarity. This method for obtaining similarity judgments for large objects sets has been widely used (Rosenberg & Kim, 1975).

Results and Discussion

Now we can evaluate the answers to the three questions stated above. First, do speakers of English and speakers of Chinese divide the objects into linguistic categories differently? The answer is that they do, as shown in Table 1. For American students, the objects fell into three main categories: "jar", "bottle", and "container", that were roughly equal in size, with a few objects being given other names. For Chinese students, most of the objects fell into one large category that encompassed all the English jars, most of the English bottles, and some of the English containers. The remainder were distributed across four other categories. Clearly, the division of objects into linguistic categories differs between the two languages.

Next, we ask to what extent the perception of similarity among the objects is the same or different. A Chi-square test comparing the American and Chinese similarity matrices did not show a significant difference overall, $\chi^2(1769) = 48.67$, n.s., and the correlation of the similarity values in the two matrices was .90, which is highly significant ($p < .0001$).

Thus, a strong correspondence was observed in the perceived pairwise similarity of the objects by speakers of Chinese and of English despite the substantial difference in linguistic categorization. This correspondence suggests that differences between Chinese and English object names do not have a substantial effect on perceived similarity for these objects.

Table 1: English linguistic categories: Category name and number of objects given that name. Chinese linguistic categories: Description of category in terms of English names and number of objects given the corresponding Chinese name.

English Linguistic Categories	N	Chinese Linguistic Categories	N
A. Jar	19	A. 13 bottles, 8 containers, 19 jars	40
B. Bottle	16	B. 3 containers, 2 bottles, 5 cans	10
C. Container	15	C. 3 jug, 1 bottle, 1 container	5
D. Can	5	D. 3 containers, 1 box	4
E. Jug	3	E. 1 tube	1
F. Tube	1		
G. Box	1		

However, the correspondence is not perfect, so we can look at the extent to which differences in categorization of particular objects are paralleled by differences in perceived similarity. We looked at each of the 1770 possible pairs of objects and determined whether the two objects were put into the same linguistic category or in different ones by each language. This yields a 2 x 2 classification of the pairs. For some pairs, the two objects are in the same category in both English and Chinese; for some, the two are in different categories in both English and Chinese. For the remaining pairs, the two objects fall into the same category in Chinese but into different categories in English, or vice versa.

The two same/different cells are the most critical for our analysis. If naming influences perceived similarity, then in those cells where the two languages disagree about whether the objects belong in the same linguistic category, there should be a discrepancy in similarity between speakers of the two languages (illustrated in Table 2): Speakers of the language that put them into the same category should see them as more similar than speakers of the language that put them into different categories. The English speakers should see them as more similar than the Chinese speakers do when English puts them in the same category and Chinese into different categories, and the opposite prediction holds when Chinese considers them the same but English does not. In other words, if similarity judgments are closely tied to linguistic categories, we should find a 3-way interaction in the similarity judgments between Chinese classification, English classification, and the group making the similarity judgment (Chinese vs. American students). We test this interaction using an analysis of variance with one between-subjects variable (Group: Chinese versus American) and two within-subjects variables (same versus different name in Chinese and same verus different name in English).

Table 2: Predictions for relative similarity judgments if perceived similarity depends on linguistic category membership.

	Chinese	
English	Same Category	Different Category
Same Category	American: high Chinese: high	American: high Chinese: low
Different Category	American: low Chinese: high	American: low Chinese: low

Table 3 presents the mean similarity judgments for objects of each of the four types. The Chinese same/English same cell is represented by 297 pairs of objects, the English same/Chinese different cell by 112, the Chinese same/English different by 544, and the remaining Chinese different/English different cell by 817. Clearly, similarity and naming have a general correspondence: Object pairs that belong to the same category in both languages are perceived as highly similar by speakers of both languages, and pairs where the two objects belong to different categories in both languages are perceived as not very similar by speakers of both languages. This result is supported by a strong interaction between English and Chinese name classification, $F(1,240) = 123.7$; $p < .0001$. (MSe for this and all subsequent analyses that include a within-subjects variable was .0090.) In other words, pairs named in the same linguistic category by both groups were seen as highly similar by both groups. But this observation does not indicate that use of a name determines similarity judgments because similarity is clearly higher when both languages give the pairs a common name than when only one language does. A plausible interpretation of the data in Table 3 is just the opposite: Objects in the same-same condition may be put into the same category by everybody because of high *a priori* perceived similarity.

Table 3: Mean similarity judgments as a function of language of subject and sameness of linguistic category membership.

	Chinese	
English	Same Category	Different Category
Same Category	American: .46 Chinese: .49	American: .17 Chinese: .15
Different Category	American: .13 Chinese: .20	American: .08 Chinese: .09

Although the means show a tendency in the direction of the reversal between the two cells that would indicate a parallel between similarity and naming, the critical test is the three-way interaction that lets us evaluate directly whether perception of similarity follows naming when the two languages disagree. It is far from significant, $F < 1$, despite the great power in this experiment arising from the 1770 pairs of items that went into it. So we conclude that

naming may have some effect, but not a large one, on the perception of similarity, and that the two are at least to some extent independent.

The remaining results from the anaylysis of variance showed that the effect of group was not significant, $F(1,80) = 1.12$; $MSe = .044$; n.s., although the effects of sameness of category were highly significant for both Chinese, $F(1,240) = 336.0$, and English, $F(1,240) = 355.5$; both p's $< .0001$. Group interacted to some extent with sameness of category with respect both to Chinese, $F(1,240) = 7.20$; $p < .01$, and English, $F(1,240) = 2.87$; $p < .10$. These interactions indicate that classification according to each language was a slightly better predictor of differences for the group whose native tongue was that language than for the other group. In general, these results provide little support for the claim that naming and similarity closely correspond.

Conclusion

Our data come from only a single domain (containers) and two languages (English and Chinese). Hence, our conclusions are necessarily tentative. What they suggest is that names learned for objects do not exert a strong influence on the shape of conceptual similarity space or on object locations in that space. Learning to call the blue smurf a "juice box" may make that object a member of the linguistic category "box" without making it seem more similar to rectangular things made of cardboard. In that sense, it may not be thought of as a box even though it is called a "box."

We do not mean to suggest that names never influence how people think about objects. Stavy and Wax (1989) found that Israeli children as old as 12-15 years often fail to report that plants are living things, an error rarely made by American children of the same age. Stavy and Wax attribute the difference in error rate to linguistic differences: in Hebrew the word for "animal" is very close to the word for "life" but the word for "plant" is not, whereas in English they are equally unrelated. In cases such as this, a semantic cue in the category name may provide (possibly misleading) information about the nature of the category members.

In any event, the results reported here support our contention that recognition categories and linguistic categories are separate entities. They are clearly linked – linguistic categories tend to mirror recognition categories – yet linguistic categories are nevertheless subject to certain influences that recognition categories are not. Thus, object recognition and naming are related, yet distinct. Recognizing the distinction makes thinking about categorization more complicated, but ultimately we hope it will bring some order to the wide variety of conflicting evidence that exists about the nature of categorization.

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