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# Labeling Bias and Categorical Induction: Generative Aspects of Category Information

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When a person is characterized categorically with a label (e.g., *Linda is a feminist*), people tend to think that the attributes associated with that person are central and long lasting (S. Gelman & G. D. Heyman, 1999). This bias, which is related to category-based induction and stereotyping, has been thought to arise because a category label (e.g., *feminist*) activates the dominant properties associated with the representation of the category. This explanation implies that categorical information influences inferential processes mainly by conjuring up main attributes or instances represented in the category. However, the present experiments reveal that this attribute-based explanation of induction does not provide a complete picture of inferential processes. The results from 3 experiments suggest that category information can affect inferences of attributes that are not directly related to the category, suggesting that categories not only activate likely attributes but also help integrate unlikely or even unrelated attributes.

One of the core purposes of categories is to integrate information and apply it to future predictions (Anderson, 1990; Rosch, 1978; E. E. Smith, 1994). For example, one forms the category "liberal" by classifying people who have similar political opinions and then uses the category to make an inference, such as predicting the policy that a member of the category advocates. In this regard, categories help bind information and serve as a medium for inferences.

How do categories integrate diverse information and license inductive inferences? Main psychological accounts of inductive judgments suggest that two factors—(a) matching attributes between entities and (b) the coverage of premises over a conclusion (hereafter I call these two factors *attribute-based similarity*)—are the guiding forces of inferences (see Heit, 2000, for a review; Kunda & Thagard, 1996; Osherson, Smith, Wilkie, Lopez, & Shafir, 1990; Osherson, Stern, Wilke, Stob, & Smith, 1991; Rips, 1975; Sloman, 1993; E. R. Smith & Zarate, 1992; Tversky, 1977). According to this view, for example, the conclusion *Lions have Disease X*, given a premise, *Zebras have Disease X*, is credible proportional to the extent to which the two entities—zebras and lions—have features in common and the magnitude of an entity in a premise (i.e., zebras) exceeds that of a conclusion (lions; i.e., coverage).

This similarity-based account of categorical induction has inspired many areas of cognitive psychology and social cognition and has yielded a rich array of empirical findings that illuminate the relationship between feature-based similarity and category membership (Heit & Rubinstein, 1994; Lassaline, 1996; Lassaline & Murphy, 1996; Murphy & Ross, 1994; Osherson et al., 1990; Osherson et al., 1991; Rips, 1975; Sloman, 1993). In the field of judgment and decision making, researchers have also emphasized the dominance of similarity information (e.g., representative heuristics; Kahneman & Tversky, 1973; Shafir, Smith, & Osherson, 1990; Tversky & Kahneman, 1983). The same focus has been prevalent in stereotyping and impression-formation research (Allport, 1954; Duckitt, 1992; Hamilton & Sherman, 1994; Kashima, Woolcock, & Kashima, 2000; Kunda & Thagard, 1996; Stangor, 2000).

The main assumption underlying the similarity-based account is that categories are "containers" that record features of items contained in categories. In this view, a category is represented by a vector that stores a cluster of fixed features, exemplars, a summary of features, a summary of representative exemplars, or some combination of these (Anderson, 1990; Kruschke, 1992; Medin & Schaffer, 1978; Nosofsky, 1986; Reed, 1972). This type of representation has been developed to account for people's ability to classify items into categories. However, a growing number of studies have shown that the relationship between categories and feature-based similarity is far more dynamic (Ross, 1997, 1999; Schyns, Goldstone, & Thibaut, 1997; Schyns & Rodet, 1997; Wisniewski & Medin, 1994). Attributes of a category are rarely fixed (Medin, Goldstone, & Gentner, 1993; Murphy & Medin, 1985). They spawn opportunistically according to the way people interact with a category (Schyns, Goldstone, & Thibaut, 1997; Schyns & Rodet, 1997). The background knowledge, intentions, and goals of an observer often define attributes of entities (Medin, Lynch, & Coley, 1997; Ross & Murphy, 1999; Tversky, 1977; see also Goldstone, 1994b). Rather than being a container, a category's main purpose can be viewed as an integrator of information (Anderson, 1990; Murphy & Medin, 1985; Rosch, 1978; E. E. Smith, 1994). A category elicits assumptions, theories, and beliefs of an observer, and in turn the observer generates and integrates features to accommodate his or her own beliefs about the category (Gelman, Coley, & Gottfried, 1994; Medin & Ortony, 1989; Mur-

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phy & Medin, 1985; Schyns et al., 1997; Wisniewski & Medin, 1994). However, major theories of categorical induction have paid little attention to this generative aspect of category information.

The objectives of this article are twofold: (a) to demonstrate that categorical information affects inductive judgments above and beyond attribute-based similarity and (b) to highlight the significance of an integrative influence of category information. I formulated my working hypothesis from the assumptions that categories are more than just a collection of underlying features and instances and that categories are formed to integrate diverse information.

The rest of this article is organized as follows. The term *categorical induction task* is defined, and two dominant types of categorical induction tasks are illustrated. Sloman's (1993) influential computational model is described; this is followed by an explanation of how the model uses attribute-based similarity to account for inferential processes. Finally, three experiments that contradict the similarity-based account of induction are introduced. The Sloman model was chosen in this study because of its explanatory strength. Compared to other models (e.g., Osherson et al., 1990), the Sloman model uses fewer assumptions; it delineates the format of representation of individual concepts clearly; and the model is compatible with other similarity-based models, such as those proposed by Osherson et al. (1990), E. R. Smith and Zarate (1992), and Kashima et al. (2000).

## Definition and Two Types of Categorical Induction Tasks

In the field of cognitive psychology, researchers have used the term *category-based induction* primarily for inductive arguments, in which premises and a conclusion are categorically related and both have an identical property. In a typical task, participants are given premises, such as *All grizzly bears have Disease X* and *All polar bears have Disease X*, and participants judge the strength of a conclusion such as *All bears have Disease X* (Heit, 2000; Heit & Rubinstein, 1994; Medin, Coley, Storms, & Hayes, 2003; Osherson et al., 1990; Osherson et al., 1991; Rips, 1975; Sloman, 1993).

In this article, I use the term *categorical induction* to include a wide range of research that investigates the relationship between categorical information and inductive judgments in general. These studies include research in inductive reasoning (Heit, 2000; Murphy & Ross, 1994; Ross & Murphy, 1996; Shafir et al., 1990; Tversky & Kahneman, 1983; Yamauchi & Markman, 2000), stereotyping, and impression formation (Bodenhausen, 1990; Dovidio & Gaertner, 2000; Fiske, 1998; Kunda, Miller, & Claire, 1990; Kunda & Oleson, 1995). A great deal of research has investigated people's ability to classify items into a group (Medin & Schaffer, 1978; Posner & Keele, 1968, 1970). I do not include these studies in my definition of *categorical induction*.

Two basic types of categorical induction tasks are summarized in Table 1. These tasks generally involve assessment of the strength of a conclusion on the basis of known premises or facts. One type of task, which I call the *category-extension type*, is commonly known as the category-based induction task. In this type of task, items described in premises and an item in a conclusion are often categorically related, and premises and conclusions are stated explicitly with verbal predicates. The task of participants is to assess the likelihood that a different item in a conclusion can have the same attribute as items in premises. The categories used in these tasks are almost exclusively natural categories, such as animals and plants (Coley, Medin, & Atran, 1997; Heit, 2000; Heit & Rubinstein, 1994; Medin et al., 2003; Osherson et al., 1990; Osherson et al., 1991; Rips, 1975; Sloman, 1993; but see Sloman, 1998, for an exception).

Table 1
*Premise–Conclusion Relationships of Two Types of Inductive Judgment Tasks*

| Stimuli | Category-extension type | Attribute-extension type |
|---|---|---|
| Premise 1 | Item A has attribute x | Item A has attribute x |
| Premise 2 | Item B has attribute x | Item A has attribute y |
| Conclusion | Item C has attribute x? | Item A has attribute z? |

*Note.* Category-extension type tasks have been primarily used for category-based induction studies. Attribute-extension type tasks have been used primarily for probability judgment and impression formation studies. The two types of tasks are analogous. In the category-extension type task, participants predict the likelihood that a different item can have a fixed attribute. In the attribute-extension type task, participants predict the likelihood that a fixed item can have a different attribute.

Another type, which I call the *attribute-extension type*, has been adopted in the field of probability judgment and impression-formation research (Bodenhausen, 1990; Gelman & Heyman, 1999; Kashima et al., 2000; Kunda et al., 1990; Kunda & Oleson, 1995; Kunda & Thagard, 1996; Shafir et al., 1990; Tversky & Kahneman, 1983). The most well-known task is the so-called "Linda problem" introduced by Tversky and Kahneman (1983). In this task, participants are given a premise, such as *Linda is a feminist*, and judge the likelihood of attributes associated with the same person (e.g., *Linda majored in philosophy in college*). The attribute-extension type task is different from the category-extension type task because premises and a conclusion in this task involve a single item, and the task is to assess the likelihood that the same item has a different attribute. Notice that category-extension tasks and attribute-extension tasks are analogous. In category-extension tasks, the target attribute is fixed while the items in premises and the item in a conclusion vary. In attribute-extension tasks, the item is fixed while the attributes of the item vary (see Table 1).[1] Although these two types of tasks are different in specifics, they investigate the relationship between categorical information and inductive inferences. In this article, I use attribute-extension tasks and explore an integrative aspect of categorical induction by investigating the notion that category information affects inferential judgments separately from attribute-based similarity.

In the next subsection I describe Sloman's (1993) influential computational model. The Sloman model is a quintessential similarity-based model. It uses exclusively attribute-based similarity to account for inferential processes. The model was developed to account for category-extension tasks; however, it can be ad-

[1] There are other tasks that investigate the relationship between category information and inductive judgments with visual stimuli (e.g., Gelman & Markman, 1986; Goldstone, 1994a, 1995; Murphy & Ross, 1994; Tajfel, 1970; Tajfel & Wilkes, 1963; Wisniewski & Medin, 1994). A similar examination was introduced elsewhere (Yamauchi & Markman, 2000), so this article focuses on the aforementioned two tasks.

justed to attribute-extension tasks with some extra assumptions. I use Sloman's model to highlight predictions from similarity-based accounts of categorical induction.

## Sloman's (1993) Feature-Based Computational Model for Inferential Judgments

Rips (1975), Osherson et al. (1990), and Sloman (1993) have addressed category-extension type tasks. All have suggested two important factors for categorical induction: (a) similarity (or relatedness) between items in premises and an item in a conclusion and (b) the coverage of premises over a conclusion.[2] I illustrate these two points with Sloman's (1993) feature-based induction model, because it provides simple yet elegant explanations for most of the psychological phenomena examined by Osherson et al. (1990).[3] According to the Sloman model, the strength of a conclusion, such as *Lions have Disease X*, given a premise, *Zebras have Disease X*, is expressed in Equation 1:

$$a_x(C|P_1) = \frac{F(P_1) \cdot F(C)}{|F(C)|^2} \tag{1}$$

in which $a_x(C|P_1)$ stands for the strength of conclusion $C$, given premise $P_1$. $F(P_1)$ is the vector representing an item in premise $P_1$ (i.e., zebras), and $F(C)$ is the vector representing an item in the conclusion $C$ (i.e., lions). Each element of these vectors stands for a feature value of the corresponding item (e.g., having four legs). $F(P_1) \cdot F(C)$ is the dot product of the two vectors, and $|F(C)|$ is the magnitude of the vector, which is defined respectively in Equations 2 and 3:

$$U \cdot V = \sum_{i=1}^{n} u_i v_i \tag{2}$$

$$|\mathrm{U}| = \sqrt{\sum_{i=1}^{n} u_i^2} \tag{3}$$

In Equation 2, $U$ and $V$ stand for vectors, and $u_i$ and $v_i$ are individual elements of each vector. In the Sloman model, the similarity between items is defined with Equation 4:

$$\mathrm{sim}(P_1,C) = \frac{F(P_1) \cdot F(C)}{|F(P_1)||F(C)|} \tag{4}$$

Substituting Equation 4 into Equation 1 will yield:

$$a_x(C|\mathrm{P}_1) = \frac{F(P_1) \cdot F(C)}{|F(C)|^2} = \frac{|F(P_1)|[F(P_1) \cdot F(C)]}{|F(P_1)||F(C)||F(C)|} = \frac{|F(P_1)|}{|F(C)|}\,\mathrm{sim}(P_1,C) \tag{5}$$

As Equation 5 makes clear, this model states that the strength of a conclusion given a premise is proportional to the similarity between an item in a premise and an item in a conclusion and the coverage of the vector representing a premise over that of a conclusion. In this model, the influence of categorical information is incorporated by the relative magnitudes of vectors in premises and in a conclusion. For example, Argument A, which is shown below, is stronger than Argument B, because a vector representing *animals* is more inclusive than a vector representing *zebras*.

Argument A:

($P_1$) Animals have Disease X.

(C) Zebras have Disease X.

Argument B:

($P_1'$) Zebras have Disease X.

(C) Animals have Disease X.

Sloman's (1993) model can be applied to attribute-extension type tasks by assuming that events, episodes, and predicates are represented by a feature vector in a manner similar to the one used in category-extension type tasks. For example, the strength of a conclusion *Linda majored in philosophy in college* given a premise *Linda is a feminist* can be judged by evaluating feature vectors associated with the two predicates (see Osherson, Smith, Shafir, Gualtierotti, & Biolsi, 1995, for a similar approach). In this case, the predicate *is a feminist* can be represented by a vector that lists the values of individual features (e.g., [smart, active, conservative, enjoys sports, has an advanced degree . . .]$^T$ = [1, 1, −1, 0, 1 . . .]$^T$). Similarly, the predicate *majored in philosophy* can be represented by a vector that lists the values of individual features (e.g., [smart, active, conservative, enjoys sports, has an advanced degree . . .]$^T$ = [1, 0, −1, 0, 0 . . .]$^T$). The strength of a conclusion can be assessed by comparing the overlap between the two vectors as suggested in Sloman's (1993) model (but see also Sloman, 1994, 1997, for another approach to evaluate predicate induction).[4] There are several other models that have been developed in social cognition research (Kunda & Thagard, 1996; E. R. Smith & Zarate, 1992). These models are essentially analogous to Sloman's (1993) model.

## Overview of Experiments and the Generative Aspect of Category Information

Three experiments described in this article use variants of the "Linda problem" (Tversky & Kahneman, 1983) and contrast two types of inferential arguments: one that contains categorical information and another that does not contain categorical information. Research has shown that explicit reference to category information bolsters the assessment of an attribute that is crucial to category membership (Gelman & Heyman, 1999; Gelman & Markman, 1986; Goldstone, 1994a, 1995; Wisniewski & Medin, 1994). For

[2] Osherson et al. (1990) characterized this factor as the degree to which the premise resembles and spans "the lowest-level category which includes both the premise and conclusion categories" (p. 190).

[3] Smith, Osherson, and colleagues (Osherson et al., 1995; E. E. Smith, Shafir, & Osherson, 1993) have proposed the *gap model*, which incorporates the plausibility of a premise.

[4] The modification introduced to Sloman's (1993) model in this study assumes that the strength of a conclusion-predicate is determined by the number of overlapping features between a premise-predicate and a conclusion-predicate. Alternatively, Sloman (1994, 1997) has suggested that explanatory coherence between a premise-predicate and a conclusion-predicate plays a significant role in determining the inductive strength of an argument.

example, Gelman and Heyman (1999) showed that when a person is characterized categorically (e.g., *Rose is a carrot-eater*) as opposed to descriptively, without specific reference to a category label (e.g., *Rose eats a lot of carrots whenever she can*), children age 5 to 7 think that the properties associated with the category remain stable across different circumstances. For example, children think that an attribute associated with the person (e.g., *eats a lot of carrots*) will stay in the future, was present in the past, and remains unchanged even when other people try to change it. In this study I used the experimental setting developed by Gelman and Heyman and examined whether category information, which is stated with an explicit categorical statement, influences inductive judgments above and beyond underlying attribute-based similarity (i.e., the number of shared features and the coverage of a premise).

Unlike Gelman and Heyman's (1999) study, participants in this study estimated the likelihood of both likely attributes, which are directly related to the category, and unlikely attributes, which are unrelated to the category. For example, given a premise, *Linda is a feminist*, participants estimated the likelihood of a likely attribute—*Linda majored in philosophy*—and an unlikely attribute: *Linda works as a bank teller*. Because unlikely attributes have no clear associations with the category (e.g., feminist), I assumed that elevated estimations of the likelihood of unlikely attributes will attest to integrative applications of category information. Category information, whether it is denoted by labels or indicated by a cluster of items, conjures up an intuitive theory and assumption about the category in general (Gelman et al., 1994; Medin & Ortony, 1989; Murphy & Medin, 1985). The observer integrates unlikely attributes with his or her intuitive notion of what the category is in order to justify his or her belief about the category. As a result, enhanced estimations of the likelihood of unlikely attributes would arise. Wisniewiski and Medin (1994) documented such a generative aspect of categories. In their seminal studies, they showed that the presence of specific labels modifies the way people perceive children's drawings. When drawings were labeled as "drawn by children in Group 1/Group 2," participants focused on surface features, such as *have straight arms, more pockets*. When the same drawings were labeled as "drawn by creative/noncreative children," participants focused on abstract features that were consistent with the intuitive norm of the category and supportive features that help justify their intuitive belief (e.g., *these drawings have more details . . . things like buttons, pockets*). In this manner, the presence of concrete categorical information is likely to lead people to seek evidence to justify their own initial knowledge about a category.

## Experiment 1

The stimulus materials of Experiment 1 were descriptions of hypothetical people. In one condition (categorical condition), each person was characterized categorically (e.g., *Linda is a feminist*), and in the other condition (descriptive condition) each person was characterized descriptively, without any labels (e.g., *Linda believes in and supports feminism*). Given each stimulus description, participants were asked to judge the likelihood of attributes associated with each person. There were four attribute questions in each stimulus. Two questions were concerned with the attributes that can be easily derived from the category (i.e., likely attributes, e.g., *watches presidential debates* given the category *feminist*), one question was about an attribute that was not easy to infer from the category (i.e., unlikely attributes, e.g., *works as a bank teller* given the category *feminist*), and the other question was a conjunction of one likely attribute and one unlikely attribute. The conjunction question was included in this experiment to collect pilot information for other unrelated studies. Therefore, the results from the conjunction questions are not discussed further. The main goal of this study was to examine whether the presence of categorical information would enhance the estimation of both likely and unlikely attributes (i.e., labeling effect).

### Method

*Participants.* A total of 100 undergraduate students participated in this experiment for course credit. These participants were randomly assigned to either the categorical condition ($n = 52$) or the descriptive condition ($n = 48$).

*Materials.* The stimulus materials of Experiment 1 were 15 person-statements shown in a booklet (see Appendix A for samples). These person-statements were based on some form of personal categories, such as occupations (a truck driver, an aerobics instructor, an art collector), characteristics (an overachiever, a competitor, a feminist, a liberal, a party animal), status (a millionaire, a high school dropout, a drug addict), hobbies (a stamp collector, an amateur poet), and national or cultural origins (a Korean, a New Yorker). Each person-statement, which was accompanied by four attribute questions, was characterized either categorically or descriptively in two conditions. Among the four attributes, two were concerned with major characteristics of the category (i.e., likely attributes, *Linda likes to watch presidential debates*), one was about an attribute that was highly unlikely to be in that category (i.e., unlikely attribute, *Linda works as a bank teller*), and the remaining statement was a conjunction of a likely attribute and an unlikely attribute (*Linda likes to watch presidential debates* and *works as a bank teller*). The order of presenting these four attribute questions was determined randomly for each person-statement. These stimulus materials were based on the materials used in the conjunction fallacy studies conducted by Tversky and Kahneman (1983) and Shafir et al. (1990).

A pilot study with 201 college students indicated that the categorical information stated in the stimuli in the categorical condition can be readily inferred from the descriptive statements used in the stimuli in the descriptive condition. After reading the same descriptive statements given in the descriptive condition, participants in the pilot study estimated the likelihood that the target person belonged to the target category on a 0–100 scale (a score of 100 was given if the likelihood that the person belonged to the category was 100%). In this pilot study, participants endorsed the categorical statements with estimation scores of 100 in more than 76% of the cases, and the overall average estimation score was 95.8. For individual stimuli, all average estimation scores given to the 15 stimuli exceeded 91.0. In 11 out of the 15 stimuli, average estimation scores exceeded 95.0. Thus, the two types of statements literally purported the same categorical information. In the same setting, these participants clearly distinguished likely and unlikely attributes. The average estimation score given to the likely attributes was 61.5, and the average estimation score given to the unlikely attributes was 15.1, $t(200) > 100$, $p < .01$. This pilot study suggests that participants were able to predict categorical information from the statements given in the descriptive conditions, and they were also able to distinguish likely and unlikely attributes introduced in this experiment.

*Procedure.* The participants' task was to estimate the likelihood of possible attributes on a 0–100 scale. Participants were tested in groups of 10 to 15 people. The task was self-paced.

*Design.* The design of Experiment 1 was a 2 (labeling: categorical vs. descriptive conditions, between-subjects factor) × 2 (attribute type: likely vs. unlikely, within-subjects factor) factorial. The dependent measure was the participants' estimation scores, which were indicated on a 0–100 scale.

Attribute estimations made to two likely attributes were combined and analyzed together. In this study, and throughout the experiments described in this article, both subject-based and item-based analyses were performed.

## *Results and Discussion*

The main results of Experiment 1 are summarized in Table 2. The results were consistent with the idea that category information elevates participants' estimations for both likely and unlikely attributes. A subject-based analysis of variance revealed a main effect of labeling: Participants in the categorical condition produced significantly higher estimation scores than participants in the descriptive condition, $F(1, 98) = 5.09$, $MSE = 140.1$, $p < .05$, $\eta^2 = 0.049$. There was no interaction between labeling and attribute type, $F(1, 98) < 1.0$, $MSE = 117.5$, $p > .10$, $\eta^2 = 0.004$, suggesting that the impact of labeling was not limited to the likely attributes. There was a strong main effect of attribute type: Participants in the two conditions provided significantly higher estimation scores for likely attributes than for unlikely attributes, $F(1, 98) = 961.3$, $MSE = 117.5$, $p < .001$, $\eta^2 = 0.907$.

The subject-based analysis is useful for making statistical inferences pertinent to a population of participants. However, this analysis is not sufficient to generalize over the population of participants and items simultaneously (Clark, 1973). For this reason, I estimated the minimum value of the quasi $F$ ratio after following the procedure suggested by Clark (1973, p. 347; see also Winer, Brown, & Michels, 1991). The minimum quasi $F$ ratio (i.e., min $F'$) is derived from a subject-based $F$ ratio and an item-based $F$ ratio and measures the extent to which the effect of an independent variable can be generalized to a population of the participants and a population of the items simultaneously. This analysis indicated that there was a significant impact of labeling, min $F'(1, 112) = 4.44$, $MSE = 39.9$, $p < .05$, and the attribute type, min $F'(1, 98) = 214.8$, $MSE = 1{,}237.9$, $p < .001$. The interaction between labeling and attribute type did not reach a significant level, min $F'(1, 98) < 1$.

Table 2
*Average Estimation Scores in Experiment 1*

| Categories | Likely attributes: Categorical | Likely attributes: Descriptive | Unlikely attributes: Categorical | Unlikely attributes: Descriptive |
|---|---|---|---|---|
| feminist | 65.05 | 64.35 | 30.10 | 27.50 |
| truck driver | 65.04 | 50.11 | 19.13 | 15.58 |
| avid art collector | 51.30 | 49.93 | 9.35 | 8.98 |
| fierce competitor | 74.13 | 70.83 | 20.87 | 13.96 |
| avid stamp collector | 56.62 | 53.23 | 19.73 | 18.71 |
| aerobics instructor | 77.98 | 71.85 | 7.96 | 7.90 |
| amateur poet | 69.88 | 59.43 | 32.37 | 27.60 |
| Korean | 68.84 | 65.36 | 27.17 | 22.94 |
| New Yorker | 60.84 | 55.05 | 18.73 | 14.81 |
| outspoken liberal | 69.02 | 71.45 | 24.06 | 21.46 |
| typical over-achiever | 66.25 | 62.78 | 16.10 | 14.52 |
| high-school drop-out | 67.96 | 58.95 | 13.65 | 13.44 |
| party animal | 69.20 | 65.14 | 27.73 | 21.42 |
| millionaire | 76.16 | 68.13 | 6.69 | 6.29 |
| drug addict | 79.95 | 79.88 | 16.08 | 12.94 |
| Average | 67.88 | 63.10 | 19.31 | 16.54 |

*Note.* The average estimation scores were calculated over individual participants.

The pilot study showed that the categorical statements could be readily inferred from the descriptive statements, but they were not completely equivalent. For example, the average estimation score of endorsing categorical statements given the corresponding descriptive statements was 95.8 rather than the perfect score of 100. This subtle disparity between the two types of statements might have contributed to the labeling effect. To counter this explanation, an analysis of covariance was applied across individual items. In this analysis, attribute type (likely vs. unlikely) was treated as a repeated measure variable, and labeling condition (categorical vs. descriptive) was treated as a nonrepeated measure variable. The estimation scores obtained in the pilot study were used as the covariate for the items used in the descriptive condition. A score of 100 was given to the items used in the categorical condition. Thus, the covariate shows participants' estimations that each of the categorical statements is true given the two types of statements. This analysis revealed that the labeling effect was present even after controlling the inferential disparity between the categorical statements and the descriptive statements. There was a marginally significant main effect of labeling, $F(1, 27) = 3.50$, $MSE = 57.1$, $p = .072$, $\eta^2 = 0.115$. There was no interaction effect of labeling and attribute type, $F(1, 27) = 1.25$, $MSE = 59.2$, $p = .27$, $\eta^2 = 0.044$.

In summary, both subject-based and item-based analyses revealed a significant effect of categorical statements, and this effect is general enough to extend to a population of participants and materials. It is improbable that unlikely attributes such as *trading stocks using the Internet* is part of the representation of a corresponding category such as *amateur poet*. In this regard, the presence of the main effect on both likely and unlikely attributes seems to indicate that the impact of category information arises from a source other than simple activation of dominant attributes associated with categories (Gelman & Heyman, 1999; E. M. Markman, 1989). The generality of this finding was tested in Experiment 2.

The person categories that were used in Experiment 1 often have a family resemblance structure. In these categories, members of a category cluster with respect to prototypical instances (Cantor & Mischel, 1977; Rosch & Mervis, 1975; Wattenmaker, 1995; Wattenmaker, Dewey, Murphy, & Medin, 1986). These categories are similar to natural categories such as *dogs* or *cats* and have a strong inductive power due to their within-category coherence (Murphy, 2002).

The categories that people use in everyday situations do not necessarily have a structure arranged by family resemblance. For example, members of categories such as *birthday gifts* cohere not with respect to overall resemblance among the members but with respect to a norm and ideal that an observer applies to a category. Think of a cookbook and a DVD player as two typical birthday gifts. These items barely have fixed features in common; however, they are dynamically similar to each other as different observers apply different norms, such as handiness, memorability, or cost. Similarly, given situation-based categories such as *lunch foods*, typical instances such as sandwich and pizza do not relate to each other in terms of the general resemblance of their fixed features; they are similar to each other in terms of a particular norm appropriate to the category (e.g., convenience; see Ross & Murphy, 1999). Thus, if a fixed attribute structure is the main factor that affects inductive judgments, then the labeling effect that was observed in Experiment 1 would be weakened given categories that do not have a clear general similarity structure. I tested this hypothesis in Experiment 2.

# Experiment 2

In Experiment 2, I used ad hoc categories and script categories and investigated whether the impact of category information would be present in these categories. Ad hoc categories and script categories are organized with specific norms, goals, ideals, or situations and are different from social and personal categories (Barsalou, 1983, 1985; Cantor & Michel, 1977; Ross & Murphy, 1999; Wattenmaker, 1995). For example, members of the ad hoc category *diet food* cluster with respect to a specific goal (e.g., reducing body weight). Similarly, script categories, such as *summer food* and *holiday activities*, are characterized by a situation in which people interact with the members of a category (Ross & Murphy, 1999). These categories are different from the social and personality categories that were used in Experiment 1, which are known to be arranged by overall summation of a variety of diverse attributes (Wattenmaker, 1995). If the labeling effect observed in Experiment 1 is pervasive, then category information should modify inductive judgments associated with ad hoc and script categories.

## Method

*Participants.* Participants were 277 undergraduate students who volunteered to take part in this experiment for course credit. The data from 3 participants were excluded because these participants failed to follow the instructions. Altogether, 274 participants were randomly assigned to either a categorical condition ($n = 146$) or a descriptive condition ($n = 128$).

*Materials.* The stimulus materials in Experiment 2 consisted of 15 ad hoc and script categories, which included *diet food*, *health food*, *winter clothing*, *birthday gift*, *wedding gift*, *vacation site*, *summer food*, *holiday activity*, *winter sport*, *suburban car*, *honeymoon site*, *children's game*, *Asian food*, *tabloid journal*, and *ethnic restaurant* (see Appendix A). All item names were specified arbitrarily with six letters of three consonant–vowel pairs (e.g., *NUMATA*). Each ad hoc item was characterized categorically in the categorical condition or descriptively in the descriptive condition. The statements used in the two conditions were identical except for the first sentence of each stimulus. The same number of sentences was used to describe each item in the two conditions.

Each stimulus description was followed by two likely attribute questions and two unlikely attribute questions. The likely attributes were directly related to the corresponding categories, and the unlikely attributes were not directly related to the corresponding categories. For example, given the label *health food*, it is difficult to conceive that an attribute such as *popular in Texas but not in Louisiana* shares features with the internal representation of the concept *health food*.

Appendix A illustrates four samples of the stimulus materials. For each stimulus, a likely attribute question and an unlikely attribute question were presented in an alternate order: A likely attribute question was given first, followed by an unlikely attribute question, and this order was repeated. The number of sentences to describe each stimulus was balanced in the two conditions.

A pilot study with 303 college students indicated that a majority of undergraduate students can readily infer one type of statement (e.g., categorical statements) from the other type of statement (e.g., descriptive statements). After reading the descriptive statements given in the descriptive condition, 159 participants estimated on a 0–100 scale the likelihood that the target item belonged to the target category. Similarly, after reading the categorical statements given in the categorical condition, 144 participants estimated the likelihood that the target item had a dominant feature described in the descriptive condition. In this study, participants given the descriptive statements endorsed the categorical statements with estimation scores of 100 in more than 57% of the cases, and the overall average estimation score was 88.8. Analogously, participants given the categorical statements endorsed the descriptive statements with estimation scores of 100 in more than 50% of the cases, and the overall average estimation score was 86.2.

Another pilot study with 50 college students also revealed that a majority of undergraduate students regarded each of the categorical statements and the descriptive statements as essentially equivalent in their meanings (see Appendix B for the instructions). In this pilot study, participants were presented with the two types of statements one pair at a time and indicated on a 0–100 scale the extent to which these statements (categorical and descriptive statements) essentially "mean the same thing." An average rating was 88.2 ($SD = 8.31$), and participants rated a score of 100 in 56% of the total responses.

*Procedure.* The procedure of this experiment was analogous to the one described in Experiment 1, with some modifications. In this experiment, each stimulus description was shown on a computer screen, and participants responded by typing estimation scores. The order of presenting each stimulus was determined randomly for each participant. For each stimulus, all participants estimated the attributes in the same sequence. The entire experiment took about 20 min for each participant.

*Design.* The design of this experiment was identical to that described in Experiment 1. There was one between-subjects condition (labeling: categorical vs. descriptive) and one within-subjects condition (attribute type: likely vs. unlikely). The dependent measure of this experiment was estimation scores (range: 0–100). Attribute estimations made to likely features were combined and analyzed together. Attribute estimations obtained from unlikely features were combined and analyzed together.

## Results and Discussion

Results from this experiment were consistent with the idea that explicit categorical statements can elevate the estimation of likely and unlikely attributes (see Table 3). A subject-based analysis of variance indicated that there was a main effect of labeling: Partic-

Table 3
*Average Estimation Scores Obtained in Experiment 2*

| | Likely attributes | | Unlikely attributes | |
|---|---|---|---|---|
| Categories | Categorical | Descriptive | Categorical | Descriptive |
| birthday gift | 59.53 | 55.55 | 39.69 | 33.57 |
| diet food | 59.08 | 58.66 | 37.73 | 36.87 |
| health food | 83.25 | 83.11 | 26.60 | 24.00 |
| winter clothing | 70.54 | 68.35 | 37.52 | 33.23 |
| summer food | 79.69 | 76.00 | 27.86 | 23.61 |
| holiday activity | 75.05 | 73.80 | 44.14 | 40.16 |
| winter sport | 75.78 | 75.30 | 41.11 | 36.42 |
| vacation site | 78.78 | 75.75 | 28.81 | 24.62 |
| Asian food | 71.18 | 65.11 | 36.44 | 31.40 |
| suburban car | 69.56 | 65.67 | 31.11 | 29.60 |
| tabloid journal | 61.02 | 61.78 | 30.35 | 28.45 |
| children's game | 72.24 | 75.14 | 25.76 | 23.70 |
| healthy exercise | 79.84 | 77.92 | 32.79 | 27.96 |
| honeymoon site | 67.63 | 62.95 | 33.73 | 30.10 |
| ethinic restaurant | 53.53 | 50.68 | 40.10 | 35.18 |
| Average | 70.45 | 68.38 | 34.25 | 30.59 |

*Note.* The average estimation scores were calculated over individual participants.

ipants in the categorical condition produced significantly higher estimation scores than participants in the descriptive condition, $F(1, 272) = 4.73$, $MSE = 235.5$, $p < .05$, $\eta^2 = 0.017$. There was no interaction between labeling and attribute type, $F(1, 272) < 1$, indicating that the impact of labeling was not limited to the likely attribute questions. A main effect of attribute type was also significant, $F(1, 272) = 1952.1$, $MSE = 95.6$, $p < .001$, $\eta^2 = 0.878$. The minimum quasi $F$ ratio (min $F'$) showed that participants in the categorical condition gave high estimation scores more often than participants in the descriptive condition did, min $F'(1, 271) = 4.25$, $MSE = 47.4$, $p < .05$. The interaction between attribute type and labeling was not significant, min $F'(1, 277.7) < 1$.

An analysis of covariance was conducted to partial out the disparity between the categorical statements and the descriptive statements in the same manner described in Experiment 1. This analysis measured whether the labeling effect would be present even after controlling the likelihood that the categorical statements are supported in the two conditions, specifically, whether the labeling effect would be present even after controlling the disparity that categorical statements would be supported in the two conditions. As in Experiment 1, the estimation scores obtained in the pilot study were used as the covariate for the items used in the descriptive condition. A score of 100 was given to the items used in the categorical condition. This analysis showed that the labeling effect was present even after controlling the inferential disparity between the categorical statements and the descriptive statements. There was a significant main effect of labeling, $F(1, 27) = 5.77$, $MSE = 31.8$, $p < .05$, $\eta^2 = 0.176$. There was no interaction effect of labeling and attribute type, $F(1, 27) < 1$.

The results suggest that there is a significant labeling effect in both likely and unlikely attributes for ad hoc and script categories. Unlike social and personal categories, ad hoc and script categories are arranged mainly by the norms, ideals, goals, and situations associated with an observer (Barsalou, 1983, 1985; Ross & Murphy, 1999). Nonetheless, the labeling effect was present in these categories. The impact of category information is clearly not limited to the person categories used in Experiment 1.

Where does the labeling effect on unlikely attributes come from? Sloman's (1993) model suggests that (a) matching attributes between a premise and a conclusion and (b) the coverage of a premise over a conclusion (i.e., attribute-based similarity) are the determinants of inductive strength. However, it is difficult to account for the labeling effect with these two factors. As discussed earlier, unlikely attributes have no clear relationships with either categorical statements or descriptive statements. For example, the premise *NUMATA is a health food* has little bearing on the conclusion *NUMATA is popular in Texas but not in Louisiana*. In this sense, if Sloman's (1993) model is appropriate, then the labeling effect observed on unlikely attributes should have arisen from the other factor—the coverage of premises (see Equation 5). However, this idea is questionable because there is no prior reason to assume that the coverage of categorical statements is systematically different from that of descriptive statements. The following analysis will clarify this point.

The example shown below illustrates the structure of an individual stimulus given in Experiment 2. The stimulus arguments presented in the two conditions were identical except for their first sentences. Thus, a judgment of an unlikely attribute can be expressed as a pair of a premise and a conclusion.

A (categorical condition)

$P_1$: NUMATA is a health food.

Conclusion (unlikely attribute): NUMATA is popular in Texas but not in Louisiana.

B (descriptive condition)

$P_1'$: Eating NUMATA regularly helps people stay healthy.

Conclusion (unlikely attribute): NUMATA is popular in Texas but not in Louisiana.

If one applies these two arguments into Equation 5 of Sloman's (1993) model, one can express the labeling effect observed on unlikely attributes in Experiment 2 with the following inequality:

$$a_x(C|P_1) > a_x(C|P_1')$$

$$\frac{|F(P_1)|}{|F(C)|}\,\mathrm{sim}(P_1,C) > \frac{|F(P_1')|}{|F(C)|}\,\mathrm{sim}(P_1',C) \tag{8}$$

where $C$ is a conclusion, $P_1$ is a categorical statement, and $P_1'$ is a descriptive statement.

The labeling effect for likely attributes can be explained by means of enhanced relatedness between a premise and a conclusion, $\mathrm{sim}(P_1,C) > \mathrm{sim}(P_1',C)$. For example, the noun label *health food* may activate some prototypical exemplars of the category (e.g., tofu) along with their dominant characteristics (e.g., contains no fat). As a result, the labeling effect arises. This explanation is consistent with the idea presented in Gelman and Heyman's (1999) study and in much of stereotyping and impression-formation research (Fiske & Neuberg, 1990; Hamilton & Sherman, 1994).

For unlikely attributes, it is difficult to apply this explanation, because the contribution of the similarity between a premise and a conclusion can be negligible in the two conditions. In this sense, there should be no major differences between categorical and descriptive statements in terms of the effect of the similarity factor. A separate pilot study confirmed this point (see Appendix B for information regarding the experiment in which this assumption was tested). As a consequence, Sloman's (1993) model states that the labeling effect on unlikely attributes can be reduced to the following expression:

$$a_x(C|P_1) > a_x(C|P_1')$$

$$\frac{|F(P_1)|}{|F(C)|}\,\mathrm{sim}(P_1,C) > \frac{|F(P_1')|}{|F(C)|}\,\mathrm{sim}(P_1',C)$$

$$\frac{|F(P_1)|}{|F(C)|} > \frac{|F(P_1')|}{|F(C)|}$$

$$|F(P_1)| > |F(P_1')| \tag{9}$$

The model reveals that the labeling effect on unlikely attributes stems from different magnitudes associated with categorical statements and descriptive statements (see Equation 9). In Experiment 3, I controlled this magnitude factor and tested whether the labeling effect would be still present.

## Experiment 3

The materials and the procedure adopted in Experiment 3 were analogous to those described in Experiment 2 except for the following modifications. In Experiment 3, two likely attribute questions were removed from each stimulus and one probe question was inserted at the end of each stimulus. The probe questions given in the descriptive condition were the categorical statements given in the categorical condition. The probe questions presented in the categorical condition were the descriptive statements given in the descriptive condition. Thus, the stimuli in Experiment 3 had the following structure:

A (categorical condition)

P1: NUMATA is a health food.

Conclusion (unlikely attribute): NUMATA is popular in Texas but not in Louisiana.

Probe question: Eating NUMATA regularly helps people stay healthy.

B (descriptive condition)

P1′: Eating NUMATA regularly helps people stay healthy.

Conclusion (unlikely attribute): NUMATA is popular in Texas but not in Louisiana.

Probe question: NUMATA is a health food.

These probe questions were used to equate the magnitude of two types of premises: categorical statements and descriptive statements. Consider Equations 10 and 11:

$$a_x(P_1'|P_1) = \frac{|F(P_1)|}{|F(P_1')|}\,\mathrm{sim}(P_1,P_1') = 1 \qquad (10)$$

$$a_x(P_1|P_1') = \frac{|F(P_1')|}{|F(P_1)|}\,\mathrm{sim}(P_1',P_1) = 1 \qquad (11)$$

Let us assume that Equation 10 represents a case in which a participant endorses probe question $P_1'$ (i.e., a descriptive statement) given premise $P_1$ (i.e., a categorical statement) with a score of 100, whereas Equation 11 represents a case in which a participant endorses probe question $P_1$ (i.e., a categorical statement) given premise $P_1'$ (i.e., a descriptive statement) with a score of 100. By combining Equations 10 and 11, we get Equation 12:

$$a_x(P_1|P_1') = a_x(P_1'|P_1)$$

$$\frac{|F(P_1')|}{|F(P_1)|}\,\mathrm{sim}(P_1',P_1) = \frac{|F(P_1)|}{|F(P_1')|}\,\mathrm{sim}(P_1,P_1') \qquad (12)$$

Because $\mathrm{sim}(P_1',P_1) = \mathrm{sim}(P_1,P_1')$ (see Equation 4), Equation 12 can be reduced to Equation 13:

$$\frac{|F(P_1')|}{|F(P_1)|} = \frac{|F(P_1)|}{|F(P_1')|}|$$

$$F(P_1')| = |F(P_1)| \qquad (13)$$

Thus, according to Sloman's (1993) feature-based model, if participants endorse the two types of probe questions with an equal score (e.g., 100), then the perceived magnitude of two premises can be treated as equivalent. The question is whether the labeling effect on unlikely attributes would appear even when the data are analyzed solely for the participants who endorse the corresponding probe questions with a score of 100. If the labeling effect emerges separately from attribute-based similarity (i.e., the number of matching features and the coverage of a premise), the effect should be present even for the limited data set. Experiment 3 tested this prediction.

## Method

*Participants.* Participants were 309 undergraduate students who volunteered to take part in this experiment for course credit. Among the 309 participants, 9 were excluded because they did not follow the instructions. Participants were randomly assigned to one of two conditions: (a) a categorical condition ($n = 143$) and (b) a descriptive condition ($n = 157$).

*Materials.* The materials used in this experiment were identical to those described in Experiment 2 except for two minor modifications. First, all likely questions in the stimuli in Experiment 2 were removed in this experiment. This measure was taken to eliminate a possible anchoring effect (i.e., higher estimation scores given to likely attributes unexpectedly raise estimation scores given to unlikely attributes). Second, a probe question was inserted at the end of each stimulus. Thus, each stimulus had two unlikely attribute questions and one probe question. The probe questions in the categorical condition were descriptive statements used in the first sentences of the stimuli in the descriptive condition. The probe questions in the descriptive condition were categorical statements used in the first sentences of the stimuli in the categorical condition.

*Procedure and design.* The procedure of this experiment was identical to that described in Experiment 2, and the design was analogous to that described in Experiment 2. There was one between-subjects variable (labeling: categorical vs. descriptive). The dependent measure of this experiment was the estimation scores (range: 0–100) given to each attribute question. Attribute estimations made to unlikely attributes were combined and analyzed together. In order to equate the coverage of categorical and descriptive statements (see the introductory Experiment 3 section), statistical analyses were applied only to the data that met the following criteria: (a) individual data points that had a corresponding probe score of 100 were selected, and (b) the number of data points that satisfied the first criterion (Criterion [a]) were counted for each participant, and the data from the participants who had 12 or more data points (80% of the responses made by the participant) were chosen. This was done to ensure that average response scores of individual participants would be calculated from at least 12 items.

## Results and Discussion

The purpose of this experiment was to investigate the presence of the labeling effect while controlling the coverage of the two types of premises. In total, 61 participants in the descriptive condition and 38 participants in the categorical condition met the data selection criteria (a total of 1,359 data points were analyzed).

Even with the restricted data, participants in the categorical condition produced higher scores ($M = 30.5$) significantly more often than participants in the descriptive condition ($M = 23.0$), $t(97) = 2.26$, $p < .05$, $d = 0.47$ (see Table 4), suggesting that categorical statements indeed influenced participants' assessment of the unlikely attributes beyond the perceived coverage of the two types of premises.[5] To test the generality of this result, I reanalyzed the data with more lenient criteria. In this analysis, the borderline scores were set at 90 and 80, respectively (Criterion [a]). For one data set, the data were selected from the participants who responded to the corresponding probe questions with a score of 90 or higher. For the other data set, the data were selected from

[5] I did not calculate min $F'$ for this analysis because there were not enough data points to obtain an item-based $F$ ratio.

Table 4
*Average Estimation Scores Obtained in Experiment 3*

| Categories | Categorical | Descriptive |
|---|---|---|
| birthday gift | 35.40 | 26.77 |
| diet food | 36.13 | 27.75 |
| winter clothing | 23.26 | 18.40 |
| holiday activity | 32.89 | 23.37 |
| vacation site | 21.01 | 14.84 |
| suburban car | 41.25 | 31.48 |
| children's game | 36.56 | 30.23 |
| honeymoon site | 21.74 | 16.04 |
| health food | 32.03 | 24.52 |
| summer food | 33.30 | 19.91 |
| winter sport | 24.73 | 21.31 |
| Asian food | 15.00 | 16.72 |
| tabloid journal | 26.40 | 22.05 |
| healthy exercise | 35.07 | 24.92 |
| ethnic restaurant | 38.95 | 29.70 |
| Average | 30.25 | 23.20 |

*Note.* These average estimation scores were calculated over the participants who responded to the probe questions with a score of 100 and whose individual data points were 12 or more.

the participants who responded to the corresponding probe questions with a score of 80 or higher. The basic trend of the results was unchanged with these inclusive data sets. With the cutoff point of 90 or higher, participants in the categorical condition produced higher estimation scores ($M = 30.7$, $N = 59$) than participants in the descriptive condition ($M = 23.7$, $N = 91$), $t(148) = 2.64$, $p < .01$, $d = 0.44$. With the cutoff point of 80 or higher, participants in the categorical condition ($M = 29.7$, $N = 107$) made higher estimation scores than participants in the descriptive condition ($M = 25.7$, $N = 127$), $t(232) = 1.97$, $p < .05$, $d = 0.26$.[6] These results are consistent with the idea that the labeling effect on unlikely attributes arises separately from the two similarity factors, feature matching and coverage (see Appendix B for a description of a pilot study controlling similarity between a premise and a conclusion).

It should be noted that responding to the probe questions with the perfect score of 100 does not necessarily mean that the categorical statements and the descriptive statements are equal in their meanings. What the analysis of the probe questions reveals is that when the categorical statements were given in premises, the participants in the categorical condition accepted the descriptive statements as perfectly likely; analogously, when the descriptive statements were given in premises, the participants in the descriptive condition accepted the categorical statements as perfectly likely. In other words, these participants in the two conditions separately endorsed the following two sets of truth values: (1) true(categorical statements) → true(descriptive statements); (2) true(categorical statements) → true(descriptive statements). As these conditional statements clarify, neither set of truth values leads to the equivalence of the two types of statements (i.e., categorical statements = descriptive statements). Rather, what is clear is that these participants regarded the two types of statements as equivalent in their *representational magnitude* (e.g., see Equation 13) developed in Sloman's (1993) model. Because a significant labeling effect was present even after equating the magnitude of premises, the Sloman model is insufficient to capture the labeling effect observed in Experiment 3. The unlikely attributes that were presented in the conclusion of each argument have little to do with the representation of the categories that were presented in the premises. In this sense, the influence of category information on the current inductive judgment task appears to go beyond the simple feature-matching operations suggested by Sloman (1993).

Recognizing the role of category information does not necessarily suggest that the similarity-based models are incorrect. It is clear that attribute-based similarity, as advanced by Rips (1975), Osherson et al. (1990), and Sloman (1993), is an important factor for inductive judgments. The results from the present experiment reinforce this point. An overwhelming majority of participants both in the categorical condition and in the descriptive condition assigned low estimation scores to unlikely attributes. What is clear is that the average estimation score obtained in the categorical condition was higher than that in the descriptive condition, even when perceived similarity between a premise and a conclusion and the relative coverage of a premise over a conclusion was controlled. This finding is noteworthy, particularly because the attributes that participants rated had little to do with the corresponding categories.

## General Discussion

### *Summary and General Findings*

In an attempt to highlight a generative aspect of category information, I investigated the extent to which category information influences inductive inferences beyond similarity information. Specifically, I contrasted the impact of categorical statements with that of noncategorical statements when participants estimated the attributes that were not directly related to the category. The results from these experiments provide new evidence for the view that category information, unlike other feature information, can influence inductive judgments beyond the simple function of attribute matching.

In Experiment 1, I used an inductive judgment task similar to those developed by Tversky and Kahneman (1983), Shafir et al. (1990), and Gelman and Heyman (1999) and tested how categorical statements would modify participants' assessments of attributes. The results from Experiment 1 showed that the presence of category information (e.g., *Linda is a feminist*) elevates participants' evaluations of likely attributes that were directly related to the category (e.g., *Linda likes to watch presidential debates*) and that of unlikely attributes that were not directly related to the category (e.g., *Linda works as a bank teller*). In Experiment 2, I

[6] The effect size of the analysis applied to the data with the cutoff score of 80 or higher is considerably smaller ($d = 0.26$) than the effect sizes obtained in the other analyses ($d$s = 0.47 and 0.44, respectively, for the data set of the cutoff point of 100 and the data set of the cutoff point of 90 or higher). This reduced effect size was probably due to unbalanced probe scores obtained in this data set. The average probe score obtained from the participants in the categorical condition was significantly lower ($M = 94.6$) than that of the participants in the descriptive condition ($M = 96.0$), $t(222) = 2.32$, $p < .05$, $d = 0.30$. This means that the participants in this particular data set perceived the categorical statements to be more limited than the descriptive statements in their magnitudes (coverage sizes; see Equation 14). However, this difference works against the hypothesis of Experiment 3.

tested the generality of these findings with ad hoc and script categories (Barsalou, 1983; Ross & Murphy, 1999). Even with these categories, the effect of category information was significant on both likely and unlikely attributes. In Experiment 3, I controlled two factors—similarity between a premise and a conclusion, and the coverage of a premise over a conclusion—and showed that, even after controlling these two factors, the effect of category information was present.

Taken together, the results from the three experiments are consistent with the idea that category information modifies inductive judgments beyond the simple operation of attribute matching. The influence of category information was present in inductive arguments pertaining to people, objects, and events. The effect was also significant in person categories as well as ad hoc and script categories.

### *Implications and Extensions*

The results from these three experiments agree with a number of findings from research on impression formation and stereotyping that have documented that categorical information intensifies the interpretation of underlying attributes associated with the category (Andersen, Klatzky, & Murray, 1990). The results are also consistent with developmental studies in which young children have been shown to distinguish category information and similarity information in attribute induction (Gelman & Markman, 1986). In their classic studies, Gelman and Markman (1986) showed that 4-year-old children tend to assume that objects that bear the same noun labels have a property in common, even though these objects are drastically different in their appearance. Similarly, Gelman and Heyman (1999) demonstrated that 5- to 7-year-olds tend to believe that attributes of a person are long lasting when the person is characterized with categorical statements. The present study extends these studies with the following two points: (a) the presence of category information can modify the assessment of attributes that are not directly related to the category, and (b) this impact can occur even when the similarity between a premise and a conclusion, and the coverage of a premise over a conclusion, are controlled.

Recently, some limitations of similarity-based models have been reported in several studies (see Murphy, 2002, for an excellent review; Heit, 2000; Heit & Rubinstein, 1994; Lin & Murphy, 2001; Lopez, Attran, Coley, Medin, & Smith, 1997; Medin et al., 2003; Proffitt, Coley, & Medin, 2000; Ross & Murphy, 1999). These limitations include the models' inability to incorporate the influence of different predicates (Heit & Rubinstein, 1994), background knowledge of an examiner (Proffitt et al., 2000), and complex reasoning skills that an examiner applies (Heit, 2000; Medin et al., 2003). The present study extends these findings by documenting that categorical information by itself could modify participants' inductive judgments beyond general similarity information. Because the impact of category information occurs in the assessment of unlikely attributes that are unrelated to the category, I argue that this effect results from a participant's attempt to integrate peripheral information with his or her own notion of what the category is about. This idea is consistent with findings by Wisniewski and Medin (1994) and Kunda and her colleagues (Kunda et al., 1990; Kunda & Oleson, 1995).

### *Theoretical Considerations*

Exactly how does category information help integrate diverse attributes? Although answering this question fully requires a series of additional experiments, there are at least two possible reasons why category information can affect inductive inferences beyond underlying attribute-based similarity. One explanation concerns the representation of a category. Categories have traditionally been characterized as a collection of features, specific exemplars, or prototypes (Kruschke, 1992; Medin & Schaffer, 1978; Nosofsky, 1986; Reed, 1972; E. R. Smith & Zarate, 1992). This approach may be inappropriate. Category representation can be more dynamic. Murphy and Medin (1985) suggested that people's beliefs and naïve expectations give rise to conceptual coherence (see also Wisniewski & Medin, 1994). According to their view, members of categories cohere not just because they have matching features in common but also because these members are bound by the observer's intuitive knowledge about the category. This theory-based account implies that new features can be integrated into a category as long as these features help rationalize the observer's belief about the category.

The mere presence of categorical information may facilitate this theory-based role of categories (see also Medin & Ortony, 1989).[7] Category labels have been shown to guide people to create new features that can justify their belief about the category (Wisniewski & Medin, 1994). In the present setting, when a person is characterized with a label (e.g., *Jane is a liberal*), an unrelated statement such as *Jane likes Chinese food* may be perceived as likely, as long as this feature helps rationalize the observer's intuitive belief (e.g., *Many liberal people like ethnic food. Because Jane is a liberal, she should like Chinese food*).

Recent findings in social cognition research are consistent with the idea that categories help justify and thereby maintain stereotypes (Yzerbyt, Rocher, & Schadron, 1997). When individuals are confronted with potentially contradictory or ambiguous attributes (e.g., a rich African American businessperson), they often create a subtype of the category (e.g., Black entrepreneur) and use it to preserve their initial stereotypical belief (Hewstone, 1996). Kunda and her colleagues also noted that combinations of two contradictory concepts generate new features that accommodate contradictory beliefs; for example, when participants in their experiment were asked to describe the characteristics associated with a new concept, such as *Harvard-educated carpenter*, participants generated new features, such as *being rebellious* or *antisocial*, which were not part of each separate concept—*Harvard educated* and *carpenter*. Thus, the new category label *Harvard-educated carpenter* leads people to generate new attributes so as to integrate the two contradictory concepts (Kunda et al., 1990; Kunda & Oleson, 1995).

Another explanation for the integrative influence of category information concerns the process of inductive judgments. Although inductive processes have been characterized primarily with attribute-matching mechanisms, inferential judgments may be carried out with two separate strategies: (a) a similarity-based feature-matching process and (b) a rule-based reasoning process (Heit,

[7] It should be noted that categories that people form by means of sorting and categories to which individual labels point are not necessarily identical (see Malt, Sloman, Gennari, Shi, & Wang, 1999).

2000; Medin et al., 2003; Sloman, 1996). Category information might impose some form of rules on inductive processes (see Rips, 1989; E. E. Smith, 1989), and people use this rule (e.g., items that bear the same name have features in common) to interpret unrelated attributes. The idea that inductive judgments consist of two separate processes is consistent with a wide range of findings in cognitive psychology, including analogy (Clement & Gentner, 1991; Forbus, Gentner, & Law, 1995; Gentner, 1983; Gentner & Markman, 1997; Gentner, Rattermann, & Forbus, 1993; A. B. Markman & Gentner, 1993), reasoning (Cheng, Holyoak, Nisbett, & Oliver, 1986; Johnson-Laird, 1983; Kahneman & Tversky, 1972, 1973; Tversky & Kahneman, 1974, 1983), learning English syntax (Pinker, 1991), and problem solving (Chi, Feltovich, & Glaser, 1981). Although future research should explore exactly how people derive inferential decisions, it appears that two different strategies mediate inferential judgments, and category information seems to provide a general rule that helps integrate diverse information.

## Conclusion

Similarity relationships between a premise and a conclusion have been shown to be an important factor that determines the strength of inductive arguments. The present study indicates that category information also plays a critical role in inductive judgments separately from underlying similarity information. Specifically, when a premise contains categorical information by means of concrete labels, people tend to evaluate an argument as more compelling. The present results suggest that induction is carried out not just by matching similarity but also by abstract reasoning processes elicited by category information.

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# Appendix A

## Stimulus Materials Used in the Experiments

### Experiment 1

*Categorical Condition*

1. Linda is a feminist. She is concerned with issues of discrimination and social justice.

A. Linda likes to watch presidential debates.

B. Linda majored in philosophy in college.

C. Linda likes to watch presidential debates, and she works as a bank teller.

D. Linda works as a bank teller.

2. Jack is a truck driver. He frequently talks on his CB radio and goes to sporting events when he can.

A. Jack's hobby is watching birds.

B. Jack began his job immediately after completing high school.

C. Jack likes to play softball on Sundays, and his hobby is watching birds.

D. Jack likes to play softball on Sundays.

3. Hazel is an avid art collector. She goes to art auctions in New York and Paris every year.

A. Hazel has a vacation house in Florida.

B. Hazel loves to wear custom-made designer clothes.

C. Hazel has a vacation house in Florida, and she loves to watch professional wrestling.

D. Hazel loves to watch professional wrestling.

4. Ted is a fierce competitor. He does anything to win.

A. Ted's hobby is writing poems.

B. Ted works in a big law firm.

C. Ted likes action movies, and his hobby is writing poems.

D. Ted likes action movies.

5. Richard is an avid stamp collector. He loves his job, but is not very well liked by his colleagues.

A. Richard works as an engineer.

B. Richard does not like to go out on social events.

C. Richard works as an engineer, and he plays beach volleyball for a hobby.

D. Richard plays beach volleyball for a hobby.

6. Julie is an aerobics instructor. Ever since childhood she has been in excellent physical shape.

A. Julie smokes at least one pack of cigarettes a day.

B. Julie has a degree in physical education.

C. Julie loves rock-climbing, and she smokes at least one pack of cigarettes a day.

D. Julie loves rock-climbing.

7. Laura is an amateur poet. She loves to read Shakespeare and likes foreign movies.

A. Laura writes short stories for a hobby.

B. Laura went to France last summer on vacation.

C. Laura writes short stories for a hobby, and she trades stocks using the Internet.

D. Laura trades stocks using the Internet.

8. Kim is a Korean. He studied computer science in graduate school and works at a big software company.

A. Kim owns at least two computers and one wireless phone.

B. Kim majored in mathematics.

C. Kim owns at least two computers and one wireless phone, and he loves to sing opera.

D. Kim loves to sing opera.

9. Jennifer is a New Yorker. She dresses flamboyantly on social occasions.

A. Jennifer studied fashion design in art school.

B. Jennifer paints during her free time.

C. Jennifer studied fashion design in art school, and she goes fly-fishing on Sundays.

D. Jennifer goes fly-fishing on Sundays.

10. Carol is an outspoken liberal. She is very interested in current political events.

A. Carol knits for a hobby.

B. Carol works at a publisher.

C. Carol subscribes to a national newspaper, and she knits for a hobby.

D. Carol subscribes to a national newspaper.

11. Ralph is a typical over-achiever. He graduated at the top of his class and was the president of the student council.

A. Ralph is elected as the president of a local labor-union.

B. Ralph has many friends in prestigious law firms.

C. Ralph is elected as the president of a local labor-union, and he works for a small construction company as a plumber.

D. Ralph works for a small construction company as a plumber.

12. Mike is a high-school drop-out. He has been working since and loves riding his motorcycle.

A. Mike plays the flute for a hobby.

B. Mike works as a mechanic.

C. Mike bowls several times a week, and he plays the flute for a hobby.

D. Mike bowls several times a week.

13. Helen is a party animal. She loves buying new clothes and looking at women's magazines.

A. Helen drives a new sports car.

B. Helen frequently goes to fashion shows.

C. Helen drives a new sport car, and she likes gardening.

D. Helen likes gardening.

14. Ron is a millionaire. He manages more than 100 lawyers in his law firm.

A. Ron lives in a trailer house.

B. Ron has a house in California.

C. Ron frequently visits foreign countries for business, and he lives in a trailer house.

D. Ron frequently visits foreign countries for business.

15. Bob is a drug addict. He now lives in a dark apartment and spends all his meager savings on cocaine.

A. Bob was arrested at least once.

B. Bob was fired 3 times in last three years.

C. Bob was arrested at least once, and he takes a yoga class several days a week.

D. Bob takes a yoga class several days a week.

### *Descriptive Condition*

The attribute questions were omitted because they were identical to those shown in the categorical condition.

1. Linda believes in feminist philosophy at heart. She participates in feminist activities as often as she can and thinks that men and women should be equal in every aspect of their social and private lives. She is also concerned with issues of discrimination and social justice.

2. Jack has driven a truck for a moving company for the last 10 years. Jack thinks that watching football games while drinking draft beer is the best way to spend Sunday evening. He frequently talks on his CB radio and goes to sporting events when he can.

3. Hazel loves to collect art. She spends a lot of money and time buying expensive paintings and sculptures. Hazel often attends fund raising events in local museums, too. She goes to art auctions in New York and Paris every year.

4. Ted loves to compete for anything. He thinks that winning is everything, and whenever he competes, he must beat his opponents. He does anything to win.

5. Richard collects stamps for a hobby. Richard has more than one thousand rare stamps in his apartment. He loves his job, but is not very well liked by his colleagues.

6. Julie teaches aerobics classes in private and public gyms everyday. Her students love her class, and because of that Julie makes good money for living. Ever since childhood she has been in excellent physical shape.

7. Laura writes poems for a hobby. She published some of her poems in a local newspaper. She attends a poetry writing class every Thursday in a local library. She also loves to read Shakespeare and likes foreign movies.

8. Kim's parents are Koreans and Kim was born and grew up in Korea, too. He studied computer science in graduate school and works at a big software company.

9. Jennifer has lived in New York City more than 20 years. When she was 8 years old, her parents moved to New York City. Ever since then, she has loved and enjoyed the city life. She dresses flamboyantly on social occasions.

10. Carol believes and embraces liberal ideas. She thinks that social inequalities are the utmost evil in urban America. She writes progressive articles about social issues, too. She is also very interested in current political events.

11. Achieving goals has always been Ralph's top priority. Since his childhood, he always had lofty goals, and attained everything he dreamed of. He graduated at the top of his class, and was the president of the student council.

12. Mike dropped out of his high school when he was 16 years old. He hung around with his high school buddies for a while, but after he got a job in downtown, he got along with different pals. He has been working since and loves riding his motorcycle.

13. Wherever there is a party, you will find Helen. Wednesday, Thursday, and Friday, Helen goes to parties at least 3 times a week. Her friends even think that Helen is addicted to parties. She also loves buying new clothes and looking at women's magazines.

14. Ron made more than 5 million dollars last year. Since he joined his company, he has been rewarded handsomely. He manages more than 100 lawyers in his law firm.

15. Bob cannot kick his drug addiction. For the last five years, he has been in and out of rehabilitation centers. He now lives in a dark apartment by himself and spends all his meager savings on cocaine.

## Experiment 2

### *Categorical Condition*

1. "KOMITA" is a birthday gift. It is particularly popular among young couples.

A. KOMITA sells well during the summer.

B. KOMITA costs about $40.

C. Many lawyers own KOMITA.

(*Appendixes continue*)

D. People can buy KOMITA in a department store.

2. “KINATE” is a diet food. It is rich in protein but has no fat.

A. KINATE is good to lower one’s cholesterol level.

B. People who like KINATE love baseball.

C. KINATE is made from vegetables.

D. KINATE sells well in mid-size cities.

3. “TASIRO” is winter clothing. It makes people stay warm and cozy. Without it, people can barely survive in the winter.

A. People who like to wear TASIRO also like to play basketball.

B. TASIRO is thick and heavy.

C. TASIRO is sold at Wal-Mart but not at K-Mart.

D. Many people in Canada wear TASIRO in the winter.

4. “HITASHI” is a popular holiday activity. On Easter or Labor day, many people get together and enjoy HITASHI.

A. HITASHI involves eating.

B. Liberal people are particularly fond of HITASHI.

C. HITASHI makes people happy.

D. People who like HITASHI eat lots of chocolate.

5. “MIYAGI” is a popular vacation site. It provides many fun things for young children.

A. People who visit MIYAGI tend to support A1 Gore.

B. MIYAGI has many family restaurants.

C. Many accountants live in MIYAGI.

D. MIYAGI has a big amusement park.

6. “YUMITE” is a suburban car. Almost all families living in the suburb own YUMITE as their first car.

A. YUMITE is relatively inexpensive.

B. YUMITE’s dealers are exceptionally generous.

C. YUMITE is popular among middle-income families.

D. YUMITE makes a model change every two years.

7. “KOMETA” is a children’s game. It gives young children lots of actions and interactions.

A. Some schools restrict children from playing KOMETA during school hours.

B. KOMETA can be played outdoors.

C. KOMETA is more popular in eastern states than in western states.

D. KOMETA is best played with multiple people.

8. “TOMERO” is a honeymoon site. Last year, more than 800,000 couples visited TOMERO for their honeymoons. TOMERO is warm year round and has many romantic beaches.

A. TOMERO has a large international airport.

B. The unemployment rate of TOMERO is higher than that in Los Angeles.

C. There are several large resort hotels in TOMERO.

D. TOMERO’s mayor loves baseball.

9. “NUMATA” is a health food. It regulates blood pressure. Many doctors recommend NUMATA to stay healthy.

A. NUMATA is popular in Texas but not in Louisiana.

B. NUMATA contains virtually no fat.

C. Many high school teachers like NUMATA.

D. NUMATA can be found in a drug store.

10. “SUNOKI” is a summer food. It is popular especially during a hot summer and helps people to reduce body temperature.

A. SUNOKI is juicy and rich in vitamin.

B. SUNOKI smells like pasta.

C. People often bring SUNOKI to a beach party.

D. People who buy SUNOKI tend to buy Diet Coke as well.

11. “TOMOKO” is a popular winter sport. People think TOMOKO should be included in the Winter Olympics.

A. TOMOKO makes people polite.

B. TOMOKO involves lots of actions.

C. People who play TOMOKO are generally smart.

D. Many people in Sweden love TOMOKO.

12. “TENBO” is an Asian food. It has exotic flavor and texture.

A. TENBO is popular in China.

B. There are many restaurants that serve TENBO in Texas, but not in Florida.

C. TENBO can be served with rice.

D. TENBO tastes like a bagel.

13. “MENIKO” is a tabloid journal. It is filled with gossips about movie and TV stars.

A. MENIKO readers prefer cats over dogs for pets.

B. People can buy MENIKO at a supermarket counter.

C. MENIKO’s editor has at least two children.

D. MENIKO is no more than $5.00.

14. “MINAMI” is a healthy exercise. It helps people to correct their posture and reduce blood pressure.

A. MINAMI involves lots of muscle stretching.

B. MINAMI requires expensive equipment.

C. MINAMI is more popular among middle-aged people than young people.

D. People who exercise MINAMI also like traveling abroad.

15. “KINUMI” is an ethnic restaurant. With about $20, one person can have a superb exotic dinner at “KINUMI.”

A. KINUMI has more waitresses than waiters.

B. KINUMI’s menu is difficult to understand.

C. KINUMI’s customers drink red wine more often than white wine.

D. KINUMI serves raw fish.

### *Descriptive condition*

The attribute questions were omitted because they were identical to those shown in the categorical condition.

1. Many people give “KOMITA” to their friends and relatives for their birthdays. It is particularly popular among young couples.

2. Many people who are dieting eat “KINATE” to reduce their weight. It is rich in protein but has no fat.

3. Many people wear “TASIRO” in the winter. It makes people stay warm and cozy. Without it, people can barely survive in the winter.

4. During holidays, people love to do HITASHI. On Easter or Labor day, many people get together and enjoy HITASHI.

5. Many people love to visit “MIYAGI” on their vacation. It provides many fun things for young children.

6. Many people living in the suburb drive “YUMITE” for many different purposes. Almost all families living in the suburb own YUMITE as their first car.

7. Many children play “KOMETA” for fun. It gives young children lots of actions and interactions.

8. Many newlyweds choose “TOMERO” for their honeymoons. Last year, more than 800,000 couples visited TOMERO for their honeymoons. TOMERO is warm year round and has many romantic beaches.

9. Eating “NUMATA” regularly helps people stay healthy. It regulates blood pressure. Many doctors recommend NUMATA to stay healthy.

10. In the summer, many people eat “SUNOKI.” It is popular especially during a hot summer and helps people to reduce their body temperature.

11. Many people love to play “TOMOKO” in the winter. People think TOMOKO should be included in the Winter Olympics.

12. Many Asian people eat and love “TENBO.” It has exotic flavor and texture.

13. MENIKO is published weekly. It is filled with lots of gossips about movie and TV stars.

14. People exercise “MINAMI” to enhance their health. It helps people to correct their posture and increase blood circulation.

15. People go to “KINUMI” to eat ethnic food. With about $20, one person can have a superb exotic dinner at KINUMI.

# Appendix B

## The Instructions Used in the Second Pilot Study Conducted Before Experiment 2

In this pilot study, we examined the extent to which undergraduate students interpreted the meaning of categorical statements and descriptive statements used in Experiment 2. Fifty undergraduate students were presented with 15 pairs of categorical statements and descriptive statements and judged the equivalence of the two types of statements on the basis of the following instructions:

> In this experiment, we would like to study the way you estimate characteristics of imaginary people, objects, or events. For the description that follows, please estimate the extent to which two sets of statements essentially define and characterize the same thing. Each imaginary item will be specified with arbitrary names (e.g., “TEMOTO”), and your task will be to examine the meaning of two sets of statements and judge whether or not the two sets of statements (A & B) essentially mean the same thing. By “mean the same thing,” we mean that one set of statements defines and characterizes the same item as accurately as the other set of statements does. You indicate your response by typing a score ranging from 0 to 100.

## Testing the Assumption That the Similarity Between a Premise and a Conclusion Was Negligible in Experiment 3

The analyses described in Experiment 3 are based on the assumption that the similarity component of Sloman’s (1993) model is negligible because categorical statements and descriptive statements are equivalent in terms of their similarity to their corresponding unlikely attributes. To verify this assumption, we recruited an additional 55 participants and asked them to compare the perceived similarity between two types of premises (categorical statements and noncategorical statements) and the unlikely attributes used in Experiment 3. In this pilot study, each stimulus contained one unlikely attribute, for example, (a) *NUMATA is popular in Texas but not in Louisiana,* and two premises, for example (b) *NUMATA is a health food* and (c) *Eating NUMATA regularly helps people stay healthy.* The task of the participants was to select the premise (either b or c) that is the most similar to the target attribute (a) in its meaning. The instructions of this additional experiment, which were taken from Osherson et al.’s (1990) experiment, were as follows:

> In this experiment, we are interested in your judgment about the similarity of two sentences. The similarity of two sentences depends on how alike they are in their meanings. For each trial, you will see three sentences: one base sentence followed by two target sentences. From the two target sentences, please select the one that is the most similar to the base sentence in its meaning.

Overall, categorical statements were selected with a proportion of .47, which was not significantly different from a chance level of .5, $t(54) = -1.34$, $p = .20$. An analysis with individual items agreed with this description. Among 30 comparisons (15 items with two attributes each), only 2 items deviated from the chance level performance with an alpha level of .05, $Z > 1.96$, $p < .05$). All the other items were not statistically different from the chance level. Thus, the results from this pilot study confirm that the categorical statements and the descriptive statements used in Experiment 3 were compatible in their similarity to the corresponding unlikely attributes.

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