The Extrinsic-Intrinsic Feature Distinction in Relation to Taxonomic Structure and the Concept of the Basic Category

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by

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Summary

Two approaches to the study of categories, the classical feature and the prototype approach (Rosch, 1973), have shed light on the topic of how categories are represented in the mind. Schwartz has suggested a combination of the two approaches in order to understand the differences between the two kinds of categories, naturally-occurring and artifactual.

Rosch and her colleagues have studied the seemingly hierarchical structure of categories and have come up with the concept of a "basic level" category as distinct from a superordinate or subordinate level category. In a series of experiments, they determined the nature of a basic level category and explained it in terms of Rosch's prototype theory.

Barr & Caplan studied categorization using an extrinsic-intrinsic feature distinction. This approach can explain differences between artifactual and naturally-occurring categories. The present study extended that approach to basic level categories.

It was found that "basic" categories appear at all taxonomic levels in naturally-occurring categories and the basic and subordinate levels in artifactual categories. Because it is not confined to one taxonomic level, the concept is more correctly termed "basic" category. The extrinsic-intrinsic feature distinction can predict basic categories and is useful in discussing the differences between naturally-occurring and artifactual categories. The absence of basic categories at the superordinate level of artifactual categories, and their presence at all levels of naturally-occurring taxonomies, points to the existence of what this paper has called "object" categories.

Rosch (1973) introduced into category literature the concept of the "fuzzy" category, i.e., that the boundaries of some categories are unclear. Borderline category members create fuzziness because, although they possess some important features of the category, they do not resemble the more common category members (e.g., "bat" is a borderline member of the category "Mammals"). Rosch's explanation for the fuzzy nature of some category boundaries was that, in opposition to the classical defining feature theory, categories are represented in our minds in terms of prototypes, and objects which more closely resemble a category prototype are more easily identified as members of that category, membership becoming more and more questionable as similarity to the prototype decreases.

Other researchers, including Smith & Medin (1981), have shown the formal equivalence between Rosch's prototype theory and what is called a probabilistic feature approach. In a probabilistic feature approach, a category is represented by a set of features, and any one member of a category will share some but not all of those features. In this way, the fuzzy boundaries of a category are seen in terms of the number of features an object possesses that are defining of the category, where the less it possesses, the less likely membership into the category will be considered.

Barr & Caplan (1985) have taken a different approach to explaining Rosch's data on fuzzy categories. They contend that rather than taking a count of the number of features which a potential exemplar possesses in common with the definition of the category, one should look at the nature of the features which are found to be defining of the category. Barr & Caplan showed that some artifactual categories appear fuzzier than a number of naturally-occurring categories. Therefore, one implication of the probabilistic approach is that artifactual categories, as evidenced by the fuzziness, will be defined by features which are less closely connected with, or defining of, the category. Barr & Caplan have shown, however, that subjects are equally able to identify artifactual categories from lists of their defining features as they are the less fuzzy naturally-occurring categories. They also noticed that the type of features that are defining of the two types of categories are noticeably different. Artifactual categories tend to be defined by extrinsic (true of an exemplar only in relation to other entities) features, whereas naturally-occurring categories tend to be represented by intrinsic (true of an exemplar in isolation) features. Barr & Caplan suggest that it is this difference between the two types of categories which can account for the more fuzzy nature of the artifactual categories. While the intrinsic features of the naturally-occurring categories require a simple "yes/no" consideration of possession by the potential exemplars, the extrinsic features which define artifactual categories are open to the addition of qualifiers, allowing exemplars to sometimes possess the feature. Those exemplars whose category membership is borderline, that is, those which make a category fuzzy, are those which possess the extrinsic features of the category only with the addition of strong qualifiers.

A contribution made by Rosch, Mervis, Gray, Johnson, & Boyes-Braem (1976) to category literature is the concept of taxonomic structure. They look for hierarchy within a taxonomy, the highest level of abstraction being the superordinate, the next lower the basic level, and the next lower the subordinate level. In a series of experiments, Rosch and her colleagues defined the concept of the basic level category of a taxonomy as that level "at which categories carry the most information, possess the highest cue validity, and are, thus, the most differentiated." They showed that the basic level categories in comparison to their superordinates had exemplars with 1) significantly more attributes in common, 2) more motor movements associated with their use, and 3) increased similarity in the overall look. In addition, basic level terms were used more than their superordinates to identify objects and were learned by children before the superordinate levels. Further differences were found between the basic levels and their subordinates, such as, that divisions beyond the basic level added little information to the conceptualization of the object, and even expertise in a field seemed not to render related subordinatue categories more useful in understanding its exemplars than were the basic levels.

This study is in part an attempt to extend the extrinsic-intrinsic feature distinction to Rosch's concept of basic category levels. It is predicted that the concept of a basic level category will cut across all taxonomic levels and, therefore, is more correctly referred to as simply a basic category. A basic category would be intrinsically represented and the most likely one named, at whatever level, by the features that define it. If this line of thinking is correct, one would expect to find basic categories at all levels of naturally-occurring taxonomies. Indeed, Rosch, et al (1976) had difficulty determining what the superordinate, basic, and subordinate levels of their biological taxonomies were. Their difficulty may be attributable to the fact that biological, or naturally-occurring, taxonomies simply do not have the superordinate/basic level/subordinate structure. One would also predict a lack of basic categories at the superordinate level of artifactual taxonomies, based on the fact that categories of that type and on that level tend to be extrinsically represented (Barr & Caplan, note 1).

This study is also an attempt to replicate Barr & Caplan's (note 1) findings concerning the differences between naturally-occurring and artifactual categories. In addition, information concerning the appearance of basic categories at all naturally-occurring taxonomic levels is sought. It is predicted that naturally-occurring categories will not show the same superordinate/basic level/subordinate level structure as do artifactual taxonomies.

Method

Subjects

Subjects were forty undergraduate volunteers at Ball State University. All received course credit for their participation. The data from only thirty-seven subjects were used because three subjects failed to follow instructions.

Stimuli

Stimuli were 18 small booklets, representing 18 categories. In each book, on every other of the 20 pages, was printed one of 10 features for the category that booklet represented. (The remaining 10 pages were blank and served to prevent the subjects from looking through to the next feature.) The 10 features used were those most often selected as defining of each category in a study by Barr & Caplan (note 2). The order in which the features were presented to the subjects was determined by a Latin square design. Table 1 shows the categories used in this study. The features for each category are shown in Appendix 1.

Procedure

Subjects first completed the consent form. They were then told that they would receive 18 booklets, each containing 10 features. The features in each booklet described one particular category. They were instructed to go through the booklets one at a time, page by page. On each page containing a feature they were to write down what category they thought was being described by the features encountered in that booklet up to that point. They were told not to continue to the next feature until a response was written for the current feature. They were permitted to look back over previous features, but they were told not to look beyond the current feature until a response had been written. Each subject received the 18 bookets in a different order.

Results

All categories were correctly identified either at the correct or a lower level by most subjects. Although naturally-occurring categories were identified marginally more often than artifactual ones (Bombs - 1 incorrect; Roses - 2; Minerals - 3; Furniture - 7; Pistols - 8), the differences between the two kinds of categories were minimal. The results, then, are consistent with an earlier study by Barr & Caplan (1985).

A significant difference was found in the kinds of features which were most successful for correctly identifying the category. A feature was called successful if it helped identify the correct category for the correct subject. An effectiveness score was calculated for each feature using the following formula:

$$\frac{Y - N}{E}$$

where Y = number of times the feature was the one at which the correct category was first named; N = number of times the feature was encountered at which the correct category was not named (these included instances in which a correct response was changed to an incorrect response); and E = number of times the feature was encountered when the previous response had been incorrect. Those five features with the highest effectiveness scores in each category were chosen as the most successful. In the event of a tie, all features involved in the tie were included in the calculations. Appendix 1 shows those features for each category that were the most successful by the appearance to the left of the feature of an asterisk. The effectiveness scores of each feature appears to the right of it.

The naturally-occurring categories were successfully identified by significantly more intrinsic features than were the artifactual categories. Extrinsic features dominated the list of the most successful features for artifactual categories ($X^2(1) = 6.97$, $p < .01$). Table 2 shows the proportions of extrinsic and intrinsic successful features for the naturally-occurring and artifactual categories.

Table 3 shows the proportion of responses at each taxonomic level for each category. Those categories which received a proportion of responses of .75 or above at the correct taxonomic level are defined as basic categories. Peculiarities in the lists of features which may have affected the results are mentioned in the discussion.

Those categories which were shown to be basic categories were represented significantly more by intrinsic features relative to extrinsic features than were those that were not basic categories ($X^2(1) = 4.76$, $p < .05$).

Discussion

The results of this study replicate those of Barr & Caplan (1985, notes 1 & 2) concerning the extrinsic nature of features for artifactual categories and the instrinsic nature of features for naturally-occurring categories. Also, as Barr & Caplan found, subjects in this study were equally able to name the artifactual and naturally-occurring categories. Thus, their hypothesis concerning the usefulness of the extrinsic-intrinsic feature distinction received further support through this study.

Some of the difficulties with certain categories used in this study were also similar to those found in the Barr & Caplan studies. Specifically, the category "Minerals" was obviously perceived by the subjects as an artifactual category, rendering the extrinsic-intrinsic differences between the artifactual and naturally-occurring categories less dramatic, though still significant. Also, the category "Vehicles" was identified by all subjects as "Car", due to very car-like features given for that category. Since these features were all intrinsic, both the artifactual/naturally-occurring comparison and the superordinate/basic level comparison were affected.

Additional peculiarities in the data unique to this study involve the categories of "Animals" and "Birds". Particularly poor features for "Animals" were offerred by the process of choosing the ten most often marked features from the Barr & Caplan (note 2) study. Better features might have revealed "Animals" to be more clearly a basic category. Also, one feature given for "Birds", "some sleep during the day, awake at night", led quite a few subjects to identify that category as the subordinate "Owl", thus rendering "Birds" less obviously a basic category.

One of the purposes of this study was to look for evidence of basic level categories as described by Rosch, et al (1976). They showed that subjects could easily name a basic level category when shown a picture representing that category's prototype. Similarly, a basic category would be easily named by a list of its features. Using this criterion, the data revealed that basic level categories occur at all taxonomic levels in naturally-occurring categories (particularly in the category "Plants"), and all but the superordinate levels in artifactual categories. The appearance of such categories at other levels than the basic levels suggests a need to change the term "basic level" category to "basic" category.

Those categories which were shown to be basic level categories were represented significantly more by intrinsic than by extrinsic features. Barr & Caplan's (1985) extrinsic-intrinsic feature distinction, then, does seem to have relevance to the concept of basic categories.

Taking into consideration those previously mentioned peculiarities with features for the categories "Animals" and "Birds", and realizing that subjects conceive of "Minerals" as an artifactual category, the data seems to show a clear difference between the appearance of basic categories in the artifactual and naturally-occurring taxonomies. The superordinate level categories in the artifactual taxonomies are not shown to be basic categories, whereas all three levels of the naturally-occurring categories do show that tendency.

One of the aspects of a basic category described by Rosch, et al (1976) is that exemplars of a basic category have a similar shape to one another. This concept would imply that basic categories denote objects. Such "object categories" would be more highly represented by intrinsic features. It follows, then, that a lack of basic categories at the superordinate level of artifactual taxonomies may be the result of a lack of object categories at that level. That is to say, the superordinate levels of artifactual taxonomies represents some umbrella aspect of their basic and subordinate levels that does not include the physical attributes of those lower level categories.

The occurrence of basic categories at all levels of the naturally-occurring taxonomies suggests that the superordinate/basic level/subordinate structure does not work for those taxonomies. A possible explanation for this lack of structure is that naturally-occurring categories are those which were observed in the world (i.e., were objects) and were given names. In contrast, artifactual categories are like what Schwartz (1977) refers to as nominal kinds. The concept of the categories exist in their nominal representations and are not constrained by existing objects. Naturally-occurring categories, then, would logically be more likely to be object categories at all taxonomic levels than would artifactual categories.

Barr & Caplan's extrinsic-intrinsic feature distinction seems to be a useful way to describe many of the differences between naturally-occurring and artifactual categories. It also has proven helpful in understanding the concept of a basic category. Furthermore, it has shed light on the nature of the superordinate/basic level/subordinate structure in relationship to both naturally-occurring and artifactual categories. It seems likely that further research into its influence on the conceptualization of categories would prove fruitful.

Reference Notes:

Note 1. Barr, R.A., & Caplan, L.J. Some comparisons of the representations of two different classes of category. Manuscript under review, Cognition.

Note 2. Barr, R.A., & Caplan, .L.J. Work in progress.

References

Barr, R.A., & Caplan, L.J. (1985). Two kinds of features? A test of two theories of typicality effects in natural language categories. Proceedings of the Seventh Annual Symposium of the Cognitive Science Society. Morgan-Kaufman.

Rosch, E. (1973). On the internal structure of perceptual and semantic categories. In T.E. Moore (Ed.), Cognitive Development and the Acquisition of Language. New York: Academic Press.

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Schwartz, S.P. (1977). In S.P. Schwartz (Ed.), Naming, Necessity, and Natural Kinds. Cornell University Press: Ithica, N.Y.

Smith, E.E., & Medin, D.L. (1981). Categories and Concepts. Cambridge, Mass.: Harvard University Press.

Table 1. Stimulus categories, listed by category type and taxonomic level.

Taxonomic Level	Naturally-Occurring Category		
Subordinate	Animals	Plants	Minerals
Basic Level	Birds	Trees	Metals
Superordinate	Cats	Roses	Diamonds

Taxonomic Level	Artifactual Categories		
Subordinate	Vehicles	Weapons	Furniture
Basic Level	Trains	Bombs	Tables
Superordinate	Station Wagons	Pistols	Rocking Chairs

Table 2. Proportions of extrinsic and intrinsic successful features for the naturally-occurring and artifactual categories.

	A	B	C
Extrinsic	.44	.28	.52
Intrinsic	.50	.63	.38

A = Naturally-Occurring Categories (with Minerals)

B = Naturally-Occurring Categories (without Minerals)

C = Artifactual Categories

Table 3. Proportions of responses for each category at each taxonomic level. The numbers under the superordinate column are the proportion of responses given at the superordinate level for that particular term (similarly for basic and subordinate columns).

Category	Superordinate	Basic Level	Subordinate
Animals	0.54	0.14	0.32
Birds	0.0	0.65	0.35
Cats	0.0	0.0	1.0
Plants	1.0	0.0	0.0
Trees	0.0	1.0	0.0
Roses	0.03	0.03	0.95
Minerals	0.18	0.15	0.68
Metals	0.0	0.54	0.46
Diamonds	0.0	0.0	1.0
Vehicles	0.0	1.0	0.0
Trains	0.0	1.0	0.0
Station Wagons	0.0	0.10	0.90
Weapons	0.05	0.78	0.16
Bombs	0.0	0.92	0.08
Pistols	0.0	0.14	0.86
Furniture	0.63	0.37	0.0
Tables	0.0	1.0	0.0
Rocking Chairs	0.0	0.14	0.86

Note: A basic category is defined as a category named at the correct taxonomic level at a proportion of .75 or above.

Appendix 1. List of the ten top features from Barr & Caplan (note 2) for the eighteen categories used in this study, and their effectiveness scores as calculated by the formula below:

$$\frac{Y - N}{E}$$

Y = number of times the feature was the one at which the correct category was first named

N = number of times the feature was encountered at which the category was not named (these included instances in which a correct response was changed to an incorrect response)

E = number of times the feature was encountered when the previous response had been incorrect

Animals	Effectiveness Score
* some make good pets	1.0
* many species	1.0
some are plant eaters	0.0
* some are meat eaters	1.0
* some are hunted	1.0
* can have four legs	0.50
all sizes	- 1.0
all shapes	- 0.71
some are slow	0.11
some are quick	0.25

Birds	
come in a variety of colors	- 1.0
various types	- 1.0
have heads	- 0.85
* hatch eggs	0.88
* some sleep during the day, awake at night	0.0
vary in size	- 1.0
* have feathers	1.0
* have beaks	1.0
* fly	0.0
* have wings	0.67

*Most successful features.

Cats	Effectiveness Score
eyes	- 1.0
* hunt mice	0.75
four legs	- 1.0
* wash themselves	0.17
two ears	- 0.75
claws	- 0.27
* meow	1.0
* paws	0.33
long hair or short hair	0.0
* purr	1.0

Plants	
* produce oxygen	0.33
use carbon dioxide	- 1.0
* some are edible	0.33
* sometimes in houses	0.33
contain chlorophyll	0.25
* need water	0.82
* carry on photosynthesis	1.0
* can be potted	1.0
* need sunlight	0.33
all sizes	0.0

Trees		Effectiveness Score
	grow in soil	- 0.67
*	branches are uneven and go in all directions	1.0
*	provide shade	1.0
*	branches with leaves	1.0
	have roots	0.50
	are naturally made, not synthetic	- 1.0
	living	- 0.75
*	used for firewood	0.80
*	different kinds	- 0.50
	birds live in them	0.43

Roses		
*	flower	- 0.11
	have green leaves	- 1.0
	have stems	- 1.0
	petals	- 1.0
	sweet smelling	- 0.81
	are different colors	- 1.0
*	thorns	1.0
*	can be red	- 0.33
*	grow on a bush	- 0.60
*	can be yellow	- 0.71

	Effectiveness Score
Minerals	
vary in importance to survival	- 0.83
vary in strength	- 0.87
* mined	0.67
found in a variety of places	- o.67
vary in usefulness	- 1.0
* found in the earth	0.27
* natural resource	-.27
* valuable	- 0.43
* natural	- 0.50
we use them	- 1.0
Metals	
* in framework of buildings	- 0.83
* strong	- 0.53
* may rust easily	0.29
* can be molded	0.0
have a boiling point	- 0.71
can be formed	- 1.0
* some are precious	- 0.23
sturdy	- 0.83
found in the earth	- 0.87
* have a melting point	- 0.53

Diamonds	Effectiveness Score
precious	- 0.54
* able to cut glass	0.86
jewel	- 0.20
* expensive	0.0
* are cut in carats	1.0
* used to set in jewelry	0.0
have sentimental value	- 0.67
* stone	0.71
meaningful	- 1.0
hard	- 1.0

Vehicles	
* can have brakes	1.0
* can run on gas	1.0
can need a driver	0.33
* can have tires	1.0
* can have tail lights	1.0
a way of transportation	0.50
many different colors	- 1.0
* can have engines	1.0
* can have windshield wipers	1.0
can have head lights	0.60

Trains	Effectiveness Score
carry passengers	- 0.60
* powerful	0.20
* carry cargo	0.20
large engines	- 1.0
* travel on tracks	1.0
means of transportation	- 0.33
* run by steam, electricity, coal	0.71
* have a caboose	0.60
one of the first forms of cross-country transportation	- 1.0
* engineer	0.67

Station Wagons	
* many windows	- 0.90
long	- 0.92
* back seat can fold down for more room	0.07
* family car	0.73
* type of car	- 0.20
runs on gasoline	- 1.0
used for transportation	- 1.0
one long seat in front	- 1.0
seats many	- 1.0
* no trunk	- 0.89

Weapons	Effectiveness Score
* used by military	0.43
may be simple or complex	- 1.0
can kill people	- 0.40
* defense	0.09
* not used for play	0.11
man-made	- 0.71
cause pain	- 0.75
dangerous	- 0.27
* may use bullets	0.64
* should be used with caution	0.0

Bombs	
* destroy	- 0.14
dangerous	- 1.0
can kill people	- 0.85
cause disaster	- 0.75
weapon	- 0.44
threatening	- 0.72
* can have a timer	0.33
* destructive	0.56
* explosive	0.0
* blow things up	- 0.20

Pistols	Effectiveness Score
used as a weapon	- 1.0
several different kinds	- 1.0
used for protection	- 1.0
* hand weapon	- 0.91
cause death or serious injury	- 1.0
* type of gun	0.50
* have a handle	- 0.64
come in different sizes	- 1.0
* used at target ranges	- 0.57
* police carry them	- 0.71

Furniture	
all shapes	- 0.83
all sizes	- 1.0
* different materials are used, such as fabrics, wood, stuffing, etc.	0.25
* used for decorations of home	0.0
many different styles	- 1.0
modern	- 1.0
many different colors	- 1.0
* sturdy	- 0.33
* belongs in a house	- 0.20
* man-made	- 0.45

Tables	Effectiveness Score
can be handmade	- 0.77
man-made	- 1.0
* wooden	- 0.75
different shapes and sizes	- 1.0
different colors	- 1.0
* furniture	- 0.58
are made of many different materials	- 1.0
* flat surface	0.36
* have legs	0.0
* manufactured	- 0.71

Rocking Chairs	
* arms on the side	- 1.0
* man-made	- 1.0
* comfortable	- 1.0
* back rests	- 1.0
* give a calm feeling	- 1.0
* used to sit in and rock babies	0.48
* many sizes	- 1.0
* rocks back and forth	0.85
* furniture	- 0.60
* pleasant	- 1.0