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THE ORGANIZATION OF INFORMATION IN TERMS OF ITS USE: A DEONTIC MODEL OF KNOWLEDGE REPRESENTATION

City University of New York PH.D. 1986

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THE ORGANIZATION OF INFORMATION IN TERMS OF ITS USE: A DEONTIC MODEL OF KNOWLEDGE REPRESENTATION

by

ANTHONY RIFKIN

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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Abstract

THE ORGANIZATION OF INFORMATION IN TERMS OF ITS USE:
A DEONTIC MODEL OF KNOWLEDGE REPRESENTATION

by

Anthony Rifkin

Advisor: Professor Katherine Nelson

The representation of featural information for natural categories should be based on how features are most commonly asserted as descriptions, rather than in terms of fixed relations to the categories and instances they can describe. Such general "norm" relations would not be invalidated if they are not instantiated in particular contexts, and the use of features could be adapted for any number of contexts. The present study investigates a deontic model of representation in which features bear general "norm" relations to categories and their members, and do not formally delimit category boundaries or the instances they can describe.

Two experiments identify these relations. In one, the more typical instances of a category are found to be classified more often as belonging to these categories, while less typical instances are more frequently classified as belonging to contrasting categories. In the second experiment, it is found that features that can describe all members of a category ("Obligatory" feature norms) are used to define the memberships of the categories' more and less typical instances. In line with the instances' family resemblances,

the membership of less typical instances in contrasting categories are defined by features that are "Impermissible" as membership definitions in the target categories, and the membership of more typical instances in the target categories are defined more often by "Permissible" feature norms that describe some, but not all, of the categories' members.

A third experiment examines the context-sensitive retrieval of this information, when instances are compared and the categories they belong to are not mentioned. It is found that descriptions of the instances' similarities are based on their least-upper-bound shared membership, and that descriptions of their differences are generated from the level immediately below their least-upper-bound membership. A taxonomic organization is therefore identified from within which the feature norms are generated as descriptions. Contexts are also identified in which instances are excluded from the description of the same norms, and in which instances are described by the categories' norms while being excluded from the categories. In addition, the deontic model is used in a computer implementation demonstrating how these descriptions are generated within particular contexts.

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I would like to thank Katherine Nelson for her continuing support and guidance over the years; Don Scarborough, Joe Glick, Tim Finin and John Black for their helpful comments and interest in my work; and George Miller for suggesting a deontic model of representation. I would also like to thank the Brooklyn College Psychology Department for allowing me to use their subject pool, as well as Nancy O'Donohue, Karyl Schwarz, Allan Supraner, Jay Seitz, Agatha Jarvis and their classes for participating in my experiments. I am especially thankful to all the members of my family for their inspiration and support, to Charles MacDermed for the example of his indomitable intellect, and all my friends in the Developmental Psychology Program who saw me through and were always there for a discussion. Finally, my deepest gratitude goes to Andrea Blau for her love, patience and support, and for being the best friend anyone could ever have.

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Introduction

A number of different disciplines have been interested in how knowledge is organized. In some cases, formal theories have been used to model knowledge representation. For example, classical Aristotelean models have examined the use of necessary and sufficient features for determining memberships within fixed category boundaries. More recently, fuzzy set theory (Zadeh, 1965, 1978) has been used to model prototype structures and fuzzy boundaries for categories. However, psychological evidence indicates that people's representations may not be consistent with the constraints of formal theories (Cohen and Murphy, 1984; Johnson-Laird, 1980). In particular, people do not adhere to the extensional constraints which classical or fuzzy set theories place on categories and their instances (Cohen and Murphy, 1984). In contrast to formal approaches, it has been proposed that people may organize their knowledge in terms of schemas or naive "theories" that describe category instances (Miller and Johnson-Laird, 1976; Rumelhart, 1980). Rather than being formally definitional, these schemas represent general knowledge and beliefs about things that need not be applied to sets of instances in a fixed fashion.

One reason why people may not formally organize their knowledge is that they may represent information to suit the different ways they use it. People use information in ways that are formally contradictory (Smith and Osherson, 1982; Tversky and Kahneman, 1983), but the ways in which they use

information may be a function of the contexts they use it in. For example, people's natural category definition or schema for "snails" might include that they are "slow". Based on the extensional sets of any formal model, the complex concept "fast snail" would therefore be an empty set. But people do not necessarily take the term "fast" in "fast snail" to mean that such a "snail" is not "slow". Rather, within the context of constructing the concept "fast snail", they may recognize that the term "fast" is being used relative to the general characteristic of "snails" being "slow".

As such, people may use information dynamically to meet the demands of particular contexts. As with the semantics of relative terms such as "fast" and "slow" (Katz, 1972), it may be the case that all natural category information can be adapted to fit particular contexts. For example, "vehicles" are generally described as being "used for transportation", but it might not be possible to use a "broken vehicle" for "transportation". The description of "vehicles" as being "used for transportation" is therefore relative to the specific "vehicles" that may be described in particular contexts.

How information is represented such that its use can vary presents a special problem for identifying the representational relations between categories, features and instances. It may be necessary for there to be more than one relation between any two pieces of information. Otherwise, a relation that is applicable in one context may be invali-

dated in another context (e.g., "snails" being "slow", or "vehicles" being "used for transportation"). In line with this perspective, Osherson and Smith (1981) suggested that two types of extensional set relations may be used, prototype structuring for perceptual identification processes and the all-or-none relations of a more classical model for determining category memberships. On the other hand, if relations are specified by general schemas that do not need to be applied to sets of instances in a predetermined fashion, then a single relation between two pieces of information could be used in more than one way. One of the goals of a schema theory approach is therefore to identify general types of relations which are sensitive to different contextual uses.

Within a schema approach, the relations between categories, features and instances might best be determined by examining how information is used in different contexts. While there may be a multiplicity of contexts, similar types of processing may be used within general classes of contexts. For example, the processes used for determining and defining category memberships may be similar to those used for describing similarities between category members. In both cases, the category may be accessed and featural information associated with the category could be used to describe the members. When category members are compared and the category is not mentioned, the category may be implied. This is similar to the context-sensitive use of implicit

sets described by Olson (1970) and Tversky and Hemenway (1984). In this case, the category is the implicit set distinction in terms of which the members are described.

However, the use of featural information associated with a category does not delineate how this information is related to the category. The same set of instances may not be described by a category's features in all contexts. For example, "vehicles" may be described as being "used for transportation" in contexts where their membership is being defined or their similarities are being described. But in another context, it may be noted that the same instances of "vehicles" may not be "used for transportation" if they are "broken". To identify the relations of features to categories, it would be necessary to examine the contexts in which features are used to describe a category's instances and the contrasting contexts in which this information is not used.

In the context of listing features for category members, Rosch and Mervis (1975) found that some categories may have no features which are shared by all their members. As such, a category may have no features that can be used to describe all of their members. However, Hampton (1979) asked subjects for features that define memberships in categories, and was able to identify features that can be applied to all members of the same categories studied by Rosch and Mervis. But he found that these features were not sufficient to exclude non-members. As such, these features may not be listed for the category members on their own, but may be

used to describe the instances of a category if an explicit or implicit reference is made to the category itself within particular contexts.

In addition, the attribution of features to a category member could depend upon whether or not an instance is being viewed solely in terms of its membership in that category. For example, less typical instances of a category are more likely to have more dominant memberships in contrasting categories and to share features with other members of these contrasting categories (Rosch and Mervis, 1975). These instances are also more susceptible to differences and changes in opinion about their membership in the categories they are less typical of (McCloskey and Glucksberg, 1978). If the boundaries of a category can be shifted, then the use of features for describing particular instances may also be shifted. For example, it might be said that all instances of "clothing" are things that are "worn" and that a less typical instance of "clothing", such as a "purse", can be "worn" as part of an outfit. However, a "purse" may also be said to be "carried" rather than "worn", when considered in light of its membership in the contrasting category "bag".

It should be noted that the categories that will be examined here as "contrasting" categories are not contrasting in the strictly logical sense of A-not-B. This is so because instances may be considered to be members of a category and a contrasting category simultaneously. For example, a "purse" might be considered to be a type of "cloth-

ing" and a "bag". The term "contrasting" is used here to emphasize that these categories can be contrasted. Based on this organization, an instance could be described either in terms of a category's features (e.g., a "purse" is "worn") or excluded from this description while being described by the features of a contrasting category (e.g., a "purse" is "carried").

It therefore follows that the features associated with categories need not be necessary descriptions of the categories' instances. It is proposed here that the features associated with categories are characteristics that are commonly asserted for the categories and that these features are used as "norms" for describing categories and instances. If features are used as "norms", rather than having fixed, all-or-none relations to categories and instances, their use could be modified to meet the demands of particular contexts. For example, based on a commonly asserted relation between a feature and a category (e.g., all types of "clothing" being "worn", or all types of "vehicles" being "used for transportation"), a feature could be considered common to all members of a category and used to describe that category's members. In another context though, the exceptions to applying a feature norm could be focussed on.

A model of knowledge representation will be presented here to illustrate how features may be used as norms. Within this model, features will be designated as "deontic norms" (Wright, 1963) in accordance with the ways they are commonly

asserted for categories. Features will be described as deontic norms because these norms are not invalidated by the exceptions of individual cases. This is so because they are generic prescriptions rather than strictly logical descriptions (Wright, 1963, p. 23, p. 111). For example, a common prescription for an action is "Open the window". This statement prescribes what ought to be done, based on a common ability to do it. That is, a window is a thing that can be opened, and this statement prescribes that someone ought to do this. However, if, in response to this request, one tries to open the window but can't (e.g., it is stuck), this does not invalidate the prescription. There is still the generic ability to open windows, even though the individual act was invalidated. On the other hand, if the generic ability were invalidated (e.g., if windows were not things that could ordinarily be opened) then the prescriptive norm would be invalidated.

This framework seems well suited for how we use features. For example, our assertion that "chairs" are "used to sit on" is not invalidated by the individual case of a "broken chair" that can not be "used to sit on", as this feature still has a generic applicability to "chairs". Similarly, "chairs" may be said to have "seats", "backs" and "legs" without being invalidated by instances of "bean bag chairs". In other words, features may be used as "norms" to assert what should be or usually is the case, and may be associated with a category because they are commonly prescribed charac-

teristics of that category. While such feature norms may be used to generally describe what should be the case, they may also be applied dynamically to meet the needs of particular contexts. As such, exceptions may be focussed upon without invalidating the general applicability of a feature.

In addition, features may be considered to be applicable to subsets of instances within a category, rather than to all members of a category. For example, some, but not all, types of "furniture" are "made of wood", and "furniture" may also be "used to sit on" even though all types of "furniture" are not expected to be "sat on". Within other psychological models of knowledge representation, some of these features have been designated as "characteristic" rather than "defining" features (Hampton, 1979; Smith, Shoben and Rips, 1974). These features can not be necessary or sufficient for a category (and, therefore, "defining" in the traditional sense), as they are not applicable to all members of a category. On the other hand, if these features are "norms", then they could be used to define memberships within categories. This would be the case if they are commonly prescribed to subsets within a category and are specifically related to the memberships of these subsets of instances in the category.

Three types of deontic norms will be used to describe the relations of features to categories. These three types of norms have principally been used in deontic modal logic for theories of action and change (Hilpinen, 1971; Wright,

1963). They are "obligation" (what ought to be, or should be), "permissibility" (what is permitted, or may be), and "impermissibility" (what is not permitted, or may not be). The norm relations of features to categories will be designated in terms of their use in defining the membership of instances in categories and the sets of instances that they delineate in relation to the categories. The instance set relations between the feature norms and the categories can be expressed in terms of quantification and the "ideal" worlds these relations represent.

Features will be designated as one of these three types of norms based on the following criteria. Features will be described as "Obligatory" for a category if they can be taken as common to "all" instances of that category and can be used to define the membership of all the instances in that category. For example, all types of "clothing" may be considered to be things that can be "worn" and may be defined as members of "clothing" because they can be "worn". The "Permissible" features of a category will be those features that are common to "some" of the instances of that category and are used to define these instances' membership in the category. For example, some types of "clothing" are "used to keep warm" and this feature may be used to define these instances' membership in "clothing". Features will be designated as "Impermissible" for a category if they are used to define the membership of none of the instances of a category. For example, none of the instances of "clothing"

may be considered members because they are "used when cooking".

It should be noted that the designations of features as norms will be made explicitly in terms of how the features are used for defining category memberships. Therefore, if it is "impermissible" for a feature to be used to define membership in a category, that does not mean that it is "impermissible" for an instance of that category to <u>have</u> that feature. For example, we may not say that an "apron" is a type of "clothing" <u>because</u> it is "used when cooking", even though we know that "aprons" are a type of "clothing" that have this feature. Rather, the feature "used when cooking" may be used to define an "apron" as a type of "kitchen item". The feature "worn", on the other hand, may be used to define an "apron" as a type of "clothing". In this way, the feature norm designations will be made by explicitly noting which features are associated with which categories, as well as noting whether the features are considered to be common to "all" or "some" of the members of these categories.

If this structuring of information is context sensitive, then categories and their features should be accessible without the categories being explicitly mentioned. As discussed earlier (p. 3), categories may be used as implicit set distinctions when their members are being described. For example, "aprons" may be described as being "worn" or "used for cooking" based on whether their membership in "clothing" or "kitchen items" is relevant to the context they are being

described in. In addition, subset distinctions within the categories may also be accessed for describing instances. Permissible features should be used to describe the members of these subsets, as these features describe "some" but not "all" members of the categories. For example, if two types of "clothing" that are members of the subset "warm clothing" are mentioned together, then they may be described as being "used to keep warm".

The type of contexts that are of concern here are those which require information to be accessed from a natural category organization. One of the goals is to identify the specific locations of information that provide a basis for retrieving information that is relevant to particular contexts. It is also of interest to examine how the information is used in different contexts. It should be found that category and feature descriptions are adapted to fit particular contexts based on their relations within a natural category organization. The description of instances when they are being compared will be examined, and the category/set distinctions that instances share membership in should provide the basis for these comparisons. If the natural category organization described here is "context sensitive", then the same organization should be used for comparing instances that is used for describing/defining the instances' category memberships.

It is hypothesized that instances will be compared in terms of their "least-upper-bound" shared memberships within

the taxonomic organization of categories, subsets and contrasting categories, when no explicit mention is made of the categories they belong to. For example, the least-upper-bound shared category for "coat" and "jacket" may be the subset "warm clothing" under "clothing". Relevant responses for what is the same about these instances would therefore be that "they are both used to keep warm" or that "they are both warm clothing". If two instances of a category do not share membership in a subset of a category, then the category itself should be accessed as the instances' least-upper-bound shared membership. For example, a "jacket" and "pants" may not share membership in a subset of "clothing" (e.g., they may not be defined as "clothing" by any of the same permissible features, such as being "used to keep warm"). These instances would therefore be said to be the same because they are both "clothing" and are "worn".

For describing what is different about two instances, it is proposed that the level immediately below the least-upper-bound shared category will be used. If two instances of a category do not share membership in a subset, then subset information should be used to describe what is different about these instances. For example, a "jacket" is "worn on the upper body" and "pants" are "worn on the lower body", or a "jacket" is "used to keep warm" and "pants" are "worn at all times". In contrasting instances that do belong to the same subset, comparisons may be made within that subset (i.e., "below" the subset level). For example, a "coat" is a

"warmer" piece of clothing than a "jacket".

In addition, when comparing instances from different categories (e.g., "coat" from "clothing" and "saw" from "tools"), a taxonomic level higher than these categories should be accessed for the least-upper-bound shared membership of these instances. For example, a comparison of what is the same about a "coat" and a "saw" might be made in terms of their both being "functional artifacts" and being "used by people". The comparison of what is different about these instances would be made in terms of their respective categories, as these categories would be at the level below their least-upper-bound shared membership. For example, it might be said that a "coat" is "clothing" and a "saw" is a "tool", or that a "coat" is "worn" and a "saw" is "used to build things". In this way, information may be accessed based upon implicit category/set distinctions within the proposed taxonomic organization, to meet the needs of particular contexts.

At the same time, the proposed taxonomic organization should reflect a family resemblance structuring of information. In support of family resemblance structuring, Rosch and Mervis (1975) found that more typical members of a category share more features with other members of that category, and that less typical instances share more features with members of contrasting categories. However, Rosch and Mervis's findings were based on the features listed for single instances. These features may or may not be directly

related to the categories and the memberships of instances in the categories. For example, "handle", "teeth" and "cuts" are features listed for a "saw" (Rosch, Mervis, Gray, Johnson, and Boyes-Braem, 1976). It might not be said that a "saw" is a "tool" because it has a "handle" and "teeth", but it might be said that a "saw" is a "tool" because it is "used to cut". As such, a feature like "cuts" could be related to a category like "tools" as well as to its individual instances, even though the feature may only describe some of the category's instances. The family resemblances within the proposed taxonomic organization should therefore be reflected in the features directly related to the categories which are used to define the instances' memberships.

Based on the present model, the membership of a category's more and less typical instances should be defined by that category's Obligatory features. This should be the case if Obligatory features can be used to describe all of the members of a category. However, Permissible features should be used to define the membership of a category's more typical instances more often than they are used to define the membership of their less typical instances. This should be the case because the more typical instances of categories share more features with other members of those categories (Rosch and Mervis, 1975). As Permissible features should describe some, but not all, of a category's instances, these features would be shared by only some of the instances in a category and would reflect the more typical instances'

greater family resemblance to other members of these categories. The memberships of more typical instances should therefore be defined by Obligatory features and Permissible features, while the memberships of less typical instances should be defined by the Obligatory features alone. As well, less typical instances should have more Impermissible features which define their memberships in contrasting categories, as these instances share more features with members of contrasting categories (Rosch and Mervis, 1975).

For example, "jacket" is a highly typical member of "clothing" (Rosch, 1975). Its membership should be defined by the Obligatory features of this category (e.g., "worn") and by this category's Permissible features (e.g., "used to keep warm", "covers upper body", etc.). The membership of a less typical instance, such as "watch" in the category "clothing", should also be defined by the Obligatory features of that category (e.g., it is "worn"). But few, if any, Permissible features should be used to define its membership in the category. Rather, less typical instances should have features which are Impermissible definitions for the category, which are used to define their memberships in contrasting categories. For example, the feature "tells time" may not be used to define the membership of a "watch" in the category "clothing", but may be used to define it as a "timepiece".

If the features are "norms" and do not bear "all-or-none" relations to the categories and their instances, then

they should also be dynamically applied to this family resemblance structuring. As found by McCloskey and Glucksberg (1978), the less typical instances of a category are more susceptible to changes in opinion about their membership in these categories. Similarly, a feature of a category could be both applied or not applied to its less typical instances, depending upon the context. For example, an Obligatory feature might be used to describe what is the same about the more and less typical instances of a category. As such, a "sweater" and a "purse" might be described as the same because they are both "worn" as parts of an outfit or "clothing". On the other hand, a "sweater" and a "purse" might be said to be different because one is "worn" and the other is "carried" and "holds items". A less typical instance like "purse" could therefore be included in the category "clothing" (e.g., it is "worn") or excluded from "clothing" in terms of its membership in a contrasting category. That is, a "purse" could be taken to be a "bag" which is "carried" and is used to "hold items" instead of its being a type of "clothing" that is "worn".

In this way, shifts in the use of feature norms (e.g., "worn") would be dependent upon the contexts they are used in. The negation of a feature norm for an instance in one context would not invalidate that feature being used to describe the instance in another context. As such, a "purse" might be said to be something that <u>can</u> be "worn". But in contrast to other types of "clothing", it may be more com-

monly described as being "carried". In this way, Obligatory, Permissible and Impermissible features could be used as norms to describe sets of instances, without necessitating an all-or-none relation to these instances. In line with the family resemblances of instances, the shifts in applying the feature norms should most notably occur with less typical instances, as these instances should be described in terms of their memberships in contrasting categories or sets in the appropriate contexts.

Finally, it is predicted that primarily "functional" features will be used as feature norms for categories and their instances. These features should be used for defining the memberships of instances and making comparisons between instances. "Functional features" are broadly defined here as the functions or purposes of things, the actions performed with them, or the actions of an object independent of an agent (see Nelson, 1978). These features should be used because of their centrality and importance in people's conceptualizations of objects (Barsalou and Bower, 1980; Nelson, 1974). When subjects are asked to list the features of concrete, "basic level" categories, the parts of objects are the most frequently listed features (i.e., structural features such as "blade" and "handle" for "saw"; Hemenway, 1981). In contrast, functional features may be more relevant to decisions about why an instance might be considered a member of a category, and what is the same and different about instances. For example, a "saw" may be said to be a

type of "tool" because it is "used to cut", and "used to cut" may also be used to describe what is the same about a "saw" and "scissors" and what is different about a "saw" and a "hammer". As such, functional features may play a central role in the taxonomic structuring of information based on their use as norms for describing instances.

As proposed by Miller and Johnson-Laird (1976), "functional schemata" may be used to translate the perceptual features of objects into functional conditions (e.g., which are the relevant parts of an object and what are the relations between the parts). For example, a "saw" has a "blade" so that it can "cut", and the "handle" and "blade" of a "saw" are related to each other in terms of how a "saw" is "used to cut". Functional features may therefore have a more general "explanatory" capacity which would be useful when describing objects. However, it will be important to examine how these different types of features are used in relation to each other, as well as how these features may be classified. For example, it should be noted when the "blade" of a "saw" is mentioned in relation to its "cutting", and whether "used to cut" can also be classified as "structural", if this feature implies the presence of a "blade". In this way, the organizational relations between the different types of features can be more closely examined.

Overview of Experiments

The purpose of the present research is to identify how people organize their natural category knowledge such that

it can suit the different ways they use it. While people may not have well-defined or well-bounded category structures, they are capable of determining and defining category memberships to meet the demands of particular contexts. General relations must therefore be represented between categories, features and instances that do not formally delimit the ways this information can be used. Instead, these relations must indicate how information may be used in different contexts.

The research will examine these relations in the following manner. First, the taxonomic organization of categories and cross-classifications of instances will be identified. The instance-set relations between categories will be examined to determine whether the categories that instances belong to have category/subset relations or contrasting category relations. Second, the relations between categories and features will be examined. These relations will be determined by noting which features are used to define memberships in the categories and the instance sets that these features are applicable to within the categories. The features will be identified as applicable to all members of a category, some members of a category, or as not being related to a category if they are not used to define memberships in that category, but are used to define memberships in a contrasting category. Third, how the above taxonomic organization and relations betweeen features and categories are used to generate descriptions of instances will be looked at, in relation to the contexts in which the

instances are mentioned. Two contextual determinants will be examined, 1) how instances are described relative to the other instances they are mentioned with, and 2) whether the context focusses on the similarity or differences between the instances.

These three aspects of the research were carried out in three experiments, in the order described above. Brief descriptions of the experimental tasks are given in Table 1. In all of the experiments, the instances used as stimuli were high typical members (most typical instances) and low typicality members (least typical instances) of 4 superordinate categories, "clothing", "tools", "furniture", and "vehicles".

In the first task of Experiment 1, subjects were asked to list the categories that the instances belong to. In the second task of Experiment 1, subjects were asked to compare the superordinate categories to the other categories listed for the instances, in terms of their instance-set relations (e.g., "Are all bags types of clothing?"). Based on these instance-set relations, the other categories were classified as "subsets" of the superordinates, "contrasting" categories of the superordinates, or categories at a "higher" level than the superordinates.

In the first task of Experiment 2, subjects were asked why the most and least typical instances of the superordinates are members of these categories, and why they are members of the other categories generated for them in Experi-

Table 1

Descriptions of and Predictions for Experimental Tasks

Task Descriptions	Predictions
Experiment 1: Instance Categorizations	
Task 1: Category memberships	
Listing categories that superordinates' Most and Least Typical Instances belong to.	Most Typical Instances should receive more Superordinate and Subset categories than Least Typical Instances do. Least Typical Instances should receive more Contrasting and Higher-level categories than Most Typical Instances do.
Task 2: Instance-set overlaps	
"Yes" and "No" responses for questions comparing superordinates to other categories generated for instances in Task 1 (e.g., "Are all types of clothing bags?"). Instance exceptions requested if "No" responses given (e.g., listing "shirt" as "clothing" that is not a "bag"). Comparisons of superordinates to Experiment 2, Task 1 feature definitions also included (e.g., "Are all types of clothing things that are worn?").	Least Typical Instances should be excluded from superordinates more often than Most and Middle Typicality Instances for questions in which the superordinates follow the other categories or feature definitions (e.g., "purse" listed as not being "clothing" for "Are all bags types of clothing ?"). (see "Results and Discussion" section following Experiment 2, Task 1).
Experiment 2: Feature Definitions	
Task 1: Membership definitions	
Definitions for why Most and Least Typical Instances are members of superordinates and of other categories generated for them in	Superordinate memberships of Most and Least Typical Instances should be defined with equal frequency by features applicable to all

Table 1 (continued)

Task Descriptions	Predictions
Experiment 1, Task 1. Determination of whether features are applicable to all or some members of the superordinates based on the superordinate-feature instance-set comparisons in Experiment 1, Task 2.	of a superordinate's members (Obligatory features). Superordinate memberships of Most Typical Instances should be defined by features applicable to some of superordinate's members (Permissible features) more often than Least Typical Instances' memberships. Least Typical Instances' memberships in Contrasting categories should be defined by features not used to define memberships in superordinates (Impermissible features) more often than for Most Typical Instances' contrasting memberships.
Task 2: Feature classifications	
Classifying feature definitions as "functional", "structural", "physical", "locational" or some other classification. Judges asked to give multiple classifications for a feature, if more than one is felt to be applicable. Features used for comparing instances in Experiment 3, that were not used to define memberships in Task 1, were also included in this task.	Features used to define memberships should be primarily "functional" (i.e., they should be classified only as "functional", or should be classified more often as being "functional", but also as having other classifications as well/ multiple classifications).
Experiment 3: Context Sensitivity	
Task 1: Instance Comparisons	
Comparing instance pairs in	What is the same about

Table 1 (continued)

Task Descriptions	Predictions
terms of what is the same and different about them. Instances pairs will share membership in either a subset of a superordinate, a superordinate but not a subset, or in a higher-level category (i.e., not sharing membership in a superordinate). Subset memberships based on subset classifications for instances in Experiment 1, Task 1, and Permissible feature definitions in Experiment 2, Task 1 (i.e., features describing some members/subsets within the superordinates). Classifications of features used to describe similarities and differences (i.e., as "functional", "structural", etc.) based on classifications given the features in Experiment 2, Task 2.	instances?: Instance pairs should be described in terms of their least-upper-bound shared membership in a subset, superordinate, or higher category. at is different about instances?: Instance pairs should be described in terms of set distinctions at the level immediately below their least-upper-bound shared memberships (e.g., different subsets if membership shared in superordinate but not subset). Descriptions adapted to contexts: The same feature or category should be used to describe what is the same and different about an instance pair. In the "same" context, the feature or category will be used to describe both instances. In the "different" context, the instance that is less typically described by the feature or category will be excluded from that description and the excluded instance will be given a contrasting description. Feature classifications: feature descriptions at all taxonomic levels (subset, below-subset, superordinate and higher) should all be primarily "functional" (see predictions for Experiment 2, Task 2).

ment 1. Instance-set comparisons between the superordinates and the features used to define memberships in the superordinates (e.g., "Are all types of clothing things that are worn?") were tested with the superordinate-other category comparisons in Experiment 1, Task 2, and are reported as part of Experiment 1, Task 2. Based on these comparisons, the features were identified as being applicable to either all or some of a superordinate's members. In addition, those features used to define instances' memberships in contrasting categories, but not in the superordinates, were also identified. In the second task of Experiment 2, subjects were asked to classify the features as "functional", "structural", "physical", "locational", or some other classification. The types of features used to define memberships in the superordinates were examined based on the classifications they received in this task.

In Experiment 3, subjects were asked to compare pairs of instances in terms of what is the same and different about them. The instance pairs in this experiment shared membership in either a subset of a superordinate, a superordinate but not a subset, or were members of different superordinates (i.e., shared membership at a taxonomic level higher than the superordinates). The types of features used to describe the instances in this experiment (i.e., "functional", "structural", etc.) were also examined, based on the classsifications they received in Experiment 2, Task 2. Features that had been used to describe the instances in

this experiment, but had not been used to define memberships in Experiment 2, were also included in the Experiment 2, Task 2 classification task.

The predictions for these experiments (see Table 1) are all related to how information may be used in different contexts. A deontic model of representation was developed to account for the adaptable relations between categories and features, and the flexible manipulation of instance sets that are expected to be found. In terms of a taxonomic organization, instances should be classified as belonging to the categories that they are most typically considered members of (Experiment 1, Task 1). The greater family resemblance of the more typical instances to other members of the superordinates should be seen in their receiving a greater number of subset classifications (Experiment 1, Task 1) and permissible feature definitions for their memberships (Experiment 2, Task 1) than the less typical instances. In contrast, the less typical instances should receive more contrasting category classifications, as well as more definitions for their memberships in these categories that are impermissible as membership definitions in the superordinates. The feature norms associated with categories should therefore be used to describe instances in accordance with the instances' most common classifications.

However, the relations between features and categories, and the instances they can describe, should not be fixed. For one, as instances can be cross-classified, the member-

ships of less typical instances in the superordinates should be defined as often as those of more typical instances, by features that can be used to describe all members of the superordinates (i.e., a superordinate's Obligatory norms; Experiment 2, Task 1). But the less typical instances should also be excluded from the superordinates when the superordinates are contrasted to their feature norms (Experiment 1, Task 2). For example, a "necklace" may be defined as "clothing" because it is "worn", but may also be said to be something that is "worn" that is not "clothing". In addition, it should be found that instances are excluded from the description of a feature that they are also described by, depending on the context (see the third prediction for Experiment 3 in Table 1).

Based on these relations, feature norms and category memberships may be adapted simultaneously to fit particular contexts. For example, the membership of a less typical instance (e.g., "purse" in "clothing") could be defined by a feature that is used to describe all of the category's members (e.g., "worn"), even though this feature is not always considered to be descriptive of the instance and the instance is not always considered to be a member of the category. This flexibility, in turn, would allow instance pairs to be described in terms of their least-upper-bound, shared memberships (Experiment 3). For example, a most typical and a least typical instance of a superordinate should be described as similar in terms of their superordinate and its

Obligatory norms, even though the less typical instance may be excluded from the description of these norms and the superordinate, when the differences between these instances are being described. Note, however, that in the "difference" context, the superordinates' less typical instances in such cases are expected to be described primarily by subset/Permissible feature distinctions, the differences between instances should be described most frequently in terms of the level immediately below their least-upper-bound, shared membership, which would be the subset level for a superordinate pair.

A computer implementation of the descriptions generated in Experiment 3 was also undertaken to further examine the proposed system of representation. In this implementation, a knowledge base was constructed using the taxonomic organization and cross-classifications described here, and the representation of features as norms for categories and instances. Strategies were then implemented for retrieving the information to describe instances' similarities and differences. While these strategies were generally guided by the least-upper-bound shared memberships of the instances, more specific strategies were also needed to generate the particular types of descriptions produced for the instances in Experiment 3, and to flexibly adapt descriptions for specific instance comparisons. These strategies required additional relations to be represented in the knowledge base, indicating additional ways that information needs to be

organized to facilitate its different uses. This implementation is described in Appendix 5.

Finally, in the experiments reported here, superordinate categories and their instances were used to test the proposed deontic model of representation for particular reasons. Superordinates have been found to have few, if any, attributes common to all of the members (Rosch, et al, 1976). Features that are considered to be common to all members of a superordinate can therefore be examined for their use as "norms" (i.e., as Obligatory rather than necessary features). In addition, as superordinate categories were used, all of the instances in the experiments are "basic" level categories (e.g., "coat" and "jacket" for "clothing", and "saw" and "hammer" for "tools"; Rosch, et al, 1976). Since basic level categories have been found to have significantly more features associated with them than the superordinates do (Rosch, et al, 1976), they provide a rich sample of features that may be used for defining their memberships in the superordinates and for describing what is same and different about them. While the largest percentage of features listed for basic-level categories are structural parts (Tversky and Hemenway, 1984), it is predicted here that primarily functional features will be used to describe and define the memberships of instances (Experiment 2, Task 1 and Experiment 3). This would indicate that functional features are best suited to be used as general "norm" descriptions, in contrast to more specific structural features.

Experiment 1: Instance Categorization

In line with the "family resemblance" of superordinate instances, Rosch and Mervis (1975, Experiment 2) hypothesized that "the more prototypical a member of a superordinate category, the less dominant its membership would prove to be in categories other than (that) superordinate" (p. 585). In support of this hypothesis they found that the more typical a member was of a superordinate, the more likely it was to elicit that superordinate as a category to which it belongs. Conversely, less typical instances were found to elicit other categories more frequently.

In reporting these findings, Rosch and Mervis (1975) did not determine what the taxonomic relations were between these "other" categories and the superordinates. In particular, these other categories might be subsets under the superordinates, contrasting categories at the same taxonomic level as the superordinates, or taxonomically higher categories which subsume the superordinates. These taxonomic distinctions are important because more typical members may belong to more subsets of the superordinates. As the more typical instances of superordinates share a greater number of features with other members of these categories (Rosch and Mervis, 1975, Experiment 1) these features may be shared within subsets of the superordinates. In contrast, less typical instances should belong to more contrasting categories, and should share features with other members of these contrasting categories that they do not share with members of

the superordinates.

Subsets of superordinates were generated when subjects were asked to list the categories that instances belong to for Loftus and Scheff's (1971) categorization norms. For example, "guitar" was classified as a member of the subset "Stringed Instrument" under the superordinate "Musical Instrument", as well as being classified as a "Musical Instrument". And "sofa" was classified as a member of the subset "Seat" (a "type of seat") under the superordinate "Furniture", as well as being classified as "Furniture". In both of these cases, the subsets are related to particular features that are shared by some, but not all members of these superordinates. "Seats" are "Furniture" that are used to "sit on" and may have "backs" and "legs", and "Stringed Instruments" are "Musical Instruments" that are played by "plucking" or "stroking" the "strings". As the more typical members of superordinates share more features with other members of these categories, features may be shared within subsets and the more typical members of the superordinates should be more likely to belong to these subsets.

In comparison, less typical members, which elicit the superordinates less often (Rosch and Mervis, 1975), should be classified more frequently as belonging to contrasting categories of the superordinates. For example, "clock" and "telephone" are low typicality members of "Furniture" (Rosch, 1975). These instances should elicit this superordinate and its subsets less frequently as categories they

belong to. Instead, tney should be classified more often as belonging to contrasting categories, such as "Timepiece" and "Communication Device" respectively. In addition, these less typical members should share features with other members of the contrasting categories that they do not share with members of the superordinate "Furniture" (e.g., features such as "tells time", "communication", "mechanical parts", and "electronic parts"). The lower family resemblance of less typical members found by Rosch and Mervis (1975, Experiment 1) could tnerefore be based on the membership of these instances in contrasting categories.

Categories that are taxonomically higher than the superordinates should also be considered, as Rips, Shoben and Smith (1973) found that less typical instances may be more closely connected to higher categories than to the superordinates. For example, they found that "chicken" is judged to be more similar to "animal" than it is to its immediate superordinate "bird". Less typical instances should therefore be more likely to elicit taxonomically higher categories.

It is therefore predicted that less typical instances should elicit contrasting and higher categories more frequently, and that more typical instances should elicit the superordinates and subsets of the superordinates more frequently. Two tasks were performed to test these predictions, with different subjects participating in each task. In the first task, subjects were asked to list the categories that

superordinate instances belong to. The procedures used in this task were similar to those used by Rosch and Mervis (1975, Experiment 2) and Loftus and Scheff (1971). The second task was used to classify the categories received in the first task. In this second task, subjects were asked to compare categories received in the first task to the superordinates in terms of their instance set overlaps. For example, subjects were asked whether all "weapons" are types of "tools", and whether all types of "tools" are "weapons". Categories received in the first task (e.g., "weapons") were then classified as either subsets or contrasting categories of the superordinates (e.g., "tools"), or as categories taxonomically higher than the superordinates.

Task 1: Category memberships

Method

Subjects. Subjects were 36 students from introductory undergraduate psychology classes at Brooklyn College of the City University of New York. The subjects were run in groups and participated in the experiment for course credit.

Stimuli. A total of 48 instances including 6 "most" typical instances and 6 "least" typical instances from each of 4 superordinate categories, "Tools", "Furniture", "Clothing" and "Vehicles", served as stimuli (see Table 2). The "most" typical instances within each superordinate category received an average rating of 1.9 or lower in Rosch's (1975) typicality norms and were the 6 most typical instances used by Rosch and Mervis (1975) in their "family resemblance"

Table 2

Superordinate Instances in Experiment 1, Task 1

Most Typical Instances	Least Typical Instances
Furniture	
Chair	Clock
Bed	Rug
Table	Closet
Dresser	Stove
Sofa	Counter
Desk	Picture
Vehicles	
Car	Skates
Ambulance	Blimp
Truck	Wheelbarrow
Streetcar	Sled
Bus	Elevator
Motorcycle	Horse
Tools	
Hammer	Cement
Tape Measure	Soldering Iron
Saw	Slide Rule
Drill	Scissors
Ruler	Stapler
Nails	Hatchet
Clothing	
Skirt	Handkerchief
Pants	Purse
Coat	Necklace
Shirt	Gloves
Jacket	Apron
Dress	Watch

experiments, except for the instances of the category "Tools" which Rosch and Mervis (1975) did not test and the instance "streetcar" which was used here instead of "trolleycar". The "least" typical instances from each superordinate received an average rating of 4.2 or greater in Rosch's (1975) typicality norms and 14 of these instances were among the 6 least typical instances of the superordinates tested by Rosch and Mervis (1975).

Procedure. The stimuli were presented in testbooklets, with one stimulus item printed at the top of each page. The instructions were printed on the first page of each testbooklet, and were as follows:

"This is a simple experiment to find out what categories people feel different things belong to. On the top of each page you will see the name of something. Under each name you will see 3 lines. On each line I want you to write a category to which the thing belongs. For example, if the name were diamond, you might write stone, jewel, or mineral (etc.).

Note that all the words you will see are to be interpreted as things, not as actions. For example, if you saw the word dress, interpret it as the thing that is worn, rather than the action of getting dressed.

With each name, write the first three categories you think of. There will be 16 names in all that you will respond to. Work at your own pace, writing down three categories for each name in the order that you find them.

Now, when you are done reading these instructions, look up and I will tell you when to start."

Three sets of instances were constructed, each containing 16 stimulus items with 4 instances from each superordinate, 2 most typical instances and 2 least typical instances. Each testbooklet contained one of these three sets. Four orders of each set were presented. In each of the orders, most and least typical instances were presented alternately and 3 instances from the other superordinates were presented between instances from the same superordinate. No time limit was set on the task, and most subjects completed it within 20 minutes. Twelve subjects were assigned to each of the stimulus sets.

Task 2: Instance set overlaps

Method

Subjects. Subjects were 110 undergraduates from 5 lower division psychology classes at Lehman College and Hunter College of the City University of New York. All subjects participated on a volunteer basis as part of their classroom activity.

Stimuli. Two sets of stimuli were presented. In the first set, the stimuli were all questions of the form "Are all _____ types of _____ ?". In each of the questions, a category received in Task 1 was mentioned first and one of the superordinates was mentioned second. Each category compared to a superordinate was one that had been listed for an instance of that superordinate in Task 1. For

example, "Appliance" had been listed for "stove" (a less typical instance of "Furniture") and "Used for warmth" was listed for "jacket" (a more typical instance of "Clothing"). As such, two of the stimulus questions in this task were "Are all appliances types of furniture?" and "Are all things used for warmth types of clothing?". Fifty-four of the categories received in Task 1 were tested with the 4 superordinates "Tools", "Furniture", "Clothing", and "Vehicles" in the first set of questions (see Table 3).

The second set of stimuli consisted of 166 questions of the form "Are all _____ types of _____?" or "Are all types of _____ _____?". In the second question form, the superordinates preceeded the categories (e.g., "Are all types of furniture appliances?"). All of the categories tested in the first set of stimulus questions were compared to the superordinates in this second form of question, with the exception of "Things made of material" not being compared to "Clothing". Also included in the second set of stimuli were questions that compared the superordinates to features used to define their instances' memberships in Experiment 2, Task 1. These features are listed under the 4 superordinates in Table 4, and were compared to the superordinates in both question forms. For example, the questions included "Are all things that move people types of vehicles?" and "Are all types of vehicles things that move people?". A few other comparisons were also made (see Table 4) using both question forms, with the exception of those

Table 3

Categories Tested with Superordinates in Experiment 1, Task 2

Clothing	Furniture
Things that have 2 legs	Things used to Eat on
Feminine Things	Wood Objects
Things made of Cloth	Appliances
Bags	Things used to Sit on
Things used for Warmth	Storage Places
Garments	Things used to Put/Store Clothing in
Jewelry	Things that have Frames
Timepieces	Things used to Sleep on
Things made of Material	Tables
Protection	Things used for Cooking
Things Worn by Women	Work Areas
Things used to Blow your Nose in	Timepieces
	Things used to Put Things on
	Things used to Cover the Floor
Tools	**Vehicles**
Building Substances	Things used to Transport
Hard Substances	Things made of Metal
Things used to Cut	Transportation
Things used to Cut Wood	Aircraft
Things used to Hold Things Together	Bicycle/Bike
Things used to Measure	Toys
Things used with Wood	Trolleys
Office Equipment	Animals
Things used to Make Holes	Cars
Things used to Calculate	Things that have Wheels
Weapons	Tools
Rulers	Machines
Things that are Hot	Things used to Transport Things
Metal Objects	Things that have Passengers

Table 4

Additional Classifications Tested with Superordinates in Experiment 1, Task 2

Clothing	Furniture
Things that are Worn (that one Wears)	Things that Take up Space
Things that Cover	Things that are Stationary
Things that Cover the Body	Things used in Houses/Homes
Things Made for the Body	Things used in Rooms
Parts of Outfits	Things used for Comfort
Fashions	Things that Decorate
Things that Decorate the Body	Things that Decorate Rooms
Things that Protect the Body	Things that Hold the Body
Things that Protect from Weather	Things that Hold Things
Things that Cover from Weather	Things Placed on Walls
Things Carried in Pockets	

Tools	Vehicles
Things that are Useful	Things that Move
Things that Do Something	Things that Move Things
Things that help do Work	Things that Move People
Things that help do Job	Things that Travel
Things used by Hand	Things that Transport People
Things used with Manual Force	Things that Transport People and Things
Things used to Build	Things that Carry Things
Things used to Fix Things	Things that Carry People
Things used to Destroy	Things used to Get from One Place to Another
Things that Take Things Apart	Things that Take you Places
Things that Join Things Together	Things that are Ridden
Things used to Hit	Things that are Driven
Things used to Hit Nails	Things that have Motors/ Engines
Things Made of Wood	
Things that have to do with Metal	

Other Comparisons

Weapons - Things that are Dangerous
Toys - Things that are Played with
Sports Equipment - Things used for Recreational Purposes
Building Materials <- Things that Harden
Vehicles, Clothing & Tools - Things that are Put Away
Vehicles, Furniture & Clothing - Things that Hold/Contain People
Tools & Vehicles -> Things Made of Wood
Things used to (Eat on; Work on; Write on) -> Things used to Put Things on

that were compared in only one order, as indicated by the arrows in Table 4. For example, one of the stimulus questions was "Are all things that harden types of building materials?", but the question "Are all types of building materials things that harden?" was not included.

Procedure. The stimulus questions were presented in testbooklets, with one stimulus question printed at the top of each page. The instructions were printed on the first page of each testbooklet, and were as follows:

"The purpose of this experiment is to find out whether people consider all members of some categories to be members of other categories. The procedure will be as follows: on the top of each of the following pages you will find one question. Each question will ask whether all members of one category belong to another category. For example, questions might be "Are all pets types of animals?", "Are all things that are sailed types of boats?", or "Are all things that give light types of lamps?". Respond to each of the questions with either a "yes" or a "no", in the blank following the question. If you respond "yes" to the question, go on to the next question on the next page. If you respond "no" to a question, list under that question examples of the first category that you think don't belong to the second category. For example, you might respond "no" to "Are all things that give light types of lamps?", and then write sun, candles, flashlight, etc. under that question. When you are done listing the exceptions that come to mind easily (you do not

have to list all possible exceptions!), go on to the next question on the next page.

Now, work at your own pace, responding to each question as you see fit. Answer one question at a time, in the order that you find them. There are 18 questions in all. When you are done reading these instructions, look up and the experimenter will tell you when to start."

For the first set of stimuli (questions containing the categories and superordinates shown in Table 3), three subsets of stimuli were constructed, each containing 18 stimulus questions, with each superordinate being mentioned in either 4 or 5 questions in each subset. The 3 subsets were presented in different testbooklets and five orders of each subset were presented. In each of the orders, three questions containing the other superordinates were presented between questions containing the same superordinate. No time limit was set on the task, and most of the subjects completed the task within 20 minutes. Each stimulus subset was presented to 10 subjects.

For the second set of stimuli (questions containing the feature classifications, categories and superordinates shown in Tables 3 and 4), 8 subsets of stimulus questions were constructed, each containing from 20 to 23 questions. Each subset was presented in a different testbooklet, and the instructions for these subsets stated that the subjects would be answering from 20 to 23 questions. Each superordinate was mentioned in 3 to 6 questions in each subset, and

none of the feature classifications or categories were mentioned more than once in any subset. In each subset, each superordinate was mentioned in questions in which they preceeded feature classifications or other categories and questions in which they followed the feature classifications or categories. Five orders of each subset were presented, and between any 2 questions mentioning a particular superordinate, there were 3 questions without that superordinate, and each subset contained 2 or 3 questions without any of the superordinates. Ten subjects responded to each subset, and most subjects completed the task within 25 minutes.

Results and Discussion

The three most frequent categorizations generated for each instance in Task 1 are shown in Appendix 1. Of the 1,728 responses requested in Task 1, 1,595 responses (92%) were received. Two types of responses were not included in the analyses. One hundred and thirteen responses (7%) were not categories that the the instances belong to, but were either instances that belong to the same categories as the stimulus instances or were types of the stimulus instances. For example, "jacket" elicited "sweater", which is also a member of "Clothing", and also elicited "blazer", which is a type of "jacket". Fifty-four of these responses were generated for the most typical instances, and 59 were generated for the least typical instances. "Instance" responses were included in the analyses though, when there were appropriate subsumption relations. For example, "ambulance" was classi-

fied as a type of "car". Because an "ambulance" can be considered to be a type of "car", this categorization was included in the analyses even though both "car" and "ambulance" are more typical instances of "Vehicles" (Rosch, 1975). The second type of response that was omitted from the analyses were those that referred to different meanings for the lexical items. For example, "table" was classified as a type of "Mathematical Chart", and "drill" was classified as a "Routine". There were 35 of these responses, 24 of them being produced for the most typical instances.

A large percentage of the remaining responses (65.2%) were features or categorizations based on featural distinctions. For example, a "coat" was categorized as "Warm" and as "Something that is used to keep warm". Responses were classified as "features" if they fit one of the following criteria: 1) the categorization began with "Something" or "Thing", or ended with "thing", 2) the stimulus did not have a "type of" or "is a" relation to the categorization (e.g., a "coat" is not a type of "Warm"), and 3) the categorization was something that the instance could be considered a "type of", but was also something that the instance could be "used for" or "used to do". A categorization that the third criterion was applicable to was a "car" being classified as "transportation". While a car can be said to be a "type of" transportation, a car is also "used for" transportation and is therefore a feature of cars.

Responses were classified as "features" for the follow-

ing reasons. A primary purpose of the present experiment was to find out wnether superordinate instances belong to more subset or contrasting categories of the superordinates, in line with their typicality in the superordinates. While a feature such as "used to keep warm" may be related to a "coat" being a member of the subset "Warm Clothing" within the superordinate "Clothing", there are also things that are not members of the category "Clothing" that are "used to keep warm". For example, in Task 2, subjects were asked whether all "things that are used to keep warm" are types of "clothing". Some of the things that were listed as being "used to keep warm" that are not "clothing" were "blankets", "heaters", the "sun" and "coffee". As such, based on the responses in Task 2 alone, it was not possible to determine whether the features are related to subsets within the superordinates or to contrasting categories of the superordinates.

To make these determinations, it was necessary to first find out whether the features are used to delineate the memberships of subsets of instances within the superordinates or not. That is, it was necessary to determine whether the features are "Permissible" or "Impermissible" norms for the superordinates. The features will be given these "norm" classifications in Experiment 2, based on whether or not they are used to define the memberships of instances in the superordinates. As such, none of the featural categorizations were included in the present analyses, but reanalyses

were done for the present experiment with the featural responses included, after the features have been classified in Experiment 2 (see Experiment 2).

The remaining category responses were then classified as either 1) the superordinates of the instances, 2) "Subset" categories under the superordinates, 3) "Contrasting" categories of the superordinates, or 4) categories that are taxonomically "Higher" than the superordinates. The "Subset", "Contrasting" and "Higher" categories were classified based on the following criteria.

Categories were classified as "Subsets" of the superordinates if their labels were adjective modifications of the superordinates. For example, "Winter Clothing", "Motorvehicles", "Powertools" and "Classroom Furniture" were classified as subsets of the superordinates "Clothing", "Vehicles", "Tools" and "Furniture" respectively. The responses in Task 2 were also used for classifying the categories. Categories were classified as "Subsets" if they received a majority of "Yes" responses for the questions in which the categories preceeded the superordinates (e.g., "Are all garments types of clothing?") and did not receive all "Yes" responses for the questions in which the superordinate preceeded these categories (e.g., "Are all types of clothing garments?"). The categories were classified as "Contrasting" categories of the superordinates if they received a majority of "No" responses for the questions in which the categories preceeded the superordinate (e.g., "Are all types of jewelry

clothing?") and received "No" responses for the questions in which the superordinate preceeded the category (e.g., "Are all types of clothing jewelry?").

Responses were classified as "Higher" categories (e.g., "Transporter") if they corresponded to features (e.g., "used to transport") that received all "Yes" responses for the questions in which the superordinates preceeded the feature (e.g., "Are all types of vehicles things that transport?"), but received "No" responses for the questions in which the features preceeded the superordinates (e.g., "Are all things used to transport types of vehicles?"). Categories were also classified as "Higher" if they could subsume 2 or more of the superordinates (e.g., "Object" and "Commodity") or were contrasting categories to such higher categories (e.g., "Animate Object" in contrast to "Inanimate Object", which could subsume all of the superordinates).

The hypothesis for this experiment was that the superordinates and their subsets would be used to categorize the superordinates' most typical instances more often than they are used to categorize their least typical instances. In comparison, a greater number of contrasting and higher categories were expected to be generated for the least typical instances. Table 5 shows the total number of superordinate, subset, contrasting and higher categories generated for the 24 most and 24 least typical instances of the superordinates.

t-tests were performed to test the hypothesis. It was

Table 5

Number of Categories Listed for Superordinate Instances in Experiment 1, Task 1

	Categories			
	Superordinate	Subset	Contrasting	Higher
Most Typical Instances	136	60	62	8
Least Typical Instances	33	28	180	9
Totals	169	82	242	17

found that the superordinates were listed more often for the most typical instances, $t(46) = 7.62$, $p < .001$, and that the subsets of the superordinates were also listed more often for the most typical instances, $t(46) = 2.27$, $p < .05$. In contrast, the least typical instances were categorized more often as belonging to contrasting categories of the superordinates, $t(46) = 5.31$, $p < .001$. However, no difference was found between the number of higher categories listed for the least typical instances and those listed for the most typical instances, $t(46) = .24$, ns..

These results support the hypothesis for this experiment, with the exception of no difference being found in the listing of higher categories for the most versus least typical instances. As found by Rosch and Mervis (1975, Experiment 2), the superordinates' more typical instances were more frequently categorized as belonging to the superordinates. Rosch and Mervis also found that more typical instances are less dominantly categorized as belonging to categories other than the superordinates. They took this as indirect evidence of these instances having less in common with (i.e., bearing less "family resemblance" to) members of other categories.

This "family resemblance" implication of Rosch and Mervis's received further support here, when it was determined whether the "other" categories that the instances belong to are subsets or contrasting categories of the superordinates. It was found that the subsets of superordinates were listed

more often for more typical instances, while the less typical instances were categorized more often as belonging to contrasting categories of the superordinates. The more typical instances of superordinates should therefore have more in in common with subsets of instances within the superordinates, while the less typical instances should have more in common with members of contrasting categories. This possibility will be tested more directly in Experiment 2. Experiment 2 will examine whether the memberships of the superordinates' more typical instances are defined by features that are applicable to "some" but not "all" of their members (i.e., the superordinates' "Permissible" features) while the memberships of less typical instances in contrasting categories are defined by features that are "Impermissible" as definitions in the superordinates.

The finding that higher categories were not listed more frequently for less typical instances was counter to what was predicted. This result may be related to the small number of higher categories that were generated for the instances (see Table 5). While Rips, Shoben and Smith (1973) found that less typical instances are felt to be more similar to higher categories than to the superordinates they are less typical of, these categories may not be used as often when categorizing individual instances. Instead, instances appear to be categorized in terms of their memberships in the superordinates, and the superordinates' subsets and contrasting categories. However, taxonomically higher levels

should be relevant in contexts where the levels under them can't be used to describe instances. For example, when instances from different superordinates are being compared, they may be described in terms of their shared memberships in taxonomically higher categories. As such, the instances of "Tools" and "Clothing" could be described as "Commodities" which you "buy". This potential use of higher categories will be examined further in Experiment 3.

The present experiment also showed that features play a strong role in the classification of instances, as a majority of the categorization responses were features or categorizations based on featural distinctions. One reason why featural categorizations may have been generated in the present experiment is that listing a category a second or third time in a modified form may be felt to be redundant. For example, once the category "Clothing" has been listed for an instance of "Clothing", it may be redundant to list the subset "Warm Clothing" for that instance. Instead, the instance can be classified as something that is "used to keep warm". In this way, it could be implied that the instance is a type of "Warm Clothing" without having to explicitly state this classification.

However, the listing of features as well as the categories that instances belong to does not indicate what relations the features have to the categories. For example, "apron" was classified as "Clothing" and as something that is "used for cooking". This feature may be related to a con-

trasting category of "Clothing" that "apron" belongs to (e.g., "Kitchen Items") rather than a subset of "Clothing". It is therefore necessary to determine whether the features are related to subsets or contrasting categories of the superordinates, before examining how features are used for classifying instances within a taxonomic organization of information. In Experiment 2, the relations of features to categories will be examined in terms of how the features are used to define category memberships. After it has been determined which features are related to which categories, the categorization responses in the present experiment will be reanalyzed with the featural classifications included.

Experiment 2: Feature Norm Definitions

A good deal of attention has been paid to how the membership of instances in "natural" categories may be determined. Given tnat necessary and sufficient features may not be identifiable, the structuring of natural category information has been examined to find ways in which instances may be included or excluded from categories (see Smith and Medin, 1981, for a review). However, little research has been done on how people use features to define the membership of instances in natural categories.

Hampton (1979) asked subjects for features that they felt define membership in superordinate categories. He was able to arrive at sets of necessary features for all of the superordinate categories he studied. Included among these categories was the superordinate "Furniture", wnich Rosch, et al (1976) found had no features common to all of its members (this finding was based on judge-amended tallies rather than raw tallies). But the sets of necessary features that Hampton found proved problematic, in that, for 6 of the 8 superordinates he studied, these features were applicable to nonmembers as well as members. An extreme example was that the features applicable to all members of "Furniture" were also applicable to the nonmember "van". Subsequently, he outlined a model using nonneccessary features, and the weighting of features for instances, to exclude nonmembers.

Of interest here is that Hampton (1979) was able to find features used to define membership in the superordi-

nates that were common to all of their members. If these features are used as "norms" rather than being necessary or sufficient, then they could define the membership of instances witnout formally delimiting category boundaries. For example, less typical instances of categories (e.g., "picture" and "clock" for "Furniture") are borderline cases subject to differences and changes in opinion about their membership (McCloskey and Glucksberg, 1979). In contexts where less typical instances are considered members, the features common to all instances of a category could be used to define their membership. However, the features should also be used to describe the instances when they are excluded from a category and are considered to be nonmembers. Or, in some cases, instances may be described by the features only when they are being included in a category. For example, a "purse" might be described as being "worn" only if it is being considered a type of "clothing". In this way, features would be used as "norms" for describing category instances without formally delimiting category boundaries or bearing fixed extensional relations to instances, as their applicability would depend on the contexts they are used in.

In the deontic model of representation proposed here, features that are taken as common to all members of a category and are used to define these memberships will be designated as "Obligatory" norms for these categories. In the following experiment, subjects were asked why most and least

typical instances of superordinates are members of these categories. In Task 2 of Experiment 1, subjects were asked whether the features used to define membership in these superordinates are common to all of their instances. It is predicted that the features taken as common to all members of the superordinates (i.e., the Obligatory feature norms) should be used to define the membership of less typical instances as often as they are used to define the membership of more typical instances. In Experiment 1, Task 2, subjects were also asked whether all things that can be described by the features are members of the superordinates. In the context of this inquiry, it is expected that less typical instances will be frequently excluded from the superordinates. Thus, fixed category boundaries would not be necessitated by the use of category feature norms, as instances could be included in or excluded from a category depending upon the context and the same features could be used to describe the instances in both cases.

The family resemblance structuring of natural categories should also be reflected in the use of feature norm definitions. As found by Rosch and Mervis (1975), more typical instances share more features with other members of the superordinates (i.e., they bear a greater "family resemblance" to other members), while less typical instances bear a greater family resemblance to members of contrasting categories. In the proposed deontic model of representation, "Permissible" feature norms should be applicable to some,

but not all members of the superordinates, and should be used more often to define the membership of more typical instances. In this way, the more typical instances would bear a greater family resemblance to other members of the superordinates in the feature definitions that they share with some, but not all members of the superordinates. In contrast, less typical instances should elicit more feature definitions in contrasting categories that are not used to define the membership of instances in the superordinates, as they should share more features with members of contrasting categories than with members of the superordinates. These features will be designated as "Impermissible" for the superordinates.

In the following experiment, most and least typical instances were also presented together, and subjects were asked why these instance pairs are members of the superordinates (e.g., why "chairs and clocks" are types of "Furniture"). This condition should be similar to asking why the least typical instances alone are members of the superordinates. The memberships of these pairs should be defined by Obligatory features that are common to all members of the superordinates, as the least typical instances should share few Permissible features with the more typical instances.

In addition, it is predicted that the feature norm definitions will be primarily "functional" features. In an additional task, graduate student judges were asked to classify the feature definitions as "functional", "locational",

"structural", "physical", or as some other classification or combination of these different types. The feature definitions are expected to be classified principally as "functional" features or as having functional components (e.g., "used in houses" is both functional and locational). This prediction is made because the feature norms should provide general descriptions that can be either applied or not applied to superordinate members. For example, instances of "clothing" are things that are "worn". This general function of "clothing" can be related to the more specific "structural" parts and "locations" of particular types of "clothing", but does not necessarily have to be used to describe an instance, especially if the instance is not considered to be a member of "clothing". For example, a "purse" may or may not be considered a member of "clothing", and may or may not be said to be "worn". As such, a functional feature like "worn" can describe instances of "clothing", but whether an instance is considered to be something that is "worn" could be related to whether the instance is viewed as a type of "clothing".

Finally, the categorization responses received in Experiment 1 will be reanalyzed, as a large percentage of these categorizations (65.2%) were featural classifications. It should be found that the most typical instances elicited more Obligatory and Permissible features as classifications. This would be in line with their more frequently being categorized as belonging to the superordinates and subsets of

the superordinates (see Experiment 1), an Obligatory feature corresponding to a superordinate as a whole and a Permissible feature corresponding to a subset of "some" of a superordinate's members. In comparison, the less typical instances should be classified more often by the superordinates' Impermissible features, in line with their more dominant membership in contrasting categories of the superordinates.

Task 1: Membership definitions

Method

Subjects. Subjects were 60 students from 3 lower division, undergraduate psychology classes at Hunter College and Lenman College of the City University of New York. Subjects participated in this experiment as part of their classroom activity.

Stimuli. The stimuli were 120 questions of the form "Why is a _____ a type of _____ ?" (e.g., "Why is a hammer a type of tool?") or "Why are _____ and _____ types of _____ ?" (e.g., "Why are hammers and slide rules types of tools?"). Table 6 shows all of the instances and pairs of instances with the superordinates and other categories they were tested with in the stimulus questions (the instance pairs were only tested with the superordinates). The instances were the same as those used in Experiment 1, Task 1, and most and least typical instances were tested as pairs if they had not elicited the same Subset category in Experiment 1, Task 1, or what were suspected to be common

Table 6

Instances Tested with Superordinates and Other Categories in Experiment 2, Task 1

Furniture

Most Typical Instances	Least Typical Instances
Chair (Wood Object)	Clock (Timepiece)
Desk (Work Area)	Rug (Floorcovering)
Bed (Thing for Sleeping On)	Stove (Appliance)
Sofa (Seat)	Counter (Table)
Dresser (Wood Object)	Closet (Storage Place)
Table (Thing for Eating On, Thing to Put Things On)	Picture (Thing that has a Frame)

Most-Least Pairs

Chairs and Clocks
Desks and Rugs
Beds and Stoves
Sofas and Counters
Dressers and Pictures
Tables and Closets

Clothing

Most Typical Instances	Least Typical Instances
Jacket (Thing used for Warmth)	Necklace (Jewelry)
Skirt (Feminine Thing)	Purse (Bag)
Dress (Thing Worn by Women)	Watch (Timepiece)
Coat (Outergarment)	Handkerchief (Thing Made of Cloth)
Shirt (Thing Made of Material)	Gloves (Thing used for Warmth)
Pants (Thing that has 2 Legs)	Apron (Thing used for Protection)

Most-Least Pairs

Jackets and Necklaces
Shirts and Purses
Pants and Aprons
Skirts and Gloves
Coats and Handkerchieves
Dresses and Watches

Table 6 (continued)

Vehicles

Most Typical Instances	Least Typical Instances
Car (Thing that has Wheels)	Blimp (Aircraft)
Ambulance (Car)	Horse (Animal)
Streetcar (Transportation)	Wheelbarrow (Transport)
Motorcycle (Bicycle/Bike)	Elevator (Machine)
Bus (Thing that has Passengers)	Sled (Toy)
Truck (Thing that Transports Things)	Skates (Thing Made of Metal)

Most-Least Pairs

Buses and Sleds
Ambulances and Horses
Streetcars and Wheelbarrows
Cars and Elevators
Trucks and Blimps
Motorcycles and Sleds

Tools

Most Typical Instances	Least Typical Instances
Hammer (Metal Object)	Slide Rule (Calculator)
Saw (Thing that Cuts)	Stapler (Office Equipment)
Ruler (Thing that Measures)	Cement (Hard Substance)
Tape Measure (Ruler)	Scissors (Things that Cut)
Drill (Thing that Makes Holes)	Hatchet (Weapon)
Nails (Things that Hold Things Together)	Soldering Iron (Thing that is Hot)

Most-Least Pairs

Hammers and Slide Rules
Saws and Staplers
Rulers and Cement
Drills and Scissors
Nails and Hatchets
Tape Measures and Soldering Irons

Permissible features for these instances (e.g., "saw" and "scissors" were not paired because they are both "used to cut"). The categories other than the superordinates were those categorizations generated either first, second or third most frequently for the instances in in Experiment 1 (see Appendix 1).

Procedure. The stimulus questions were presented in testbooklets with one stimulus question printed at the top of each page. The subjects were allowed to respond to the questions in whatever way they wanted (e.g., by listing a single feature that defines the membership of an instance, by listing several defining features, or by writing out a definition that includes one or more features). The instructions were printed on the first page of each testbooklet, and were as follows:

"The purpose of this experiment is to find out what people think is the reason for different everyday objects belonging to certain categories. The procedure will be as follows: on each of the following pages you will find one question. Each question will ask why some object may be considered to be a type of thing that belongs to a category. For example, a question might be "Why is a gun a type of weapon?", "Why are words a type of weapon?", or "Why is a sword a type of thing made of metal?". Answer all of the questions, writing down the first answer that comes to mind. Work at your own pace, answering one question at a time. Answer the questions in the order that you find them. There

are 20 questions in all. When you are done reading these instructions, look up so that the experimenter knows that you are ready to start."

Six sets of stimuli were presented, each set containing 20 stimulus questions with 2 most typical and 2 least typical instances from each of the four superordinates, and 1 most-least typical instance pair from each superordinate. Each testbooklet contained one of the 6 sets, and 10 subjects responded to each set. Most subjects completed the task within 25 minutes. In each set, one most and one least typical instance from each superordinate was presented with that superordinate, and the other two instances from each superordinate were presented with the other categories they could belong to. The instances in the instance pairs were always different from those presented as single instances in the same set, and were always presented with their superordinates. Two orders were presented of each set. In each order, the questions mentioning a superordinate and those mentioning one of the other categories were presented alternately, and between any two questions containing the same superordinate, there were 5 to 9 questions that contained the other superordinates or categories. Between any two questions with instances from the same superordinate, there were at least two questions with instances from the other superordinates, and the instance pairs were always presented last.

Results and Discussion

The features used to define memberships in the superordinates are shown in Appendix 2. The features shown in parentheses in Appendix 2 are alternative forms of the features or related features. When tabulating the features, each feature was counted separately if 1) it was listed separately, when a subject listed the features that define a membership, 2) it was mentioned in a separate sentence, when a subject wrote a short paragraph defining a membership, or 3) it was mentioned as one of the features in a conjunction of two or more features (e.g., "it travels and transports people"). The features in one type of conjunction were not counted separately. These were conjunctions used to define the membership of most-least typical instance pairs. Each feature in these conjunctions described one of the instances in the pair, rather than describing both of the instances. For example, "chair" and "clock" were described as being used to "sit on" and "tell time". These conjunctions are shown in Appendix 2 at the bottom of the list of features for each superordinate, and were analyzed with the other features in a separate analysis.

The features were classified as "Obligatory" or "Permissible" for membership in the superordinates based on the responses received in Task 2 of Experiment 1. Features were classified as "Obligatory" for a superordinate if they received all "Yes" responses in that task for the questions in which the superordinate preceeded the feature (e.g., "Are

all types of clothing things that are worn (that one wears)?"). Features were also classified as "Obligatory" if 6 out of 10 "Yes" responses were received for these questions, and the exceptions listed with the "No" responses were instance-set distinctions that had not been listed for the superordinate in Battig and Montague's (1969) norms (e.g., "vehicles in a museum" was given as a description of "vehicles" that don't "move").

Features were classified as "Permissible" if they received "No" responses for the questions in which the superordinate preceeded the feature and the exceptions listed were instances of the superordinate generated in Battig and Montague's (1969) norms. For example, "shorts", "swim suit" and "sandals" were listed with the "No" responses to "Are all types of clothing things used to keep warm?". The references to subsets of exceptions also described these instances (e.g., "clothing worn in the summer" was given as a description of "clothing" that is not "used to keep warm").

A third classification of the feature definitions, "High Permissible", was also used. This classification was given to features that could describe all members of a superordinate, but received some "No" responses for the questions in which the superordinates preceeded the features. All of the exceptions listed with the "No" responses to these questions were of a certain type. These exceptions were generated by contrasting the features to other defining

features, and delimiting the features. For example, for the question "Are all types of clothing things used to decorate the body?", the exceptions "boots", "gloves", and "raincoat" were generated along with the response that clothing is "not necessarily used to decorate, but is used to protect or cover the body".

These types of contrasts will be referred to here as "exclusive disjunctions", because the features are treated like exclusive disjuncts in the context of generating exceptions. For example, "boots", "gloves", "raincoats" and other articles of clothing can be "decorative". But exceptions can be generated by contrasting this feature to other characteristics of "clothing" and noting the potential for instances of "clothing" to not be "decorative". For all of the features classified as "High Permissible", at least some of the exceptions were listed as members of the superordinates in Battig and Montague's norms. All of the exceptions that were not listed in Battig and Montague's norms were generated in a similar fasnion. For example, while "scarves" may be used to "protect the body", "decorative scarf" was listed as an instance of "clothing" that isn't.

Obligatory and High Permissible Features

It was necessary to classify features as "High Permissible" because these features can potentially be used to describe all members of a superordinate. Given their potential applicability to all members, they should be used to define the membership of least typical instances as often as

they are used to define the membership of most typical instances. As this is the same prediction that was made for the superordinates' Obligatory features, no difference should be found between the Obligatory and High Permissible features in how they are used to define the membership of most and least typical instances, or the most-least pairs.

Table 7 shows the total number of Obligatory and High Permissible features produced for the 6 most and 6 least typical instances and the 6 most-least typical instance pairs in each of the 4 superordinates. A 3 factor (categories by typicality types by feature types) ANOVA was performed, with repeated measures of the feature responses. The main effect difference between the number of Obligatory and High Permissible features was significant, $F(1, 60) = 7.42$, $p < .01$, and the main effect difference between the superordinates in the number of features they received (Obligatory and High Permissible) was significant, $F(3, 60) = 4.96$, $p < .01$. The interaction between the different superordinates and the types of features generated for them (Obligatory or High Permissible) was also significant, $F(3, 60) = 16.01$, $p < .001$. However, the interaction between the typicality of the instances (most, least and most-least pairs) and the feature types (Obligatory or High Permissible) was not significant, $F(2, 60) = 1.83$, n.s.. There was also no main effect difference for the typicality of the instances (i.e., in the number of features they elicited, Obligatory and High Permissible), and the interaction

Table 7

Number of Obligatory and High Permissible Features Received as Defining Membership in Experiment 2, Task 1

Instance types	Superordinates	Obligatory Features	High Permissible Features
Most Typical Instances	Clothing	31	11
	Tools	23	22
	Vehicles	25	33
	Furniture	5	29
	Totals	84	95
Least Typical Instances	Clothing	25	19
	Tools	17	19
	Vehicles	17	39
	Furniture	6	35
	Totals	65	112
Most-Least Typical Instance Pairs	Clothing	31	14
	Tools	17	27
	Vehicles	27	26
	Furniture	12	36
	Totals	87	103
	Grand Totals	236	310

between the typicality of the instances and the different superordinates was not significant (F was less than 1 for both of these).

These results support the hypothesis that the features that can be taken as common to all members of a category are used to define the membership of a category's most and least typical instances, as no difference was found in the total number of Obligatory and High Permissible features generated for the different typicality types. This use of the features was consistent across the different superordinates, as no significant interaction was found between the different superordinates and the typicality of the instances. In addition, the potential use of High Permissible features for describing all members of a category received support in that no interaction was found between the typicality of the instances and the number of High Permissible versus Obligatory features used to define their memberships.

This use of High Permissible features for defining category memberships highlights how features are used as "norms" rather than as "all-or-none" determinants of category membership. In the second task of Experiment 1, it was seen that High Permissible features need not be used to describe all members of a category. However, in the context of defining why instances are members of a category, these features were used as consistently as the Obligatory features for describing both more and less typical instances. In fact, the High Permissible features may play an important

role in defining category memberships, as High Permissible features were used more often than Obligatory features.

The greater number of High Permissible features is related to the significant interaction between the different superordinates and whether their Obligatory or High Permissible features were used to define the membership of their instances. High Permissible features were used to define memberships more often in some, but not all of the categories (see Table 7). Further tests were therefore performed on the simple effects in this interaction. From these analyses it was found that membership in the superordinate "Clothing" was defined more often by Obligatory features than High Permissible features, $F(1, 60) = 11.86$, $p < .01$. In contrast, High Permissible features were used more often to define memberships in "Furniture", $F(1, 60) = 38.04$, $p < .001$, and in "Vehicles", $F(1, 60) = 5.39$, $p < .05$. No difference was found for the category "Tools", $F(1, 60) = 0.16$, n.s..

These results indicate that High Permissible features are more important for certain categories. For example, memberships in "Clothing" may be defined less frequently by High Permissible features (e.g., they are "decorative"; see Appendix 2) because the instances of "Clothing" are commonly described by the Obligatory features for this category (e.g., they are "worn"). In contrast, the description of things as "Furniture" may depend on this category's High Permissible features (e.g., they are "used in rooms"). In

fact, it may be difficult to identify features that are common to all members of a category such as "Furniture" (Rosch, et al, 1976) because exceptions can be generated for their High Permissible features, as found in Experiment 1, Task 2. But these features are "norms" and not "all-or-none" determinants. Both the Obligatory and High Permissible features can be used to decribe all members of a category, but none of these features must necessarily be used in this way. For example, "worn" is an Obligatory feature of "Clothing" because "Clothing" should be "worn", but all types of "Clothing" are not necessarily always "worn".

Permissible Features

In contrast to Obligatory and High Permissible features, the Permissible features describe some category members and should be related to the instances' "family resemblances". Permissible features should be used more often for defining the memberships of more typical instances because these instances share a greater number of features with other members of their superordinates that are not shared by all of the members (i.e., they bear a greater "family resemblance" to other members of their superordinates; Rosch and Mervis, 1975). In contrast, less typical instances should elicit fewer Permissible features because they share few features with other members of the superordinates (Rosch and Mervis, 1975). Similarly, the most-least typical instance pairs should elicit few Permissible features, if the least typical instances do not share these features with

more typical instances.

Table 8 shows the total number of Obligatory, High Permissible and Permissible features received for the 6 most and 6 least typical instances and 6 most-least typical instance pairs in each of the 4 superordinates. The Obligatory and High Permissible feature responses were pooled, so that the Permissible features that describe only some members of the superordinates could be compared to the Obligatory and High Permissible features that can describe all members of the superordinates.

A 3 factor (categories by typicality types by feature types) ANOVA was performed, with repeated measures for the feature responses. All of the main effects were significant. Differences were found between the superordinates in the number of features they elicited, $F(3, 60) = 3.29$, $p < .05$, between the number of features elicited by the different types of instances (most typical, least typical, and most-least pairs) $F(2, 60) = 15.71$, $p < .001$, and between the number of different types of features elicited (Obligatory/High Permissible or Permissible), $F(1, 60) = 64.53$, $p < .001$. The interaction between the typicality of the instances and the types of features they elicited was also significant, $F(2, 60) = 6.5$, $p < .01$. The interaction between the different superordinates and the types of features they elicited was not significant, $F(3, 60) = 2.71$, n.s., nor was the interaction between the superordinates and the typicality of their instances significant, $F < 1$.

Table 8

Number of Obligatory, High Permissible and Permissible Features Received as Defining Membership in Experiment 2, Task 1

Instance types	Superordinates	Obligatory and High Permissible Features	Permissible Features
Most Typical Instances	Clothing	42	40
	Tools	45	32
	Vehicles	58	32
	Furniture	34	35
	Totals	179	139
Least Typical Instances	Clothing	44	25
	Tools	36	28
	Venicles	56	12
	Furniture	41	19
	Totals	177	84
Most-Least Typical Instance Pairs	Clothing	45	15
	Tools	44	11
	Vehicles	53	13
	Furniture	48	11
	Totals	190	50
	Grand Totals	546	273

The interaction between the typicality of instances and and the types of features may indicate that the more typical instances received a greater number of Permissible features (see Table 8). Analyses were performed on the simple effects in this interaction. Differences were found between the most and least typical instances in the number of Permissible features they elicited, $F(2, 60) = 12.38$, $p < .001$, and between the least typical instances and the most-least typical instance pairs for their Permissible features, $F(2, 60) = 4.73$, $p < .05$. No differences were found between the most and least typical instances in the number of Obligatory/High Permissible features they elicited, $F(2, 60) = 0.02$, n.s., or between the least typical instances and the most-least typical instance pairs for these features, $F(2, 60) = 0.69$, n.s..

These results support the hypothesis that Permissible features are used to define the memberships of more typical instances more often than they are used to define the membership of less typical instances. This difference between the more and less typical instances is also related to the difference found between the least typical instances and the most-least pairs, which will be discussed below. The main effect of typicality was due to the differences in the number of Permissible features that the instances elicited, as no differences were found in the number of Obligatory/High Permissible features received for the different typicality types (as was the case in the earlier analysis of the Obli-

gatory and High Permissible features). While a main effect difference was found in the number of features generated for the different superordinates, the use of Obligatory/High Permissible and Permissible features was equivalent for these categories, as no interaction was found between the superordinates and the types of features or between the superordinates and the typicality of their instances.

The greater number of Obligatory and High Permissible features features than Permissible features that were received was also due, for the most part, to the least typical instances and most-least pairs eliciting fewer Permissible features. But the most typical instances also elicited more Obligatory and High Permissible features than Permissible features (see Table 8). An analysis of this simple effect difference for the most typical instances was significant, $F(1, 60) = 4.16$, $p < .05$. Obligatory and High Permissible features therefore play a dominant role in defining category memberships, reflecting their ability to describe all members of a category, and thereby describe the relation of instances to a category as a whole.

On the other hand, the use of Permissible features reflects the "family resemblance" structuring within the superordinates. For one, the most typical instances were defined by more Permissible features than the least typical instances were. The more typical instances bear a greater family resemblance to other members of their categories through the Permissible features that they share with some,

but not all of the other members (see Appendix 2). In addition, the Permissible features that define the membership of less typical instances are less likely to be shared with other members of the categories. For example, "keep papers together" was used to define the less typical instance "stapler" as a type of "tool". Thirty four of the Permissible features elicited by the least typical instances (42% of the total number of Permissible features elicited for these instances) were used to define the membership of only one instance. In contrast, 17 of the Permissible features elicited by the most typical instances (12% of their total number) were used to define only one instance.

This is in line with Rosch and Mervis's (1975) family resemblance finding that more typical instances share more features with other members of the category, while less typical instances share fewer features with other members. In turn, the Permissible features that less typical instances do not share with other members can also be used to define their memberships in contrasting categories. For example, "purse" and "watch" were defined as "clothing" by the features "carry things around" and "tell time", respectively. These features were also used to define to their memberships in the categories "bag" and "timepiece". In this way, Permissible features are used as "norms" for describing instances relative to the categories they are being considered members of, rather than being "all-or-none" determinants of membership, and family resemblances are based on

which of these features are shared with other members of the categories.

It was also found that the least typical instances elicited more Permissible features than the most-least typical instance pairs. This was the case because a number of the Permissible features used to define the memberships of the most and least typical instances separately were not used to define the memberships of the most-least pairs (see Appendix 2). This finding further supports the family resemblance notion that less typical instances share few Permissible features with more typical instances.

However, definitions were also produced for the most-least pairs that described the instances separately. For example, "chair and clock" were defined as "furniture" because "tney are used to sit on and tell time". These definitions are shown at the bottom of the list of features for each of the superordinates in Appendix 2. All of the features in these definitions were Permissible features. When these definitions were included with the other Permissible feature definitions for tne most-least pairs, a one-tailed t-test showed no significant difference between the most-least pairs and the least typical instances within the four superordinates, $\underline{t}(6) = 1.306$. A similar analysis without the separately applicable definitions for the pairs showed a significant difference between the least typical instances and the most-least pairs, $\underline{t}(6) = 2.32$, $\underline{p} < .05$.

Impermissible Features

The second half of Rosch and Mervis's (1975) family resemblance hypothesis was that less typical instances should share more features with members of contrasting categories. In Experiment 1 here, it was found that less typical instances belong to more contrasting categories. In the present experiment, subjects were also asked to define the membership of instances in categories other than the superordinates (see Table 6). The instances had been classified as belonging to these categories in Experiment 1. It was predicted that the least typical instances' memberships in contrasting categories would be defined more often by features that are "impermissible" for the superordinates (i.e., features that are not used to define membership in the superordinates).

Table 9 shows the most and least typical instances included in the present analysis, with their contrasting categories. This sample is small because these were the only categories tested that could be clearly identified as contrasting categories of the superordinates. A number of the categories tested in this experiment (see Table 6) were related to features used to define memberships in the superordinates. For example, "machine" was identified as a contrasting category for "vehicles" in Experiment 1, and in the present experiment, subjects were asked why an "elevator" is a type of "machine". But the feature "mechanical" was received as defining membership in the superordinate "vehi-

Table 9

Number of Superordinate and Impermissible Features Defining Contrasting Category Memberships in Experiment 2, Task 1

Instances & Contrasting Categories	Superordinate Features: Obligatory and High Permissible Features	Superordinate Features: Permissible Features	Impermissible Features
Most Typical Instances			
Hammer (Metal Object)	1	1	10
Desk (Work Area)	1	5	6
Skirt (Feminine Thing)	0	9	3
Pants (Thing that has 2 Legs)	2	5	7
Totals	4	20	26
Least Typical Instances			
Sled (Toy)	0	0	10
Horse (Animal)	0	0	15
Cement (Hard Substance)	0	0	10
Purse (Bag)	0	4	8
Slide Rule (Calculator)	0	2	6
Stapler (Office Equipment)	3	3	8
Soldering Iron (Thing that is Hot)	1	2	7
Picture (Thing that has a Frame)	1	0	10
Totals	5	11	74

cle" in the present experiment (see Appendix 2).

The contrasting categories identified in Experiment 1, that are related to the superordinates' feature definitions, also elicited membership definitions that define membership in the superordinates. For example, "transports people" and "motor" were used to define why an "elevator" is a "machine". These features were also used to define memberships in "vehicle". A majority of the membership definitions for these categories were also used to define memberships in the superordinates (66.6% for the most typical instances and 64.2% for the least typical instances). Therefore, the categories related to the superordinates' feature definitions were not included in the present analysis. Reanalyses of the categorizations received in Experiment 1, based on whether they were related to the superordinates' feature definitions, will be reported later.

A Mann-Whitney test was performed on the remaining instances and categories, to determine whether the least typical instances elicited a greater proportion of Impermissible features than the most typical instances as defining their memberships in contrasting categories. For each of the instances in Table 9, scores were calculated by subtracting the number of Impermissible features (i.e., features that were not used to define membership in the superordinates) from the number of superordinates' Obligatory, High Permissible and Permissible features that were also used to define membership in the contrasting categories. The difference

between the most and least typical instances was significant, $U = 4.0$, $p < .05$.

These results support the hypothesis that less typical instances' memberships in contrasting categories are defined more often by features that are not used to define memberships in the superordinates (i.e., Impermissible features). For example, "sled", which is a less typical instance of the superordinate "Vehicles", was defined as a "Toy" by features that are not used to define memberships in "Vehicle" (e.g., it is "used for recreation" and "you play with it"). In comparison, the memberships of more typical instances in contrasting categories are defined by Obligatory, High Permissible and Permissible features of the superordinates. For example, "skirt", which is a more typical instance of "Clothing", was defined as a "Feminine thing" by features that are also used to define membership in "Clothing" (e.g., they are "worn by women" and "cover the body in a shapely manner").

The features used to define memberships in the contrasting categories reflect the instances' family resemblances. As the more typical instances' memberships in contrasting categories are defined by the same features used to define memberships in their superordinates, these are features that they share with other members of the superordinates. In contrast, the Impermissible features that define the membership of less typical instances are features they share with otner members of the contrasting categories, and

need not share with members of the superordinates.

It should be noted that the Impermissible features are impermissible for the superordinate categories as membership definitions. This does not mean that it is impermissible for the superordinate instances to "have" these features. For example, the features "living", "has 4 legs", "eats", and "drinks" were used to define a "horse" as an "Animal", and a "sled" was defined as a "Toy" because it is "used to play with". As these instances can also be considered "Vehicles", it is not impermissible for instances of this superordinate to "have" these features. Rather, these features do not describe why these instances are "Vehicles" and, therefore, are impermissible as definitions for membership in this category.

Exclusion from Category Membership

If features are used as "norms", then they should not be used as "all-or-none" determinants which set fixed boundaries around the extensional sets of categories. The features that category instances can be described as "having" should not necessarily determine their memberships, if features are generated as "norms" in response to the demands of particular contexts. For example, "skates" have "wheels" and "carry people". While these features can be used to define the membership of "skates" in the category "Vehicles", having these features should not determine whether "skates" are considered "Vehicles". Instead, "skates" can be described as "Toys" that have these features. The feature norms that are

used to define superordinate memberships should therefore also be used to describe superordinate members when they are being excluded from these categories. If instances are excluded from categories based on their membership in contrasting categories, then less typical instances should be excluded from the superordinates most often, as they are more frequently classified as belonging to contrasting categories.

The responses in Experiment 1, Task 2 provide a basis for examining the exclusion of instances from the superordinates. In that task, subjects were asked to contrast features and categories to the superordinates in terms of the instance sets they describe. For example, subjects were asked "Are all toys types of vehicles?" and "Are all things that carry people types of vehicles?". If the subjects gave a "No" response to one of the questions, they were asked to list the instances that are exceptions (e.g., listing "skates" or "balls" as toys that are not vehicles). Tables 3 and 4 show the features and categories compared to the superordinates in these questions.

Only four of these questions received "Yes" responses from all of the subjects that responded to them. Ninety-nine questions received "No" responses, and instances that could belong to the superordinates were were listed as not belonging to the superordinates for 78 of these 99 questions. The potential for excluded instances to also be included in the superordinates was determined by their having been listed as

members of the superordinates either in Battig and Montague's (1969) category norms or in response to the questions in Experiment 1, Task 2 in which the superordinates preceeded a feature or category (e.g., in response to "Are all types of vehicles things that have motors?", "skates" were listed as "vehicles" that don't have "motors").

The questions in which the superordinates' defining features preceeded the superordinates (e.g., "Are all things that carry people types of vehicles?") were compared to the questions in which other categories or features preceeded the superordinates (e.g., "Are all toys types of vehicles?"). Instances of the superordinates were excluded more often when the superordinates were contrasted to their defining features than when they were contrasted to other categories or features, $\underline{X}^2(1) = 4.59$, $\underline{p} < .05$. No difference was found between the different types of feature definitions (i.e., Obligatory, High Permissible or Permissible) that were contrasted to the superordinates, $\underline{X}^2(2) = .45$, n.s..

These results indicate that feature norms can not delineate category boundaries in an "all-or-none" fashion because they are used to describe instances when the instances are excluded from the categories, as well describing the instances' inclusion in these categories. In fact, in the absence of fixed category boundaries, the flexibility of feature norm descriptions are especially useful for manipulating category boundaries. The feature norms are well-suited for this purpose because of the large overlaps

between the sets of instances these features describe and the sets that can be considered members of the categories. For example, many of the things that "carry people" or are "used for transportation" can be considered "vehicles", and instances from within this overlap can be either included in or excluded from this category, depending on the context. In comparison, contrasting categories include larger sets of instances that are not commonly considered members of the categories (e.g., "toys" or "animals" that are not "vehicles"). As such, category members are more likely to be excluded when the category is contrasted to its features norms than if it is contrasted to other categories or features, as the feature norms provide a clearer reference to the categories' potential members.

It was also found that the superordinates' less typical instances were most frequently excluded from these categories. Of the potential members that were excluded, 78.5% were less typical instances (i.e., instances that received an average typicality rating of 4.2 or greater in Rosch's, 1975, typicality norms, or were listed 10 or less times in Battig and Montague's norms). These exclusions are in line with the less typical instances' family resemblances, as these instances belong to more contrasting categories and have more in common with members of contrasting categories. For example, when the categories "bag" and "timepiece" were contrasted to "clothing", the instances "purse" and "watch" were listed as not being "clothing".

It is also of interest that a fair number of moderately typical instances were excluded. Of the superordinate members excluded, 20.6% were moderately typical (i.e., instances that received an average typicality rating between 2.5 and 4.2 in Rosch's, 1975, typicality norms). For example, "shoes" and "hat" were listed as things that are "worn" and are "parts of an outfit" that are not "clothing". These exclusions are similar to the "exclusive disjunctions" described earlier, as these instances can be excluded if the superordinates' feature norms are given a narrower sense in these contexts. For example, "clothing" can be considered to be "worn on the body", with "body" being taken as synonymous to "torso" (e.g., the qualification "if cover the body included the head" was given with a "Yes" response to "Are all types of clothing things that cover the body?"). If "worn of the body" is delimited to the "torso", then it can be contrasted to "worn on the feet", "worn on the head", etc., and instances such as "shoes" and "hat" can be excluded from "clothing".

While people may include or exclude instances depending on the context, this does not mean that the context will necessarily determine whether or not instances are considered members of a category. In the membership definition task, subjects were asked to define the membership of instances that they might not usually consider to be members. For example, a "watch" can be considered to be a "timepiece" and not a type of "clothing". Subjects may

accept the notion of these instances being members (e.g., a "watch" being a type of "clothing") in the context of this type of task, and use the category's feature norms to define these memberships. But the membership of these instances does not have to be accepted in such a context. Some of the subjects said that instances are not members of the superordinates and gave no membership definitions for these instances. Other subjects stated that particular instances are not members (or that they did not consider them to be members), but gave membership definitions nonetheless.

Table 10 shows the number of responses received for the least typical instances and the most-least typical instance pairs that stated that they aren't members, or stated that they aren't members, but were given membership definitions anyway. None of these responses were received for the most typical instances with their superordinates, nor were any of the instances said not to be members of the other categories they were tested with (see Table 6). The exclusion of the most-least pairs was always based on the exclusion of the least typical instance in a pair from the superordinate, as stated by the subjects. Given the relatively small number of these responses and the fact that they were only received for the least typical instances, no statistical analyses were performed on these data. As can be seen in Table 10, more of these responses were received for the least typical instances on their own than when they were paired with the most typical instances, and only one response in which an

Table 10

Number of Responses for Instances Not Being Members of the Superordinates in Experiment 2, Task 1

Instance types	Superordinates	"Aren't Members"	"Aren't Members, but..."
Least Typical Instances	Clothing	3	4
	Tools	5	0
	Vehicles	2	0
	Furniture	5	3
	Totals	15	7
Most-Least Typical Instance Pairs	Clothing	3	1
	Tools	2	0
	Vehicles	1	0
	Furniture	3	0
	Totals	9	1

instance was not considered a member, but was given a definition anyway, was received for the most-least pairs.

These data confirm that the context affects how people view category memberships, but that contexts do not necessarily determine memberships. As a relatively small number of exclusions were made, subjects cooperated with the requests for the inclusion of instances, including instances that they might not otherwise consider to be members. The option was still available though to choose not to cooperate with such a request. The flexibility involved in responding to this type of context is most clearly seen with the subjects who did not consider instances to be members, but gave membership definitions anyway.

The strength of particular contexts can be seen in the responses to the most-least pairs. As the least typical instances were excluded less frequently when they were paired with more typical instances, their inclusion is apparently more strongly suggested when they are paired with these instances. For example, on its own, a "necklace" was said to be an "accessory" and something that "compliments clothing" and not a type of "clothing". But when it was paired with "jacket", the two were said to be "clothing" because "they can be worn like clothing".

The flexibility of feature norms is well-suited for the inclusion of instances that might not otherwise be considered members. For example, a "purse" was defined as a type of "clothing" because it "<u>can be</u> worn". This illustrates how

category feature norms are used in terms of their potential to descibe instances. Note that this can lead to some fairly abstract inclusions within categories, such as an "idea" being a "vehicle" because it "helps you get someplace". As the feature norms are potential rather than necessary descriptions of instances, the instances can also be excluded from from tnese descriptions. For example, a "purse" can also be said not to be "worn" and not be "clothing", in light of its being a "bag". The use of feature norms and instances' cross-classifications can therefore be coordinated, as none of the extensional relations between categories, features and instances are necessarily fixed, thus providing the basis for adjusting their relations to suit the demands of particular contexts.

The primary purpose of this experiment was to find out whether features are used as "norms" to describe category memberships, based on their potential to define the memberships of "all", "some" or "none" of a category's instances. A taxonomic organization of superordinates, subsets and contrasting categories was found, within which descriptions are generated for instances. However, if this taxonomic organization has a broader utility, then instances should be described in terms of their various memberships without having to mention tne categories they belong to. In Experiment 3, subjects will be asked to compare instances to find out whether instances' shared memberships are used to make these comparisons. It is predicted that instances will be

described in terms of their least-upper-bound shared memberships within the taxonomic organization (i.e., in subsets, superordinates, or in higher categories if they don't share a superordinate).

Before describing that experiment though, the types of features used to define memberships in the present experiment will be examined (i.e., whether they are "functional" features), and the categorization responses received in Experiment 1 will be reanalyzed. This reanalysis was done to determine whether the feature classifications generated for the more and less typical instances in that experiment are related to subsets of the superordinates (i.e., Permissible features), to all members of a superordinate (i.e., Obligatory or High Permissible features), or to contrasting categories (i.e., Impermissible features).

Functional Features

The types of features used to define the memberships of sets of instances in superordinate categories should be general in nature. The types of features most frequently listed for these instances are their "parts" (Tversky and Hemenway, 1984). For example, "blade", "handle" and "teeth" are features frequently listed for a "saw". But these features do not generally describe sets of instances, and may therefore not be used to describe why instances are related to a superordinate such as "tools". Part descriptions are not as general because they are often related to the particular, concrete characteristics of individual instances. For exam-

ple, "scissors" have "2 blades", and "scissors" may not have "teeth" or "handles" as "saws" do. But both of these instances are things that "cut". This general feature may therefore be used to describe sets of instances in relation to the superordinate "tools".

It may also be the case though, that other characteristics of objects, such as objects' structural and physical characteristics, are implied by "functional" features. For example, something that "cuts" is likely to have an "edge" that is "sharp". In this way, general, functional feature descriptions can also be related to the other characteristics of objects.

In the following task, subjects were asked to classify the feature definitions and to give the features more than one classification when they felt they were applicable. A feature such as "cuts" could therefore be classified as "functional", "structural" and "physical". Multiple classifications were also important for features in which a combination of different characteristics are explicitly referred to. For example, "used in houses" may be classified as "functional" and "locational".

The hypothesis for this experiment was that the feature definitions received in Task 1 would be primarily functional features. As multiple classifications were requested in the present task, it was recognized that any of the features may be given other classifications as well. Therefore, it was predicted that most of the feature definitions should be

classified as either only functional or dominantly functional.

Task 2: Feature classification

Method

Subjects. Subjects were 9 graduate students from the City University of New York Graduate Center. Each subject participated on a volunteer basis.

Stimuli. Most of the stimuli were features that had been received as membership definitions in the first task of this experiment. Features received in Experiment 3 that had not been received in the present experiment were also included in this task (the analysis of these features will be reported with Experiment 3). The 275 features used as stimuli are shown in Appendix 3.

Procedure. The features were presented in testbooklets, and each of the subjects responded to all of the stimuli. The subjects were given the testbooklets to complete on their own time and they took from 30 minutes to 2 hours to complete the task. The instructions were printed on the first two pages of the testbooklets, and were as follows:

"I have performed some experiments in which I asked undergraduates why objects are members of certain categories, and what is the same and different about these objects. For example, I might have asked why "knives" and "toasters" are "Kitchen Utensils" and what is the same and different about "knives" and "toasters". As well, I might have asked what is the same and different about members of

different categories (e.g., "knives" and "cars", "cars" being from the category "Vehicles"). From these experiments I received a wide range of features as defining memberships and as reasons why things are the same and different. All of the object names used in these experiments were from the categories "Tools", "Vehicles", "Furniture" and "Clothing".

What I would like you to do is specify what types of features you think these features are. For example, "cuts" and "cooking" might nave been received in relation to "knives" and these features mignt be classified as functional features (e.g., the purposes of objects, what is done with them, or what tney do). Or, the features "blade" and "handle" might have been received for "knives", and these features might be classified as structural features (e.g., the parts of an object, or descriptions of how the parts of an object are related to each other). In turn, the features "made of metal" or "hard" might have been received and these features mignt be classified as physical features (e.g., the physical properties of objects). Finally, the features "kitchen" and "outside" might have been received and tnese might be classified as locational features (e.g., where the objects are commonly located). There may also be combinations in these features (e.g., "cooking in kitchen"), and I would like you to specify the classifications that are combined for these features (e.g., functional and locational?). I want you to make your own decisions on these types though. If you disagree with the types of classifications I've given

here in the examples, that's fine. Space has been provided for you to write in your own classifications (under the heading of other) and to specify any qualifications of the classifications you may have.

On the following pages you will find all of the features I want you to classify in the left hand column. On the top of each page you will find the classifications Functional, Structural, Locational, Physical, and Other. For each feature, check at least one of the classifications you feel describes that feature, and check more than one classification if you feel that more than one is needed to describe a feature. Use the Other column if you feel it is necessary to specify any additional or alternative classifications. In that case, write in the classification that you feel is needed to describe that feature in the Other column.

Finally, you can write in any comments or "qualifications" you feel are necessary in applying a particular classification to a feature. For example, if you feel it is necessary to make the distinction that the functional feature (?) "cutting" is an "action" or "act" in contrast to "cooking" which might be considered a more extended "process", feel free to write these comments in with the checkmark for their Functional classification. You only need to make these comments though, if you feel they are necessary or if they help you make your classifications. Also, feel free to write any further comments on the reverse side of each page, if you need more space.

If the meaning or interpretation of any of the features is ambiguous, think of the feature in terms of how it might be attributed to an object (e.g., to objects in the four categories mentioned in the first paragraph here). For example, if you saw the feature "dress", it could be interpreted as the action of putting on articles of Clothing (i.e., as a feature that describes these objects). But it should not be interpreted as the name for an article of Clothing (i.e., a dress). If you have any further questions, please feel free to ask."

For ordering the stimuli in the testbooklets, the stimuli were first classified by the experimenter in terms of what their potential classifications might be. The stimuli were then ordered by alternating between the different classifications. Features were also presented alternately in terms of the different superordinates and different taxonomic levels the features were related to. For example, "Can be worn" was classified as a functional feature and is related to the superordinate "clothing". This feature was followed by the feature "Blades", which was classified as structural and is related to the subset of things that are "used to cut" under "tools". Similar features (e.g., "Build" and "Used to construct things") and similar labels for features (e.g., "Transportation" and "Made for transportaion") were presented at least 2 pages apart in the testbooklets.

Results and Discussion

A number of the judges gave qualifications for the

classifications, especially when they gave the features multiple classifications. Some of the judges ranked the multiple classifications for a feature, while others gave descriptions referring to the potential, but not necessary, applicability of a classification (e.g., that "fashionable" "could be" classified as "functional") or descriptions for why a feature might be given a classification (e.g., "measures" is "structural" because something that "measures" may be "scaled in intervals").

Each of the judges' feature classifications was given a score. If a judge gave a classification a rank of 1 for a feature, or the classification was not ranked or qualified, the classification was given a score of 1 for that feature. A classification was given a score of 1/2 if the judge gave a qualification with the classification or gave the classification a rank of 2 or greater. For the analyses, a feature was taken as having a classification if at least 2 of the judges gave a feature the classification. The lowest possible total score for a classification was 1 (i.e., two scores of 1/2) and the highest possible score was 9. Appendix 3 shows the classifications for the features and their total scores.

As can be seen in Appendix 3, a large number of the features were given multiple classifications (77.1%). The "dominant" and and "subordinate" classifications were noted for each of the features that received multiple classifications. A classification was taken as "dominant" for a fea-

ture if its score was the highest for that feature, and "subordinate" if its score was not the highest. For example, "worn on body" received a dominant "functional" classification and a subordinate "locational" classification, and is shown in Appendix 3 as Functional-Locational. Similarly, "worn to protect" was also classified as Functional-Locational, because of its implicit location of being worn on the body. In contrast, the feature "used in houses" received a dominant "locational" classification and a subordinate "functional" classification, and the order of dominance for this feature is shown in Appendix 3 as Locational-Functional. The scores are listed with the features in Appendix 3 in the order of the classifications' dominance. Three of the features received tying scores as "functional" and one of the other classifications ("locational" in each case) and were classified as dominantly locational (Locational-Functional) for the purposes of present analyses. This was done so that the strongest possible tests could be made of whether the feature definitions was primarily functional.

The hypothesis for the present experiment was that category memberships should be defined by primarily functional features (i.e., only functional or dominantly functional features). Table 11 shows the number of features used to define superordinate category memberships in Task 1 that were classified as only functional, dominantly functional, subordinately functional, or received no functional classification. To test the hypothesis, the number of features

Table 11

Number of Defining Features Classified as Functional for Different Superordinates in Experiment 2, Task 1

Defining Features	Classifications			
	Only Functional	Dominant Functional	Subordinate Functional	No Functional Component
		Clothing		
Obligatory	9	78	0	0
High Permissible	4	31	7	2
Permissible	17	47	4	12
Totals	30	156	11	14
		Tools		
Obligatory	47	10	0	0
High Permissible	56	12	0	0
Permissible	18	51	1	1
Totals	121	73	1	1
		Vehicles		
Obligatory	23	43	3	0
High Permissible	40	58	0	0
Permissible	6	25	18	8
Totals	69	126	21	8
		Furniture		
Obligatory	9	5	9	0
High Permissible	13	43	31	13
Permissible	17	27	6	15
Totals	39	75	46	28

that were only functional or dominantly functional were compared to subordinately functional features and those with no functional classification.

T-tests were performed to test the hypothesis. Within the four categories, the difference between the features that were only functional or dominantly functional versus those that were subordinately functional or not functional was significant, $t(6) = 5.68$, $p < .01$. Separate analyses of the same comparison were performed for the Obligatory, High Permissible and Permissible features. A greater number of the Obligatory features were only functional or dominantly functional, $t(6) = 3.42$, $p < .02$, as were the High Permissible features, $t(6) = 3.03$, $p < .05$, and the Permissible features, $t(6) = 3.49$, $p < .02$.

These results support the hypothesis that the feature definitions would be primarily functional, as most of the Obligatory, High Permissible and Permissible features were found to be only or dominantly functional. However, differences may also exist between the classifications of these features. Table 12 shows the totals for the classifications of the Obligatory, High Permissible and Permissible features across the superordinates. More of the High Permissible features than Obligatory features appear to be subordinately functional or without a functional component, and more of the Permissible features than High Permissible features appear to have no functional component.

These differences between the Obligatory, High Permis-

Table 12

Total Number of Defining Features from Experiment 2, Task 1 Classified as Functional

Defining Features	Classifications			
	Only Functional	Dominant Functional	Subordinate Functional	No Functional Component
Obligatory	88 (10.7%)	136 (16.6%)	12 (1.5%)	0 (0%)
High Permissible	113 (13.6%)	144 (17.6%)	38 (4.6%)	15 (1.8%)
Permissible	58 (7.1%)	150 (18.3%)	29 (3.6%)	36 (4.4%)
Totals	259 (31.6%)	430 (52.5%)	79 (9.7%)	51 (6.2%)

Note: Percentages are of the total number of features used to define membership in the superordinates (819).

sible and Permissible features may be related to the fact that these features are applicable to successively smaller sets of instances. For example, as found in Task 2 of Experiment 1, the Obligatory feature for "vehicles", "transportation", is applicable to a broader set of instances than the High Permissible feature "transports people from place to place", and the Permissible feature "operates on wheels" is applicable to a more specific set of instances than the High Permissible feature "transports people from place to place". If the classifications of the features are related to the size of the sets the features are applicable to, then the more specific the features are, the more likely they may be to have structural, locational, or physical components which reflect their specificity. For example, the Obligatory feature "transportation" was classified as Functional, the High Permissible feature "transports people from place to place" was classified as Functional-Locational, and the Permissible feature "operates on wheels" was classified as Structural-Functional.

Classifications other than the functional classification may therefore play a more dominant role with the increased specificity of the feature definitions. In line with this notion, a comparison of the Obligatory and High Permissible features was found to be significant, $\underline{X}^2(3) = 19.59$, $\underline{p} < .001$. Principle contributions to this Chi Square were tne larger proportion of Obligatory features that were dominantly functional and the larger number of

High Permissible features that were subordinately functional and had no functional component. A comparison of the High Permissible and Permissible features was also significant, $\underline{X}^2(3) = 23.67$, $\underline{p} < .001$. Major contributions to this Chi Square were the larger proportion of High Permissible features that were only functional and the larger number of Permissible features that had no functional classification.

These findings indicate that an increased dominance of structural, locational and physical components within the feature definitions is related to the specificity of the features. While the features were found to be primarily functional (i.e., only or dominantly functional), other characteristics are also indicated as being related to why the instances are members of the superordinates, as the features define the membership of successively smaller sets within these categories. The Obligatory features therefore provide the most general, functional descriptions of the superordinates' members, and the High Permissible and Permissible features more specifically define memberships by indicating other characteristics related to the instances' functions. For example, "vehicles" can most generally be described as being used for "transportation". But more specifically, they transport people from "place to place" and operate on "wheels".

However, the Obligatory, High Permissible and Permissible features are primarily functional. This may be so because functional features are best suited to be used as

"norms", given the general nature of functional features and the functional components in features. Other characteristics are not as general because they make sharper distinctions, which is why they are found in more specific features that describe smaller sets of instances. The distinctions they make are sharper because objects are commonly considered either to "have" or not "have" structural and physical characteristics, and either to "be" or not "be" in a particular location. Describing sets of instances in terms of these characteristics is therefore based on attributing them to objects per se, as they exist in the world.

In contrast, boundaries are not as well-established around the instances that can be described by functional features. This is so because functional features describe how people use things, rather than being characteristics attributed to objects per se. Functional feature descriptions therefore depend on whether people consider an object to be used for a particular function. For example, a "purse" can be said to be "worn", or may be said not to be "worn", depending on a person's perspective and how they wish to describe that object in a particular context. In this way, functional features and components in features provide a basis for generating general "norm" descriptions that do not bear "all-or-none" relations to the categories and instances they can describe. (These deontic characteristics of functional features are described further in the General Discussion).

Functional features may also be used as "norms" because of their relations to structural, physical and locational characteristics. These relations are most clearly seen in the large number of features that have multiple classifications with functional components (see Table 12 and Appendix 3). Functional features, therefore, do not need to be only functional. In fact, their relations to other characteristics are often implied. For example, "can be worn" was classified as Functional-Locational-Physical. While this feature is principally functional, a physical character and location are implied (e.g., being made of a material that "can be worn" on the body). Of course, the relations between other characteristics and functional components are also explicitly referred to within features, as in "worn on the body". Through these relations, functional features can be used as general "norm" descriptions and also refer to the more specific characteristics involved in fulfilling the functions. For example, when "clothing" is "worn", it should be "on the body".

Finally, differences may also exist between the different superordinates in the types of features that are used to define their memberships. As can be seen in Table 11, different proportions of their feature definitions were only functional, dominantly functional, subordinately functional or had no functional component. A significant difference was found between the different superordinates in the classifications of their Obligatory features, $\underline{X}^2(6) = 130.94$,

$p < .001$ (as all of the Obligatory features were classified as having a functional component, the "no functional component" classification was not included in this analysis). Significant differences were also found between the different superordinates in the classifications of their High Permissible features, $\chi^2(9) = 145.23$, $p < .001$, and their Permissible features, $\chi^2(9) = 48.92$, $p < .001$.

These differences reflect the particular characteristics of the different superordinates. For example, the Obligatory and High Permissible features for "tools" are, for the most part, only functional (e.g., they "help do work" and are "used to build"). In contrast, a large proportion of the Obligatory and High Permissible features for "clothing" and "vehicles" are dominantly functional, with subordinate locational components. This is the case because "clothing" is often on the body (e.g., they are "worn" and "cover the body") while "vehicles" go from one place to another (e.g., they "travel" and "move you"). The functions of "clothing" and "vehicles" are therefore related to where they are used and changes in location. On the other hand, instances of "furniture" are described by High Permissible features that either have subordinate locational classifications (e.g., they "decorate rooms") or dominant locational classifications (e.g., they are "used in houses"), or are only locational (e.g., they are "found in houses"). Location, as such, plays a strong role in describing "furniture".

The Permissible features, in turn, refer to structural

and physical characteristics, which are often related to the specific functions of the superordinates' instances, or the means by which the instances function. The superordinates differed in terms of whether these structural and physical components were dominant or subordinate. For example, a number of the Permissible features for "tools" were dominantly functional with subordinate structural components (e.g., they are used to "measure" and "join things together") or subordinate physical components (e.g., they are "used to cut"). In contrast, a number of Permissible features for "vehicles" were structural parts with subordinate functional classifications. For example, "has engine", "has wheels", and "tires" were all classified as Structural-Functional-Physical. Finally, some of the Permissible features for "furniture" and "clothing" were dominantly physical features that were not classified as functional (e.g., "made of wood" and "made of cloth" were classified as Physical-Structural). But Permissible features for "furniture" and "clothing" were also classified as only functional (see Table 11). These features describe the instances' specific functions, such as "furniture" being used to "sit on" or "hold things", and "clothing" being used to "protect from weather" and "keep warm".

For the most part, the Obligatory, High Permissible and Permissible features are functional descriptions of the instances. But these functions are also related to the instances' locational, structural and physical characteris-

tics. As the functional feature norms are used to define memberships in the superordinates, the other characteristics are related to how the instances of the different superordinates are used (e.g., "clothing" is used "on" the body). In this way, the feature definitions provide a functional "core" through which the instances' other characteristics are referred to. The ways in which the instances' other characteristics are coordinated with their functions will be examined further in Experiment 3, when descriptions of instances are generated without the superordinates being mentioned.

Reanalyses for Experiment 1, Task 1

In Experiment 1, a large number of the instances' categorizations (65.2%) were features or categories based on features. For example, instances of "clothing" received the categorizations "warm" and "thing used to keep warm". In Task 2 of that experiment, these features were compared to the superordinates in terms of their instance set overlaps (e.g., "Are all things used to keep warm types of clothing?"). However, it was not possible to determine whether these features are related to subsets of a superordinate, a superordinate as a whole, or to contrasting categories. For example, "coats" and "jackets" may be members of the subset "warm clothing" under "clothing" because they are "used to keep warm". But there are also things that are "used to keep warm" that are not types of "clothing", as identified in Experiment 1, Task 2 (e.g., "heaters", the "sun", "coffee",

etc.). As such, there were no criteria that could be applied to the responses in Experiment 1, Task 2, to determine whether the features are descriptive of instances' memberships in the superordinates or in contrasting categories. The feature definitions received in Experiment 2 will therefore be used to determine whether the feature classifications are related to subsets, superordinates or contrasting categories, and the categorizations received in Experiment 1 will be reanalyzed with the feature classifications included.

The predictions for Experiment 1 were as follows. The superordinates' more typical instances were expected to be categorized more often than the less typical instances as belonging to the superordinates. The less typical instances, on the other hand, were expected to be categorized more often as belonging to contrasting categories. In addition, subsets of the superordinates were expected to be used more often for categorizing the more typical instances. Each of these predictions were supported by the results of Experiment 1, when the featural classifications were not included in the analyses. Very few categories at taxonomic levels higher than the superordinates were received (e.g., "objects"), and there appeared to be no difference in their generation for more or less typical instances (see Table 5).

In line with these findings, the features that were used to classify the instances should be related to the categories they are most commonly considered to be members of.

The more typical instances are expected to elicit more of the Obligatory and High Permissible features of their superordinates. The more typical instances should also elicit more Permissible features, as these features are descriptive of subsets within the superordinates. In contrast, the less typical instances should elicit more features that are impermissible as definitions in the superordinates, but can be used to define memberships in contrasting categories. Taxonomically "Higher" features will also be identified, based on their applicability to 2 or more of the superordinates as "functional aritifacts" (e.g., "need" and "essential") and their not having been used to define memberships in the superordinates. Only a small number of these features are expected, and both the more and less typical instances should elicit them.

In addition, some of the categories that were classified earlier as contrasting or higher categories are related to the superordinates' Obligatory, High Permissible or Permissible features. For example, "storage place" was classified as a contrasting category of "furniture" because a majority of the subjects who responded to the question "Are all storage places types of furniture?" said that they aren't (Experiment 1, Task 2). The exceptions listed for this comparison included "basements", "garages", "suitcases", etc.. However, in Experiment 2, "used to store things in" was a Permissible feature used to define the membership of instances in "furniture".

For the present analyses, contrasting and higher categories were re-classified if they corresponded to the superordinates' feature definitions. Categories were re-classified as "subsets" if they corresponded to Permissible features (e.g., "storage place" corresponds to "used to store things in" and "wood object" corresponds to "made of wood" for "furniture"). Categories were re-classified as equivalent to High Permissible features, if they corresponded to a superordinate's High Permissible feature (e.g., "household item" corresponds to the High Permissible feature "used in houses" for "furniture"). Finally, categories were re-classified as equivalent to Obligatory features, if they corresponded to a superordinate's Obligatory feature (e.g., "transporter" corresponds to the Obligatory feature "used to transport" for "vehicles"). Twenty-five of the contrasting categories were re-classified as "subsets", 9 were re-classified as as equivalent to High Permissible features, and 10 higher categories were re-classified as equivalent to Obligatory features.

Table 13 shows the number of features and categories other than the superordinates received as categorizations for the superordinates' most and least typical instances in Experiment 1, Task 1. After the re-classifications, the same differences were found between the most and least typical instances for their categorization in subsets or contrasting categories. Subset categories were used to categorize the most typical instances more frequently than they were used

Table 13
Number of Instance Categorizations in Experiment 1, Task 1 with Featural Classifications Included

Superordinates	Instances: Most Typical	Instances: Least Typical	Most Typical	Least Typical
	Obligatory and High Permissible Features		Corresponding Categories	
Clothing	26	14	0	0
Tools	5	4	0	0
Vehicles	35	15	4	6
Furniture	9	2	4	5
Totals	75	35	8	11
	Permissible Features		Subset Categories	
Clothing	60	58	27	10
Tools	86	54	16	12
Vehicles	47	23	29	15
Furniture	113	60	9	7
Totals	306	195	81	44
	Impermissible Features		Contrasting Categories	
Clothing	23	73	6	31
Tools	30	58	4	21
Vehicles	40	70	3	42
Furniture	9	76	3	19
Totals	102	277	16	113
	Higher Features		Higher Categories	
Clothing	4	2	0	0
Tools	1	1	1	1
Vehicles	4	0	0	2
Furniture	2	1	2	0
Totals	11	4	3	3

to categorize the least typical instances, $t(46) = 2.44$, $p < .02$, and the least typical instances were categorized more frequently as belonging to contrasting categories, $t(46) = 5.59$, $p < .001$. The re-classified categories that correspond to Obligatory and High Permissible features will be analyzed with these features. The higher features and categories will also be analyzed together.

As predicted, the most typical instances received Obligatory and High Permissible feature classifications more frequently than the least typical instances did, $t(46) = 2.07$, $p < .05$. The most typical instances also received Permissible feature classifications more often, $t(46) = 3.19$, $p < .01$. In contrast, Impermissible features were used with a greater frequency to categorize the least typical instances, $t(46) = 6.15$, $p < .001$. Only a small number of higher categories and features were received, and no difference was found in their use for categorizing most or least typical instances, $t(46) = 1.32$, n.s..

These findings support the hypothesis that the instances' featural classifications are related to the superordinates, subsets and contrasting categories they are typically considered members of. Similar to the findings in the membership definition task of Experiment 2, the more typical instances elicited more Permissible features, which correspond to the subsets they belong to within the superordinates. In contrast, the less typical instances elicited more features that are Impermissible for defining membership in

the superordinates, which are related to their more dominant membership in contrasting categories.

The finding that the superordinates' Obligatory and High Permissible features are used less frequently to classify their less typical instances differs from what was found in the membership definition task. In Experiment 2, no difference was found in the use of these features for defining the superordinate memberships of more or less typical instances. But in Experiment 1, the least typical instances were categorized less often as belonging to the superordinates. The least typical instances are therefore less frequently described by these features in a context where their membership in a superordinate is not focussed on, as these features are "norms" that define membership in the superordinates. In contrast, the more typical instances were more frequently described by these features, even though the superordinates were not explicitly mentioned.

Finally, only a small number of higher categories and features were received. This indicates that taxonomic levels higher than the superordinates may not be as relevant for describing the instances in contexts in which instances can be described in terms of their superordinates, subsets and contrasting categories. The higher categories and features are equally applicable to more and less typical instances, because they subsume the superordinates and their contrasting categories. For example, most of the instances of the superordinates and their contrasting categories are "commod-

ities" that you "buy". While these higher levels of information are not used as often to describe single instances, they may be used when comparing instances that don't share membership in a superordinate or contrasting category. This possiblility will be examined in Experiment 3.

Experiment 3: Context Sensitivity

In the preceding experiment, it was found that features are taken as applicable to all the members of a category (i.e., Obligatory and High Permissible features), to subsets of members within these categories (i.e., Permissible features), or to instances' memberships in contrasting categories (i.e., Impermisible features). These findings suggest a taxonomic organization of featural information based on how features are used for defining category memberships and the cross-classification of instances.

However, all of the features received in Experiment 2 were elicited by explicitly mentioning the categories that instances belong to. If this taxonomic organization has relevance for everyday uses, it should be possible to access information from within it without referring directly to the categories. In particular, the categories and features most relevant to instances should be retrieved from the taxonomic organization to meet the demands of specific contexts. For example, it should be possible to describe a "chair" as something that is "used in houses" separately from describing it as something that is "used to sit on" (these being High Permissible and Permissible features of "furniture", respectively). Which pieces of information are accessed for describing an instance should be sensitive to the context in which the instance is mentioned.

It is proposed here that the information retrieved for describing an instance should be related to the set of

instances partitioned by that instance in a particular context. For example, when describing a "canary", the feature "sings" is more likely to be retrieved than the feature "flies" (Collins and Quillian, 1969). As suggested by Olson (1970), this may be so because "canary" partitions the set of "birds" (i.e., "canaries/sparrows/robins/..."), and the feature "sings" distinguishes "canaries" from other "birds". In contrast, a comparison between "canary" and "dog" may partition the set "bird/mammal/fish/...", and "sings" would no longer be as relevant, while "flying" would be. This is similar to Tversky and Hemenway's (1984) finding that subjects list attributes at one level of abstraction and fail to include them at a lower level of abstraction. For example, subjects may list "two-legged" for "bird" but not for "robin", "eagle" or other types of birds.

The taxonomic organization of categories and features could therefore be accessed as "implicit contrast sets" (Tversky and Hemenway, 1984). For example, "flying" and "two-legged" may be accessed when comparing a type of "bird" (e.g., a "canary", "robin" or "eagle") to other animals (e.g., "dog", "trout", etc.), without explicitly mentioning the category "birds". At the same time, the features associated with the categories need not be necessary features of the categories. For example, when contrasting a type of "bird" and "fish", the features "flying" and "swimming" would be relevant, even though all "birds" do not "fly". As such, a category's Obligatory and High Permissible feature

norms, which can be taken as common to all members of the category, but do not have to be, would be appropriate pieces of information for describing the members of that category when they are being compared to members of other categories.

It is further proposed that instances should be compared in terms of the "least-upper-bound" category that they share membership in. For example, a least-upper-bound category that "chair" and "sofa" share membership in would be the subset category "seat" under "furniture". A "chair" and "sofa" would therefore be described as both being "seats" and as being "used to sit on", the corresponding Permissible feature within "furniture". In contrast, "sofa" and "dresser" do not share membership in a common subset, so that their least-upper-bound shared membership would be in the superordinate "furniture". A "sofa" and "dresser" would therefore be described as "furniture" that is "used in houses".

While least-upper-bound shared categories should be used to describe what is the same about instances, contrasts between instances should be made in terms of the implicitly-partitioned sets within these categories. For example, when asking what is different about a "sofa" and a "dresser", these instances should elicit subset distinctions under their shared superordinate "furniture", such as one being used to "sit on" or "hold the body" and the other being used to "store clothing" or "hold things". As such, contrasts between instances should be made in terms of category/set

distinctions immediately below the least-upper-bound category they share membership in.

In the research that has been presented thus far, superordinate and subset levels have been examined. However, if two instances from a common subset (e.g., "sofa" and "chair") are contrasted, distinctions immediately below the subset level should be retrieved. For example, because "sofas" and "chairs" are both "used to sit on", it might be said that one is "sat on by more than one person" while "only one person sits on" the other. The differences between instances that share memberships in a subset should therefore be elaborations (i.e., refinements) of subset distinctions, which describe contrasting sets of instances within the subsets.

In addition, taxonomic levels higher than the superordinates should be accessed when comparing instances that belong to different superordinates, as the least-upper-bound shared membership of these instances would be above the level of the superordinates. For example, "tools", "furniture", "vehicles" and "clothing" may all be considered "functional artifacts". As such, when comparing a "jacket" and a "car" in terms of what is the same about them, they may be described as "funtional artifacts" that are "used by people". For difference questions, the superordinates would be the contrasting sets immediately below their shared higher category (e.g., "functional artifacts"). The superordinates and the superordinates' Obligatory or High Permissi-

ble features should therefore be used to describe what is different about these instances. For example, a "jacket" and "car" may be said to be different because one is "clothing" that is "worn by people" and the other is a "vehicle" that "transports people".

It should also be noted that there may be more than one taxonomic level higher than the superordinates. For one, subsets of "functional artifacts" may exist that are intermediate between that category and the superordinates. Subsets of "functional artifacts" could either encompass some but not all of the superordinates, or they could encompass all of one superordinate but only part of another. For example, "vehicles" and "tools" are things that require "skill to use", and "vehicles" and some types of "furniture" are things that "hold people". In addition, there should be taxonomic distinctions higher than "functional artifacts". As seen in Keil's (1979) hierarchical organization of ontological concepts, "functional artifacts" can be described as "physical objects" that are "solid", and can be contrasted to "organisms" (i.e., they are "inanimate objects"). For the present research, it is predicted that higher levels will be used to describe the similarities of instances from different superordinates. The basis for accessing the different higher levels will also be examined.

In summary, it is expected that three general taxonomic levels of least-upper-bound shared membership will be used when comparing instances, a superordinate level, a subset

level below the superordinate level, and taxonomic levels higher than the superordinates. Pairs of instances should be responded to in terms of their least-upper-bound shared memberships for similarity comparisons, and at the level immediately below their least-upper-bound shared membership for difference comparisons. A fourth taxonomic level should therefore be used (i.e., distinctions below the level of the subsets) for the differences between instances that share membership in a subset.

In addition, it is expected that the extensional sets described by the features or categories will be adjusted to meet the demands of particular contexts. Similar to what was found in Experiments 1 and 2, instances should be included in or excluded from a category or a feature's description depending upon the comparison being made. When it is asked "what is the same" about instances, categories and features should be generally applied as descriptions of both instances. For example, "purse" and "shirt" might be described as both being "worn as part of clothing". When asked "what is different" about instances, these categories or features should be used to describe one of the instances, while the other instance is excluded from their description. For example, "purse" and "shirt" might receive "one is used to hold items and the other is worn" or "one is a bag and the other is clothing". In the "what is different" context, the exclusion of an instance would be based on treating features or categories as if they were "exclusive disjuncts"

(e.g., as if a thing could either be a "bag" or "clothing", but not both). The instances that are excluded should be those which are less typically described by a category or feature. For example, a "purse" is a less typical member of "clothing" and is less typically described as something that is "worn".

Finally, it is predicted that the features used to describe instances should be primarily functional features, as was found for the feature definitions in Experiment 2. For example, instances could be compared in terms of their structural parts (e.g., "saws" and "scissors" have "blades"). However, primarily functional features may be used for describing instances, as these features provide more general descriptions than structural, physical or locational features. For example, "used to cut" for "saw" and "scissors" describes how these things are used and suggests their structural and physical similarities (i.e., that they have "blades" and should be "sharp"). Similarly, "used to sit on" for "chair" and "sofa" describes how they are used and the potential location of people in relation to these things. If primarily functional features are found to be used for instance comparisons, this will indicate that these features play a central role in describing instances, similar to their use as membership definitions in Experiment 2.

In addition, a greater number of structural, physical and locational components should be found with the greater specificity of the features, as in Experiment 2. That is,

the features at lower taxonomic levels describe smaller, more specific sets of instances, and they should have more non-functional components. The subset (Permissible) features most frequently used to describe instances should have more non-functional components than the superordinate-level (Obligatory and High Permissible) featural descriptions, and the featural distinctions below the subset level should have more non-functional components than the subset-level features. The first finding would be the same as what was found in Experiment 2. The latter finding would be an extension of what was found in Experiment 2, as the level below the subsets was not examined in that experiment. For example, "saws" and "scissors" share the subset, Permissible feature "used to cut", and may be said to be different because "one has 1 blade for cutting and the other has 2 blades for cutting". The elaborated distinctions below the Permissible features would therefore be based on the explicit mention of the instances' other characteristics with their shared subset-level, functional features (e.g., the specifications for the structural component "blades" with the feature "used to cut").

Also as an extension of Experiment 2, features from taxonomic levels higher than the superordinates should be more purely functional than the superordinate-level features. For example, the superordinate-level features "used in houses" and "transport people" have locational components, while a feature such as "used by people" may be only

functional. However, other types of features from higher levels may also be used to describe the similarities of instances from different superordinates. While the instances may all have functions, they may not share these functions. Instead, the instances may be described in terms of the higher-level similarities that functional artifacts share as physical objects (Keil, 1979). For example, a "bed" and a "handkerchief" might be described as being "soft", and a "table" and a "truck" could be described as having "flat surfaces" or as being things that might be "broken". As such, the higher-level features may also be more general physical, structural or locational features, as these types of features are descriptive of a wide variety of instances.

Task 1: Instance comparisons

Method

Subjects. Subjects were 36 undergraduates in lower division psychology classes at Hunter and Lehman Colleges of the City University of New York. All of the subjects participated in this experiment as part of their classroom activity and none of the subjects who participated in this experiment took part in any of the other experimental tasks reported here.

Stimuli. The stimuli were 36 pairs of instances and are shown in Table 14. The instance pairs were made up of the 6 "most" and 6 "least" typical instances of the 4 superordinates used in Experiments 1 and 2, with 3 additional least typical instances, "refrigerator", "bracelet" and "plaster"

Table 14

Instance Pairs Compared in Experiment 3

Superordinates	Most-Most Typical Instances	Most-Least Typical Instances	Least-Least Typical Instances
	Subset Pairs		
Furniture	Chair-Sofa	Desk-Counter	Stove-Refrigerator
Vehicles	Car-Ambulance	Truck-Wheelbarrow	Skates-Sled
Clothing	Dress-Skirt	Coat-Gloves	Necklace-Bracelet
Tools	Ruler-Tape Measure	Saw-Scissors	Cement-Plaster
	Superordinate Pairs		
Furniture	Bed-Table	Dresser-Clock	Rug-Picture
Vehicles	Streetcar-Motorcycle	Bus-Elevator	Horse-Blimp
Clothing	Jacket-Pants	Shirt-Watch	Apron-Handkerchief
Tools	Hammer-Drill	Nails-Soldering Iron	Hatchet-Stapler
	Higher Category Pairs		
Furniture and...	Bed-Truck	Table-Handkerchief	Stove-Elevator
Vehicle and...	Bus-Shirt	Car-Scissors	Blimp-Apron
Clothing and...	Dress-Saw	Pants-Counter	Gloves-Hatchet
Tool and...	Ruler-Chair	Hammer-Sled	Closet-Soldering Iron

from "furniture", "clothing" and "tools", respectively. The additional instances were selected by the same criteria used in Experiment 1, Task 1 for the other least typical instances, and were paired with least typical instances that they share membership with in contrasting categories of the superordinates (i.e., "stove", "necklace" and "cement").

Each of the instance pairs shared membership at one of three taxonomic levels, 1) in a subset of one the superordinates, 2) in a superordinate but not in a subset, or 3) at a level higher than the superordinates (e.g., "functional artifacts"). Instances were taken to share membership in a subset if they received the same subset classification in Experiment 1 or received the same Permissible feature definition in Experiment 2. The 4 least typical instance pairs that shared membership in a subset either shared membership in a subset of a contrasting category (i.e., "sports equipment" that are "recreational transportation", "appliances" that are "used with food", and "building materials" that "harden") or shared membership in a contrasting category that was listed as a type of one of the superordinates in Battig and Montague's (1969) norms (i.e., "jewelry" was listed as a type of "clothing").

Twelve instance pairs shared membership at each of the 3 levels, with 3 types of typicality pairings at each level: most-most, most-least and least-least typical instance pairs. Four of each of the types of typicality pairs were used at each level, one of each type being from each of the

four superordinates for the subset- and superordinate-level pairs. For the higher taxonomic level, 2 pairings were made between instances from each of the 4 superordinates, 3 most and 3 least typical instances being used from each of the superordinates. For the most-least pairs, half were presented with the least typical instance first (i.e., as least-most pairs).

Procedure. The stimuli were presented in testbooklets, with one instance pair printed at the top of each page. The instructions were printed on the first page of each testbooklet, and were as follows:

"The purpose of this experiment is to find out what people think is the same and different about everyday objects. The procedure will be as follows: when you turn to the first page, you will see a question that asks either "What is the same about these objects?" or "What is different about these objects?". On the pages that follow one of these requests, you will find pairs of object names. For each of the pairs, I want you to write what is the same about the objects, or what is different about them, if that was the request that was made. For example, if the request was "what is different" and one of the following pairs is Carrot-Gun, you might write "One is a vegetable and the other is made of metal" or "You eat one and the other is a weapon". Do this for each of the pairs until you come to the next page with a request on it. Then write what is the same or different (depending on the new request) about all the pairs that follow that

request, until you get to the next page with a request on it. Follow this procedure until you get to the end.

Note that all of the object names you see are to be interpreted as objects, not as actions. For example, if you saw the word "dress", interpret it as the thing that is worn and not as the action of getting dressed. Work at your own pace, and write down the first answer that comes to mind for each pair. Respond to one pair at a time in the order that you find them. There are 24 pairs in all. When you are done reading these instructions, look up so that the experimenter knows you're ready to start."

Three sets of stimuli were constructed with 12 instance pairs in each, and each of the testbooklets contained 2 of these stimulus sets. Each set was combined with each of the other two sets, resulting in 3 combinations, and 12 subjects gave responses for each combination. Each set was presented in the first half in one of its combinations and in the second half in its other combination. Each set contained an equal number of the 3 types of typicality pairings (i.e., most-most, most-least and least-least) which were presented in a different random order for each set. Each set contained an equal number of instance pairs from the 3 levels of shared membership (i.e., subset, superordinate and higher) which were presented alternately in each set. Each set also had an equal number of instances from each of the 4 superordinates, and pairs with instances from the same superordinate were separated by at least 3 pairs without instances

from that superordinate.

Four separate pages were included in each testbooklet, 2 with "What is the same about these objects?" and 2 with "What is different about these objects?" printed on them. Each of these pages was followed by 6 stimulus pair pages. The "same" and "different" requests were alternated and half of the testbooklets started with a "same" request and the other half started with a "different" request. For each stimulus pair, 12 subjects responded to what is the same about the pair and 12 subjects responded to what is different about the pair. No time limit was set on the task, and most subjects completed the task within 25 minutes.

Classification of Responses

Appendix 4 shows the "same" and "different" descriptions received for each of the instance pairs. Alternative forms of the responses and related responses are shown in parentheses in Appendix 4. Each response was classified as being from one of 4 levels of abstraction, 1) "below the subset" level, 2) the "subset" level, 3) the "superordinate" level, or 4) "higher" than the superordinate level.

The responses were classified as "superordinate" level responses if they were the superordinate category labels, or the superordinates' Obligatory or High Permissible features identified in Experiment 2 (i.e., the features used to define membership in a superordinate that can be taken as common to all members of that superordinate). "Superordinate" level classifications were also given to categories

that had been identified as contrasting categories of the superordinates in Experiment 1 (e.g., "sports equipment"), and to features identified as Obligatory or High Permissible for these contrasting categories in Experiment 2 (e.g., "used for recreational purposes").

The responses were classified as "subset" level responses if they were identified in Experiment 2 as Permissible features for the superordinates (i.e., features used to define the membership of some but not all members of a superordinate) or Permissible features for the contrasting categories (e.g., "recreational transportation" for "sports equipment"). Categories and featural classifications that were identified as subsets of the superordinates in Experiment 1 were also classified as "subset" level responses. In addition, descriptions not received as instance classifications or membership definitions in Experiment 1 or 2, that were more-specific elaborations of contrasting categories' or superordinates' Obligatory or High Permissible features, were classified as "subset" level responses. For example, an "elevator" was described as "transportation within a building" in contrast to a "bus". As "transportation" is an Obligatory feature for "vehicles", "transportation within a building" was classified as a subset-level distinction. Similarly, modifications of contrasting categories (e.g. "winter sports equipment") were classified as "subset" level responses.

Responses were classified as "below the subset" level

if they were explicit elaborations of Permissible features. For example, refinements of the Permissible feature "used to sit on" were used to describe what is different about a "chair" and "sofa" (e.g., "one is sat on by 1 person and the other is sat on by more than 1"). Distinctions within the subsets of contrasting categories were also classified as "below subset" level responses. For example, within the subset of "appliances" that are "used with food", "stove" and "refrigerator" elicited "one heats food and the other keeps food cool".

A number of different types of features were classified as "higher" level responses. The most straightforward were categories and features applicable to all the instances of 2 or more superordinates (e.g., "inanimate object", "everyday object", "used by people" and "man-made"). In addition, a number of features were classified as "higher" level responses because they are applicable to instances from 3 or more superordinates or contrasting categories, though they may not be applicable to all the members of each of these categories. For example, "can be used during work" was given as a description of what is the same about "gloves" and "hatchets", and is applicable to some types of "clothing" and "furniture", as well as all types of "tools".

Qualitative distinctions were also classified as "higher" level responses because of their applicability across superordinate-level categories. For example, there were shape descriptions (e.g., "rulers" and "chairs" both

have "definite shapes"), sizes (e.g., a "blimp" is "big" and an "apron" is "small"), colors (e.g., both a "handkerchief" and a "table" "can be white"), general locations (e.g., "beds" and "trucks" are "close to the ground"), general structural distinctions (e.g., a "dress" and a "saw" both have an "edge"), and physical qualities (e.g., a "table" is "hard" and a "handkerchief" is "soft").

Finally, two types of "metaphorical" descriptions, received for what is the same about instances from different superordinates, were classified as "higher" level responses (see Appendix 4). For one, there were features that had not been used to define superordinate memberships which are more general characteristics related to the superordinates' Obligatory, High Permissible or Permissible features. For example, a "bus" and a "shirt" were described as the same because "people get into them" and "they contain bodies". These features are related to more specific Permissible and Obligatory features, "holds passengers" for "bus" and "covers body" for "shirt". They were classified as "higher" responses because they are general descriptions which can be applied across the boundaries of the superordinates, and are "metaphorical" because their sense is different for the two instances they are used to describe.

The second type of "metaphorical" description was a concrete or literal characteristic of one of the instances that had a figurative sense for the other instance. For example, a "saw" and a "dress" were described as the same

because they are both "sharp" and "can cut (a dress by its 'cut' and a saw by its cutting)". As these types of decriptions can be generally applied across the boundaries of the superordinates, they were classified as being generated at a "higher" level. For example, a number of things may be described as having the concrete, physical quality of being "sharp", and an even broader set of things can be described as "sharp" if its figurative sense is included as well (e.g., "clothing" being "sharp").

When classifying the categories and features, each response was classified in terms of the set of instances it is applied to within the taxonomic organization under examination here. For example, the descriptions for "chair" and "sofa" that "one is larger and seats many people" and "the other only seats one" were classified as "below subset" level distinctions under the subset of "furniture" that is "used to sit on". In contrast, "chair" and "sofa" were also given the descriptions "one is smaller" and "the other is for many people", which were classified as "higher" level responses. "Smaller" and "for many people" may implicitly refer to a "sofa" being used to seat many people in contrast to a "chair" being smaller and used for only one person to sit on. But the actual descriptions "smaller" and "for many people" can be applied to a number of instances within the different superordinates. For example, a "ruler" was described as "small" in contrast to a "chair", and a "streetcar" was described as being "for many people" in con-

trast to a "motorcycle". The responses were therefore classified in line with the sets of instances they are commonly used to describe, so that the taxonomic level of descriptions was consistently identified for each of the instance pairs.

In addition, features that had not been received as membership definitions in the superordinates, but which corresponded to defining features, were given the classifications of the features they correspond to. For example, in contrast to a "stapler", a "hatchet" was described as something that is used to "split" and "slice" things apart. These features were classified as "subset" level responses, as they correspond to the Permissible features "chop" and "cut".

Each feature and category response was given one of the 4 taxonomic level classifications (i.e., "below subset", "subset", "superordinate" or "higher"). For the responses to what is the same about the instance pairs, these were the final classifications for the responses, as these responses were all singular descriptions applicable to both instances. For example, "jackets" and "pants" were described as both being "clothing that people wear". In some cases, higher pairs were described by the subset-level features of one of the instances. These descriptions were classified as "subset" level responses if they were descriptive of the instances in a literal sense (e.g., you can "sit on" both a "bed" and a "truck"), but not if they were figurative,

"metaphorical" descriptions, as described above (e.g., a "dress" and a "saw" both being things that "can cut"). The responses were therefore classified in terms of the level they were generated from, as long as they were applicable to both instances in a similar, literal sense and did not involve higher-level abstractions.

On the other hand, the responses to what is different about the instances were made up of 2 contrasting features or categories, one for each of the instances. For example, "jackets" and "pants" were said to be different because "one is worn on the upper body and the other is worn on the lower body". When the two features or categories were classified as coming from the same taxonomic level, this classification was given to the response as a whole. For example, "worn on the upper body" and "worn on the lower body" are both Permissible features of "clothing", so their combination in a difference response was classified as a "subset" level response.

However, difference responses were also made up of features or categories classified as coming from different taxonomic levels. For example, "closet" and "soldering iron" received "one is a place of storage and the other is an object that is stored", "storage places" being a subset of "furniture" and "things that are stored" being a "higher" level feature applicable to "clothing", "tools", etc.. For all the difference responses with mismatched classification levels, the lowest taxonomic classification was given to the

response as a whole (e.g., the response to "closet" and "soldering iron" was given a "subset" level classification).

The mismatched responses were assigned the lower taxonomic classifications because the more specific, taxonomically-lower features or categories serve as reference points for these difference comparisons. As can be seen in the comparison of "closet" and "soldering iron", the more specific, subset characteristic of being a "storage place" serves as a focal point which the more general "higher" level feature of being "stored" is contrasted to. As such, the mismatched difference responses were classified in terms of the most specific information given within these comparisons.

The mismatched classification levels most frequently occurred for the difference comparisons of higher-level instance pairs (i.e., instances from different superordinates). Twenty nine percent of the difference responses for these instance pairs were mismatches, while only 8% of the responses to the superordinate pairs were mismatches and none of the responses to the subset pairs were mismatches. The more frequent occurrence of mismatched levels for higher-level pairs is therefore related to the fact that these instances share only more general, higher-level similarities and that there is a much broader range of possible descriptions for their difference comparisons (see Appendix 4). As such, there is a greater possibility for mismatched levels, as a more specific feature of one of the instances can be used as a point of reference to which the other instance can

be contrasted in more general terms. The taxonomic basis for generating these descriptions will be examined further on.

Finally, some of the responses were classified as "non-responses". These included the following: 1) no response given for an instance pair; 2) "reversal errors" (i.e., descriptions of what is the same about an instance pair when what is different had been requested, or visa versa); 3) responses that were uninterpretable (e.g., "both are pertaining to metal" for "soldering iron" and "closet"); 4) responses in which one of the instances had been misinterpreted (e.g., a "sled" being described as a "tool used to break wood" in contrast to a "hammer"); and 5) the responses "nothing", "no relationship", or "no similarity" for what is the same about two instances.

Results and Discussion

To recapitulate, the hypothesis for this experiment is that instances should be compared in terms of their least-upper-bound shared membership. For what is the same about instances, the instance pairs should most frequently be described at the level of their least-upper-bound shared membership. And for what is different about instances, the instance pairs should most frequently be described at the level immediately below their least-upper-bound shared membership.

Table 15 shows the number of "same" and "different" responses from the different taxonomic levels, for the instance pairs sharing least-upper-bound memberships at the

Table 15

Number of Responses at Different Taxonomic Levels for Instance Pairs in Experiment 3

Level of shared membership	Level of Response: Higher	Super-ordinate	Subset	Below Subset	Non-Response
			"What is the same?"		
Subset	5	40	89*	4	6
Superordinate	23	64*	39	4	14
Higher	53*	14	25	1	51
Totals	81	118	153	9	71
			"What is different?"		
Subset	26	2	37	64*	15
Superordinate	16	4	92*	18	14
Higher	14	23*	75	16	16
Totals	56	29	204	98	45

* predicted level of response

subset, superordinate and higher levels. Kendall's Taus were performed to analyze the differences in level of description for the pairs, the levels of the responses (i.e., higher, superordinate, subset, or below-subset level responses) being analyzed as ordinal ranks for their correspondence to the ordinal ranks of the pairs shared memberships (i.e., higher, superordinate, or subset). In this way, the directionality of the least-upper-bound hypothesis could be tested. That is, the responses should be from higher taxonomic levels the higher the level of the instance pairs' least-upper-bound shared membership. For example, for "what is the same" about the pairs, higher pairs should be described at the higher levels, superordinate pairs should be described at the superordinate level, etc. (see Table 15 for the pairs' predicted response levels). Kendall's Tau_c was used for the grouped data with its large number of ties. The analysis of the descriptions for "what is the same" about the instance pairs was significant, $z = 7.61$, $p < .001$, as was the analysis of the responses to "what is different" about the instance pairs, $z = 4.22$, $p < .001$.

These results support the "least-upper-bound" hypothesis for this experiment. As can be seen in Table 15, 5 out of 6 of the predicted response levels for the different types of instance pairs were used with a greater frequency to describe those instance pairs. That is, instances were compared most often in terms of their least-upper-bound shared memberships. Their least-upper-bound shared member-

ships were used to describe what is the same about them and distinctions immediately below their least-upper-bound shared memberships were used to describe what is different about them.

This finding indicates that the taxonomic organization of information used for defining instance memberships in Experiment 2 is also used for describing instances in contexts where the categories they belong to are not explicitly mentioned. This taxonomic organization is sensitive to the context in which the instances are being described, that is, it is sensitive to which instances are compared in a particular context and whether a "same" or "different" comparison is made. Two additional taxonomic levels were also identified in this experiment. Higher levels of information were used most frequently for describing what is the same about instances from different superordinates, and distinctions below the subset level were used to contrast instances that share membership in a subset. The context-sensitive, taxonomic organization was therefore found to extend above the superordinate level and below the subset level.

The only instance pairs that did not elicit a greater number of responses at the taxonomic level predicted were the higher-level instance pairs in the "what is different" condition. A greater number of superordinate-level responses had been predicted for these instance pairs in this condition, but a greater number of subset-level responses were received (see Table 15). As the subset level was the pre-

dicted level of response for the superordinate pairs in this condition, the higher pairs should be described less often than the superordinate pairs by subset-level descriptions and more often by superordinate-level descriptions. A Chi Square was performed to test these differences, and the difference was significant, $\underline{X}^2(3) = 17.29$, $\underline{p} < .001$. Major contributions to the Chi Square were made by the larger number of superordinate-level responses and the smaller proportion of subset-level responses received for the higher instance pairs in contrast to the superordinate pairs.

This result supports the least-upper-bound prediction that higher instance pairs are more likely to be described as different in terms of their respective superordinates. However, the large number of subset-level responses received for these instance pairs indicates that their least-upper-bound shared membership at higher taxonomic levels may not always lead to descriptions at the level of their different superordinates. One reason for this may be the difficulty in arriving at shared higher-level distinctions for these instances. For example, in the difference condition, the number of "non-responses" was nearly equal for the subset, superordinate and higher instance pairs (see Table 15). But in the similarity condition, the number of "non-responses" differed for the different levels of least-upper-bound shared membership. A Chi Square analysis showed this difference to be significant, $\underline{X}^2(2) = 49.04$, $\underline{p} < .01$, a larger number of "non-responses" having been received for the

instances sharing membership at higher levels (i.e., the levels at which they share similarities). Eleven of the "non-responses" for the higher instance pairs stated that they had no similarity, whereas only one such response was given for the superordinate pairs and none were given for the subset pairs.

The more abstract, higher taxonomic levels may not be represented as distinctly as the other taxonomic levels and therefore may not be accessed in the same fashion as the other levels when contrasting instances. For example, "functional artifacts" is not a commonly-used category distinction (none of the subjects described instances as "functional artifacts"), so the superordinate-level immediately below this category would not be accessed for difference descriptions through the use of this category. On the other hand, higher-level distinctions may be used as a basis for contrasting higher instance pairs, but subset-level characteristics that are related to these higher distinctions may be used to form specific contrasts between the instances. For example, "bus" and "shirt" were described as both being things that are "used by people" and "contain people", and were described as different because people "ride in (one) as passengers" (a subset-level description) and the other is "worn" (a superordinate-level description).

Subset-level descriptions may therefore be used to describe specific contrasts between the higher instance pairs. This is most clearly seen in the "mismatched" levels

of difference descriptions, in which a lower-level feature of one instance is used as a point of reference for contrasting the instances. For example, a "soldering iron" was described by the higher-level characteristic of being "stored" in contrast to the subset-level description of a "closet" being a "storage place". These mismatched levels in the difference comparisons occurred most frequently for the higher-level instance pairs. Forty one percent of the difference responses for these instance pairs were mismatches, in contrast to 18% of the responses for the superordinate pairs and 12% for the subset pairs. There is a broad range of possible difference descriptions for the higher instance pairs, as these instances share only more general, higher-level similarities. As a result, there is a greater possibility for mismatched levels in the higher pairs' difference descriptions, with subset-level distinctions being used to make these comparisons more specific (see Appendix 4). The strategies that would be needed for generating the higher-level similarities and difference descriptions for these instance pairs were examined further in a computer implementation, which is described in Appendix 5.

Another reason why a greater number of subset-level responses were given for the difference comparisons of the higher instance pairs may be that people prefer to use the subset level for describing instances. That is, while the general pattern of results indicates that a least-upper-bound strategy is used for accessing information from within

the taxonomic organization, people may prefer to use the subset level whenever possible. If responses were generated solely in terms of a least-upper-bound strategy, then no diferences should be found in the total number of responses received at the predicted levels in either the "different" or "same" condition. As can be seen in Table 15 though, a greater number of subset-level responses appear to have been received in both conditions. For the "what is different" responses, the differences between the totals of the superordinate, subset, and below-subset level responses was significant, $\underline{X}^2(2) = 140.9$, $\underline{p} < .001$, and a significant difference was also found when the higher-level responses were included with the superordinate-level responses, $\underline{X}^2(2) = 66.05$, $\underline{p} < .001$. In both of these analyses, the largest contributions to the Chi Square were made by the greater number of subset-level responses and the smaller number of superordinate-level responses or superordinate- and higher-level responses.

In the "what is different" condition, these findings are at least partially due to the greater number of subset-level responses received for what is different about the higher-level instance pairs. But an analysis of the total number of responses received from the different taxonomic levels in the "what is the same" condition was also significant, $\underline{X}^2(2) = 22.1$, $\underline{p} < .001$, despite the greater number of responses for the instance pairs at their predicted levels. In this analysis, the major contributions to the Chi Square

were made by the greater total number of subset-level responses and the smaller number of higher-level responses.

These findings indicate that the subset level is a "preferred" level for describing instances. It should be noted that most of the subset-level responses were Permissible features of the superordinates or their contrasting categories (see Appendix 4). Permissible features may be preferred because of their specificity as descriptions. A number of the Permissible features describe the specific rather than more general functions of the object instances. For example, the Permissible features "used for driving" and "used for cutting" were given as descriptions of what is different about the higher-level pair "car" and "scissors". While a "car" was also described by the superordinate-level feature "transportation", "scissors" were not described by their more general, superordinate-level functions (e.g., being "used to make things"). These Permissible features may be used to describe the higher instance pairs because of their relations to higher-level features, as noted earlier for the subset-level responses in the "different" context. For example, while all of the instances from the different superordinates can be described as being "used by people", the higher-level instances can be described individually in terms of the particular ways in which they are "used" (e.g., for "driving", "cutting", etc.).

It should also be noted that the Permissible features are more general than the below-subset distinctions (e.g.,

"scissors" are "used for cutting cloth" and have "2 blades for cutting"). When describing the differences between two instances, it is always possible to elaborate on the Permissible features and generate a below-subset distinction. But the below-subset level of specificity is only really required when contrasting instances that share a Permissible feature (e.g., when contrasting "scissors" to something else that is "used to cut", such as a "saw"). As such, the subset/Permissible feature distinctions may be preferred as descriptions of instances because they are the highest level at which something specific can be stated about an instance.

For the instances that share least-upper-bound memberships at the superordinate and subset levels, the use of subset-level, Permissible features that had not been predicted for these pairs was made possible by the fact that instances can belong to more than one subset within a superordinate. For example, most of the responses to what is different about the subset pairs of "clothing" were, in fact, other subset distinctions (23 out of 36) rather than the below-subset distinctions that had been predicted. For example, "coat" and "gloves" share the subset/Permissible feature distinction of being "worn to keep warm", but Permissible features were also used to describe why they are different (e.g., one being "worn on the body and arms" and the other being "worn on the hands"). Similarly, subset-level responses were received for what is the same about superordinate pairs that had not been found to share member-

ship in a subset in either Experiment 1 or 2. For example, "dresser" and "clock" are "furniture" that are used to "keep clothes in" and "tell time", but were described as the same because they are "used in bedrooms", which is also a subset distinction within "furniture".

Instances are therefore cross-classified in subsets within a superordinate, which provides a basis for describing instances in terms of subset-level distinctions if this level is preferred for a particular comparison or context. As illustrated here, Permissible features may bear special relations to the instances. The relations of these features to the instances, and how they can be used for determining subset memberships and generating descriptions (e.g., below-subset distinctions) within a least-upper-bound framework, was examined further in the computer implementation of the responses generated in this experiment (see Appendix 5).

The above findings indicate that a "least-upper-bound" strategy is the most commonly used strategy for accessing relevant information, but that this mode of retrieval is not rigidly adhered to. The structuring of information enables descriptions to be generated from a broader range than a single taxonomic level. This can also be seen in the number of higher-level responses received for instances that share membership at each of the 3 taxonomic levels (see Table 15), such as the higher-level pair "ruler" and "chair" both having "definite shapes" and being "hard", and the subset-level pair "chair" and "sofa" being different because one is

"hard" and the other is "soft". In the present experiment, features were classified as taxonomically "higher" based on their being applicable to broad sets of instances. But these general features are also related to more specific characteristics of the instances, and are therefore relevant to more specific comparisons. For example, a "sofa" can be described as "soft" in contrast to a "chair" because it is more "comfortable to sit on". In such a context, the instances' least-upper-bound shared membership can be utilized (i.e., "comfortable to sit on" is a below-subset distinction under "used to sit on"), but additional strategies would be required for generating the higher-level descriptions (see Appendix 5).

Adaptation of Norm Descriptions

The flexible use of features is necessary if features are used as "norms" for describing the instances, rather than their having "all-or-none" relations to the instances. It was predicted that the same features would be used to describe both what is the same and different about an instance pair. As in Experiment 2, a feature should be used in a more general sense when both instances are being described by the feature, and the feature should have a more delimited sense when one of the instances is being excluded. In the "what is the same" condition, both instances should be described by a feature, and in the "what is different" condition, the same feature should be used to describe only one of the instances and the instance that is excluded from

its description should be described by another feature. In this way, a feature's more delimited sense would be indicated by stating the feature it is considered an "exclusive disjunct" of.

Table 16 shows the features that were used to describe both what is the same and different about instance pairs. As two-thirds of the instance pairs received these types of featural descriptions, the adaptation of features as "norms" to fit the particular "same" or "different" context was not an isolated phenomenon. As well, this use of features was not dependent on the taxonomic level of the comparison being made, as a nearly equal number of instance pairs at the different levels of least-upper-bound share membership received these responses.

Of particular interest are the different senses which the features have when being used to describe what is the same and different about the instances. In the "what is different" condition, the features they were contrasted to indicated how they were delimited in those contexts. For example, "transports people" and "take you to hospital" were used to describe what is the same about a "car" and an "ambulance", but "transports people to a hospital" was used to describe an "ambulance" in contrast to a "car" being "used for pleasure, business (many purposes)". As such, by focussing on the more exclusive use of an "ambulance", the sense of only being used to "transport people to a hospital" was contrasted to the more diverse ways in which a "car" can

Table 16

Responses Received as Both What is the Same and Different about Instance Pairs in Experiment 3

"What is the same?"	"What is different?"
Subset Pairs	
Chair/Sofa	
"Sit on & recline"	"Sit on only/Can sit on & lie on"
Desk/Counter	
"Write on", "Work on", "Used for work purposes", "Have drawers"	"Write on/Eat on", "Implies work/Has no drawers"
Stove/Refrigerator	
"Used in the preparation of food", "Food passes in & out of them"	"Cook or prepare food/Put things in it to keep cool & fresh", "Cook on/Take food out of"
Car/Ambulance	
"Transport people", "Take you to hospital"	"Carries people to & from where they're going/Carries ill or dying people to a hospital", "Used for pleasure, business (many purposes)/Transport people to a hospital"
Skates/Sled	
"Glide on them"	"Roll/Glide"
Saw/Scissors	
"Used to cut objects", "Used for cutting materials"	"Used to cut objects/Used to cut more fragile materials", "Used to cut wood, metal or trees/Used to cut paper or material"
Cement/Plaster	
"Used in fixing walls"	"Material used for floors & sidewalks/Material used for walls"

Table 16 (continued)

"What is the same?"	"What is different?"
Superordinate Pairs	
Bed/Table	
"Surfaces objects placed on top of", "Eat on"	"Rest body on/Put things on", "Used to sleep in/Eat on"
Rug/Picture	
"Found in living room & hung on wall"	"Placed on floor/Hung on wall"
Elevator/Bus	
"Transport people from one place to another"	"Transports people from one place to another/Transports people to different floors in a building"
Horse/Blimp	
"Fly in the air"	"Animal/Object that flies"
Shirt/Watch	
"Worn on the upper body"	"Worn on upper part of body/ Worn on wrist"
Apron/Handkerchief	
"Used to keep clean (from cooking & nose)", "Worn as part of clothing", "Garments to wear"	"Used for getting dirty/ Used for keeping clean", "Is worn/Fits in pocket", "Wear/Don't", "Wear/ Used at random"
Hammer/Drill	
"Use in fixing things & can use to make holes"	"Hammer with/Make holes", "Hit down on/Make holes"
Soldering Iron/Nails	
"Hold items together"	"Fuse metal together/ Hold objects together"
Hatchet/Stapler	
"Cut into (wood, paper)"	"Slices things apart/Puts things together","Chop things/Staple things"

Table 16 (continued)

"What is the same?"	"What is different?"
Higher Pairs	
Bed/Truck	
"Supply sleeping area", "Lie down in"	"Sleep in/Ride around in", "Sleep on/Ride in", "Lie on/Used for driving"
Car/Scissors	
"Cut things off"	"Used to travel/Used for cutting objects", "You drive in/You use to cut things"
Blimp/Apron	
"Float in air"	"Flies in the sky/Worn", "Flies in the sky/Cloth worn"
Dress/Saw	
"Handled by humans", "Can be sharp", "Can cut (dress by its 'cut', saw by its cutting)"	"Worn/Handled", "To be worn/ Sharp object", "You wear it/ Used for cutting"
Counter/Pants	
"Hold items (Put something on, in pockets)"	"Hold goods/Hold people", "Put things on/Clothing person wears"
Gloves/Hatchet	
"Used by hands"	"Cover hands/Used by hands"
Ruler/Chair	
"Measure for purpose", "Measure a room with either one"	"Used to measure/Used for sitting"
Hammer/Sled	
"Tools", "Made of metal", "Made of wood"	"Tool/Toy", "Made of metal/ Made of wood"

be used.

While features were delimited in the difference condition, features that are commonly used to describe one of the instances were extended to the other instance in the similarity condition. For example, "hammer" and "drill" were described as different because one "hits nails" and the other "makes holes", but were described as the same because you use them "in fixing things and can use them to make holes". In such cases, the use of features as "norms" for describing instances is based on the potential for an instance to be described by a feature (i.e., a "hammer" can be used to "make holes"), even though the instance may not be typically described by that feature. The "metaphorical" responses for higher-level pairs also involved this type of extension process. For example, "dress" and "saw" were described as things that "can be sharp" and "can cut (a dress by its 'cut' and a saw by its cutting)", and "car" and "scissors" were described as things that "cut things off". In both of these cases, the features are extended to include both instances by using the figurative sense of the features, resulting in a metaphorical similarity rather than a concrete likeness shared by the instances.

As can be seen in Table 16, the instances that were excluded in the "what is different" condition were nearly always the instances that are less typically described by the features. That is, a "hammer" is less typically described as being used to "make holes", an "ambulance" is

more typically described as being used to "transport people to a hospital" than a "car" is, etc.. As such, when the features are extended to both instances in the similarity condition, instances that are less typically described by the features are included in their description. These processes are similar to the inclusion and exclusion of categories' less typical instances. In Experiment 1, Task 2, less typical instances were found to be excluded from the superordinates more often than other instances, when the superordinates were contrasted to features or other categories that could describe these instances. In Experiment 2, less typical instances were more likely to be considered members of the superordinates, if their membership was being defined along with a more typical instance (this being like a similarity comparison between a more and less typical instance).

Features were therefore found to be used as "norms", which can be extended to describe instances or delimited to exclude instances, depending upon the context they are used in. Along with the other flexible uses of features (e.g., the use of Permissible and higher-level features), these findings indicate that the taxonomic organization of information is not used in an "all-or-none" fashion. Rather, features and categories are used to describe instances based on whether their descriptive potential suits the needs of particular contexts.

Feature Classifications

Finally, the classification of the features from the

different taxonomic levels was examined, that is, whether the features used to describe instances were "functional", "structural", "locational", "physical" or some other classification. It was predicted that the superordinate- and subset-level features would be primarily "functional" features, having more only-functional and dominantly-functional classifications. As well, a larger proportion of the more specific features should have subordinate functional classifications and classifications without a functional component (e.g., subset-level features being more specific than superordinate-level features), as the other components are applicable to smaller sets of instances. The below-subset features identified in the present experiment should also be primarily functional, but should have more subordinate functional classifications and classifications without a functional component than the subset-level features. On the other hand, higher-level features may be functional (e.g., "used by people") but may also include a number of features without a functional component that were used to describe the general physical, structural and locational characteristics of the instances. The classifications of the features received in the present experiment will be based on how the features were classified in Experiment 2, Task 2.

Table 17 shows the number of different types of features from each of the taxonomic levels that were used to describe the instances. Chi Squares were performed on each of the 4 levels. Both the superordinate- and subset-level

Table 17

Number of Features from Experiment 3 Classified as Functional

Taxonomic Level	Classifications			
	Only Functional	Dominant Functional	Subordinate Functional	No Functional Component
Higher	9	61	47	98
Superordinate	50	93	5	4
Subset	108	304	55	44
Below Subset	12	117	30	20

features showed significant differences in their classifications (for the "superordinate" level, $\underline{X}^2(3) = 142.48$, $\underline{p} < .001$, and for the "subset" level, $\underline{X}^2(3) = 342.54$, $\underline{p} = <.001$). The principal contributions to the Chi Squares were made by the larger number of dominantly functional features and the smaller number of features with subordinate functional classifications and without functional classifications. The below-subset level classifications were also significantly different, $\underline{X}^2(3) = 159.17$, $\underline{p} < .001$. Similar to the superordinate- and subset-level features, major contributions were made to the Chi Square by the larger number of dominantly functional features and the smaller number of features without functional classifications. However, a major contribution was also made by the small number of only functional features at this level. An additional analysis was therefore performed on the only and dominantly functional features versus the features with subordinate functional classifications and without functional classifications at this level. This difference was significant, $\underline{X}^2(1) = 33.98$, $\underline{p} < .001$.

These findings indicate that the superordinate- and subset-level features used for comparing instances were primarily "functional" features, similar to the Obligatory, High Permissible and Permissible features used to define memberships in Experiment 2 (see Table 12). Also similar to Experiment 2, a difference was found between the superordinate- and subset-level features, which is related to the

subset-level features being more specific, $\chi^2(3) = 17.84$, $p < .001$. Major contributions to this Chi Square were made by the smaller proportion of subset-level features that were only functional and the larger number of subset-level features that were subordinately functional and were not classified as having a functional component.

As an extension of the findings in Experiment 2, below-subset level features were also found to be primarily functional, but with fewer responses that were classified as only functional. This is related to the greater specificity of the features below the subset level. The difference between the subset and below-subset levels was significant, $\chi^2(3) = 19.89$, $p < .001$, major contributions to the Chi Square being made by the subset level's larger number of only functional features and the below-subset level's larger proportion of subordinately functional features.

The classifications of the "higher" level responses were also found to be significantly different, $\chi^2(3) = 75.52$, $p < .001$, but with a different pattern of dominance than the other levels. The major contributions to this Chi Square were the larger number of features without functional classifications and the smaller number that were only functional. As such, the features used to describe instances at this level were not primarily functional, unlike the feature responses from the other levels. This finding does not fit the pattern found in Experiment 2 of more general features (i.e., features applicable to larger

sets of instances) being more dominantly or only functional. An analysis of the differences between the higher- and superordinate-level responses was significant, $\chi^2(3) = 143.82$, $p < .001$, the principal differences being the larger proportion of higher-level features with no functional classification and the smaller proportion of these features that were only functional.

The "functional" basis of features, and the addition of other components to this functional basis with the increased specificity of features, was therefore found to exist at and under the level of the superordinates. For example, for "tools", the superordinate-level feature "used to construct things" was classified as Functional, the subset-level feature "used to cut" was classified as Functional-Physical, and the below-subset level feature "one cutting edge" was classified as Structural-Physical-Functional (see Appendix 3). This functional basis for comparing instances when the categories they belong to are not mentioned is also the same as that used for defining the instances' memberships in the superordinates when the superordinates are explicitly referred to. As such, primarily functional descriptions will be generated from within the taxonomic organization found here, as long as instances are described at or under the superordinate level.

The use of functional features for comparing instances is also related to their suitability as "norm" descriptions. That is, whether or not they are used to describe an

instance can depend on whether or not a person views them as applicable to an instance, as well as the sense in which a person wishes to use them as descriptions. For example, a "desk" and "counter" were described as different because one is used to "write on" and the other is used to "eat on", but these instances were also described as both being used to "write on" for what is the same about them (see Table 16). As such, instances can be described as having a particular function if they have the potential to fulfill that function, but they may be described as having a different function, especially if an instance is more typically used for another function. Other types of features may also be subject to similar interpretative processes, based on how the instances are typically perceived (e.g., "desk" and "counter" were described as both having "drawers", and a "counter" was also described as not having "drawers"). But functional descriptions have a greater degree of flexibility, as they depend on how people may use things rather than the properties that objects may or may not have independently of people.

Further support was also received for the specificity of descriptions being related to the addition of other components to the functional base. Each level below the superordinate level was found to provide more specific elaborations of the level above it. For example, "tools" can be generally described as being "used to construct things", and at the subset level, they are described in terms of the spe-

cific ways they are used when "constructing" things (e.g., "measuring" and "cutting"). These more specific functions, in turn, entail certain physical and structural characteristics (e.g., being "sharp") which are not directly related to the more general functions. At the below-subset level, components are added to the subset-level functions to provide even more specific descriptions (e.g., measuring "12 inches" or "72 inches", and having "1 blade" or "2 blades" for cutting). As such, if two instances share a least-upper-bound membership in a superordinate or subset, then their featural descriptions will be primarily functional, and the distinctions immediately below these levels will provide more specific descriptions of the instances based on elaborations of their shared functions. The relations that the instances' functions bear to the instances' other characteristics (e.g., being "sharp" and having "blades") and how these relations are used for generating descriptions will be described further in Appendix 5.

The higher-level features, on the other hand, provide an interesting contrast to the features at and below the superordinate level, as the higher-level feature responses were not found to be primarily functional. There were 2 principal types of classifications that differentiated the higher-level responses from those of the other levels. One was their classification as "physical" or "structural". The other was that a number of these features received a total score of 6 1/2 or less out of a possible 9 for any one of

their classifications in Experiment 2, Task 2. In that task, 9 judges classified each feature. A score of 1 was given for any classification that a judge gave a feature, unless a judge ranked or qualified a classification as having a secondary status for a feature, in which case the classifications were given a score of 1/2 for the feature.

For the present examination, the scores for a feature's "physical" and "structural" classifications were added together, if neither of these classifications received a total score greater than 6 1/2. For example, "has a surface" received a total score of 5 for its being "physical" and a score of 4 for being "structural", so that the total Physical and Structural score for this feature was 9. This was done because a number of features were classified as both physical and structural, but the judges often gave one of these classifications and not both. These classifications were therefore interrelated. By adding the scores for these physical and structural classifications, it was possible to distinguish them from the other classifications that received scores of 6 1/2 or less. Features such as "has a surface" were therefore included with the Physical and Structural features, rather than with the features that received scores of 6 1/2 or less for any one classification.

Table 18 shows the number of features from the different levels tested in Experiment 2, Task 2 that were either Physical and/or Structural, or had a score of 6 1/2 or less for any single classification. The number of Physical/Struc-

Table 18

Number of Features from Experiment 3
with Physical/Structural and Other Classifications,
and Scores Less Than 6 1/2

Taxonomic Level	Classification Types			
	Physical/ Structural	Score ≤ 6 1/2	"Other"*	Total Tested
Higher	44	24	41	79
Superordinate	3	6	14	68
Subset	16	15	29	117
Below Subset	4	1	3	10

* "Other" classifications generated by the judges in Experiment 2, Task 2 (e.g., "Affective" or "Cultural")

tural features shown in Table 18 includes those that had scores greater than 6 1/2 for either a Physical or Structural classification, as well as those for which the Physical and Structural scores were added together, as described above. These features also include those that received multiple classifications (e.g., Physical-Structural), with the order of dominance of the classifications being determined by the total scores for these classifications (see Appendix 3).

As can be seen in Table 18, the majority of the higher-level features (83.5%) were accounted for by these two types of classifications (i.e., Physical/Structural, or scores of 6 1/2 or less). In contrast, a smaller percentage of the features from the other levels (24.1%) are included in these classification types. While the higher-level features were not found to be primarily functional, both of their predominant classification types are related to their more general or abstract nature. For one, the physical and structural features are general characteristics applicable to broad sets of instances. For example, as can be seen in Appendix 3, there were Physical features (e.g., "quiet" and "hard"), Physical-Structural features (e.g., "flat" and "rigid"), Structural-Physical features (e.g., "have definite shapes") and dominantly physical or structural features with subordinate functional classifications (e.g., "unbreakable" which was classified as Physical-Structural-Functional). In contrast to the more specific features from lower taxonomic

levels that received similar classifications (e.g., "have legs" and "number of wheels" were classified as Structural-Physical), these higher-level features do not delineate specific sets of instances, but can be used to describe a variety of instances within the different superordinates or their contrasting categories.

Secondly, the higher-level features that received a score of 6 1/2 or less for any one classification (e.g., "essential" and "practical") are more general descriptions because of their more abstract nature. On one hand, a score of 6 1/2 or less could indicate that it is harder to arrive at a consistently agreed-upon classification for these features. However, for all but 3 of the higher-level features with scores of 6 1/2 or less, the judges in Experiment 2, Task 2 gave "other" classifications of their own. Overall, a larger proportion of the higher-level features (51.9%) than the features from the other levels (23.6%) received "other" classifications (see Table 18). As such, the the higher-level features may have been harder to classify in Experiment 2, Task 2 because the judges had not been provided with these other classifications, and had to generate them themselves.

Most of these classifications referred to how people may relate to things in ways other than how they may use them. For example, the judges classified higher-level features as "Affective", "Personal", "Cultural" and "Social/Evaluative" (see Appendix 3). These classifications were

given to features such as "fun", "dangerous", "luxury", "essential", and "practical". Similarly, one of the judges used the classification "Feature of State", which they defined as a person's belief about an object in relation to themselves that need not be functional (e.g., "would hurt someone", "self-motivated" and "luxury").

As can be seen, these classifications refer to the features' less concrete characteristics which are based on how people may respond to things (e.g., "Affective") and the values or judgements that may be applied to an object (e.g., "Social/Evaluative" and "Cultural"). Along these lines, other classifications were given that can involve people's judgements, but may also be considered to be characteristics of the objects themselves. For example, "stronger" was classified as a "Relative State", and "longer" was classified as "Temporal" as well as "Personal". Finally, this role of human judgements is also related to higher-level physical and structural features. For example, "cold" and "heavy" were classified as Physical and "Personal".

As such, the higher-level features primarily describe people's experiences of objects and the more abstract ways in which people relate to things. The physical and structural features describe ways in which objects are perceived, which can be subject to a person's judgement, and the higher-level features with other classifications describe people's affective reactions to objects, as well as the personal and cultural values of objects. These features also

provide a basis for the general "ontological" descriptions of things as "physical objects", "solids" or "functional artifacts" (Keil, 1979). This is especially true of the physical and structural features. But these higher-level features are similar to the functional descriptions of objects, in that they are based on how people relate to things. People can therefore ascribe these features to things in terms of how they relate to them, as well as using the features to describe the ontological characteristics of things. In this way, the higher levels may serve as a more general extension of the functional basis for featural descriptions found at and below the superordinate level.

Summary

A taxonomic organization of information was identified in the present experiment which is used for comparing instances when the categories that instances belong to are not explicitly mentioned. Categories and features were retrieved based on the context of the comparison being made. The two contextual determinants were whether a "same" or "different" comparison was being made, and the least-upper-bound shared memberships of the instances being compared. This taxonomic organization was therefore found to have a general utility for generating descriptions of instances, as the same organization had been used for generating membership definitions in Experiment 2, and the two additional taxonomic levels identified in this experiment (i.e., higher than the superordinates and below the subset level) were

natural extensions of this organization. In addition, it was found that the featural descriptions used when comparing instances were generated from the same "functional" basis that had been used for defining memberships.

While a general least-upper-bound strategy was used for retrieving contextually-relevant information, relevant descriptions were also generated by other means. For one, general higher-level features were used to describe instances that shared membership at each of the taxonomic levels, indicating that these features may be derived as descriptions in any context, based on the more specific relations that pairs of instances have. As well, it was found that subset-level, Permissible features were preferred as descriptions of instances, as they describe the instances' particular functions. Finally, further support was received for instance set relations not being represented in an "all-or-none" fashion within the taxonomic organization, as features were flexibily adapted as "norm" descriptions to meet the demands of particular contexts, the same features being used to describe both what is the same and different about two instances. As such, the relations of features to the instances they can describe must be represented in terms of their potential to describe these instances, rather than their having fixed, "all-or-none" relations to the instances.

These findings indicate that natural category information is taxonomically organized such that it can be accessed

by a general strategy to meet the demands of particular contexts (i.e., by a least-upper-bound strategy), but that the relations within this organization must also be able to support a broader range and flexible generation of descriptions. In a computer implementation of the responses received in the present experiment, these relations were more closely examined (see Appendix 5). In this implementation, relations were specified in the knowledge base by noting how specific strategies would use them to retrieve information for different contexts. In particular, "obligatory" and "permissible" relations were used so that descriptions could be generated in line with their potential suitability for a context, as these relations allowed descriptions to be flexibly adapted to meet the demands of specific contexts. The present experiment and the computer implementation therefore support the theoretical perspective that natural category information is organized in terms of its use, as categories, features and instances need to be accessed in terms of their potential relations rather than in terms of fixed relations.

General Discussion

In these experiments, it has been shown that people adapt their descriptions of category members to fit particular contexts. Most importantly, the same category or feature description can be said to be true of an instance or not, with the asserted or negated descriptions of instances being actively generated to suit different contexts. This finding indicates that natural category knowledge must be represented in line with its different potential uses, as each description serves a particular function within a specific context.

The nature of these descriptions suggests that a broad diversity of relations must be represented to support all the ways this information can be used. For one, categories and features cannot have singular "all-or-none" relations to the sets of things they are used to describe. In contrast to a classical logical model of representation, features are not used as necessary and sufficient determinants of category memberships. In some cases, the same features that are used to define the category membership of an instance are also used to describe the instance when it is being excluded from the category. Features are thus generated as "defining" an instance's membership *if* the instance is considered to be a member, which can depend on the context in which its membership is being considered. As well, an instance can be excluded from a feature's description by contrasting that feature to other features that are used to describe the

instance. Given these findings, the relations that are represented between categories, features and instances can not be formally delimited.

Instead of a strictly logical structure, the diverse ways in which things are described may reflect how the world is structured. As found here, the features used to define category memberships reflect the "family resemblances" of instances within these categories, similar to the "family resemblance" structures that were found when people list the properties of objects (Rosch and Mervis, 1975). How features are used to describe things may best be viewed in terms of the properties of objects in the world, and which of these properties are focussed on in a particular context.

However, the organization of natural category knowledge cannot be solely determined by the objective structure of the environment, as the descriptions that objects are given are not wholly determined by the properties of objects. For example, an object may be objectively described as being "used to put things on" because it has the property of a "flat top" or "surface". But having this property will not determine whether the object is given this description in a specific context. For example, a "bed" may fit the description "used to put things on", but in contrast to a "table" will be described as used to "rest on" or "sleep in" rather than used to "put things on". The information that is accessed as relevant within a particular context must therefore be open to interpretation and cannot be simply deter-

mined by whether or not an object has specific properties.

The flexible generation of descriptions would seem to require that a vast number of relations be accessible, if descriptions are generated to fit any number of different contexts and are not constrained by either a logical structure or a structure given in the world. But an organization of knowledge does not necessarily need to represent relations between categories, features and instances in terms of fixed or analytic specifications (e.g., as weighted values or necessary conditions). Such specifications would be of little use for arriving at descriptions that are flexibly adapted to fit particular contexts, as they would have to be negated or overlooked in a number of cases. Instead, only general relations may need to be represented. More general relations would simply indicate the different paths that might be taken to arrive at a relevant description, based on how information is most commonly used or asserted. These relations would not be invalidated by their negation in particular contexts, as their general nature would indicate that they may be used in a wide variety of other contexts.

With this perspective in mind, a deontic model of knowledge representation was developed, which was supported by the research reported here. In Experiment 1, Task 2, commonly-asserted relations between features and superordinate categories were identified, based on the features' potential applicability to members of the superordinates. In Experiment 2, the features were found to be used to define member-

ships in superordinates based on their commonly-asserted, potential relations to the superordinates, the features being either Obligatory, High Permissible, Permissible or Impermissible deontic "norms" for the superordinates.

The best example of how these potential relations are used was seen with the High Permissible norms. In Experiment 1, Task 2, some of the members of the superordinates were said not to be described by the superordinates' High Permissible norms, in contexts where subjects were asked to contrast these features to the superordinates. For example, in response to the question "Are all types of tools things used to build?", a "saw" and an "ax" were said to be "tools" that are not "used to build", as they are used to "destroy" or "take things apart". But the High Permissible features were also used to define the memberships of the same (or similar) instances in the superordinates, as these features can potentially describe all members of the superordinates (e.g., a "saw" and a "hatchet" were defined as "tools" because they are "used to build"). The relations of features to superordinates are therefore based on a feature's potential to describe "all" members of a superordinate (i.e., the Obligatory and High Permissible norms) or "some" of a superordinate's members (i.e., the Permissible features).

As the features were used to define memberships in the superordinates, these features are explicitly related to the superordinates. In contrast, the features that are Impermissible norms for the superordinates are not related to the

superordinates. Instead, these features are related to contrasting categories of the superordinates. But this does not mean that the Impermissible norms for the superordinates are features that are impermissible for members of the superordinates to "have". Rather, features are related to categories in terms of their use as commonly-asserted descriptions of category memberships. For example, types of "clothing" are not said to be "clothing" because they are "used when cooking". But this feature does describe types of "clothing" that are also "kitchen items" (e.g., an "apron").

This structuring of information is therefore taxonomic, as the features are associated with specific categories and subsets of the categories. In Experiment 1, more typical members of the superordinates were categorized more often than less typical members as belonging to the superordinates and subsets of the superordinates, and were also classified more frequently by the superordinates' features. The less typical instances, on the other hand, were classified more often as belonging to contrasting categories of the superordinates and by features associated with these contrasting categories (i.e., Impermissible norms for the superordinates).

This finding indicates that instances are most frequently described in terms of their "family resemblances", as the Impermissible norms that are used to describe the less typical instances are features that these instances share with members of contrasting categories. The less typi-

cal instances can be described as members of the superordinates, as seen in Experiment 2, when their memberships in the superordinates were defined by features that describe all members of the superordinates (i.e., the superordinates' Obligatory and High Permissible features). But when the superordinates are not mentioned, as in Experiment 1, the less typical instances are more commonly described in terms of contrasting categories and the Impermissible features that are norms for these contrasting categories.

This dynamic allows the taxonomic organization to be accessed to meet the demands of particular contexts. As found in Experiment 3, instances are most frequently compared in terms of their least-upper-bound shared memberships (i.e., at the subset or superordinate levels, or at higher levels if membership is not shared at the superordinate level). As such, a superordinate's feature norms will be used to describe a less typical instance, when the instance is compared to another member of the superordinate that it does not share a contrasting category membership with. For example, the less typical members of "furniture", "rug" and "picture", were described as similar because they are "objects in homes" and "decorate houses", which are High Permissible features of "furniture". Similarly, "apron" and "handkerchief" were described as similar because they are "worn as part of clothing", though they were described as different because one "is worn" while the other "fits in a pocket". As such, the taxonomic organization provides a use-

ful basis for generating norm descriptions that are suitable to particular contexts.

The taxonomic organization identified in the present experiments indicates the level of specificity at which instances are most likely to be described. For example, if instances share membership in a subset, their similarity will be described in terms of this subset and their differences will be described in terms of more specific distinctions within the subset. But it should also be noted that each level of description need not be explicitly represented by taxonomic relations. In the computer implementation of the responses received in Experiment 3 (see Appendix 5), subset-level descriptions were frequently not arrived at by identifying subset categories with subordinate relations to superordinates (e.g., a "carpentry tool" being A-Kind-Of "tool"). Instead, the subset level was accessed most often through the norm relations of features to the instances and their superordinates. For example, "cutting" was represented as Obligatory for "saws" and "scissors" and Permissible for "tools". "Saws" and "scissors" were therefore described as things that are "used to cut", which is a subset distinction within "tools". In addition, the below-subset-level descriptions were not represented as distinct features or categories, but were generated by combining the subset-level features with other relevant information from within the instance frames (e.g., the number of "blades" that "saws" and "scissors" have for cutting; see Appendix 5).

The generation of relevant set distinctions within the taxonomic organization may be arrived at through featural relations as well as through explicitly-represented taxonomic relations. The use of features to describe sets of instances was found to be a common practice, as a majority of the instance categorizations received in Experiment 1 were feature classifications (e.g., "things that are worn"). In addition, feature classifications can be used to generate sets of instances, as seen in Experiment 1, Task 2. For example, a rather diverse set of "things used to keep warm" were listed that are not "clothing" (e.g., "heaters", "the sun", "coffee", etc.).

As the feature norms and categories do not have all-or-none relations, the features provide an important basis for instance-set manipulations. For one, the instances in some categories are more closely related to each other, owing to the features that are common to these categories. For example, "furniture" and "appliances" are both "used in houses", and "clothing" and "jewelry" are both "worn". Because of these shared features, types of "appliances" can be considered members of "furniture", though less typical members, and pieces of "jewelry" can be considered "clothing". But the determination of these memberships depends on the context, as these instances can also be excluded from "furniture" and "clothing" in light of their membership in the contrasting categories "appliances" and "jewelry" (Experiment 1, Task 2).

The manipulation of instance sets to fit particular contexts also corresponds to other recent findings on the effects of context. Roth and Shoben (1983) found that subjects alter their judgements of the typicality of instances in line with the descriptions that are mentioned with categories. For example, in response to a sentence about drinking a "beverage" during a midmorning break, "coffee" and "tea" were judged to be good examples, while "coffee" and "milk" were judged to be good examples, and "tea" a poorer example, of "beverages" to have with donuts in the morning. Sets of instances are therefore delineated and judged more typical in line with the descriptions given in a particular context (e.g., the subset of "beverages" that one "drinks" during a "midmorning break", or the subset that one "drinks" with "donuts in the morning"). Similarly, Barsalou and Sewell (1984) found that subjects altered their typicality judgements to fit different points of view, such as the points of view of a housewife, businessman or hippie. People can therefore change their perspective of a category to fit different stereotyped points of view and particular contexts.

These findings demonstate that natural category knowledge must be organized to fit its different uses. This perspective is in line with Wittgenstein's (1953) original description of "family resemblance" structuring. He saw family resemblances as being the result of how we use words and refer to things in particular contexts. As he illustrated,

we refer to concepts by using examples to indicate what we mean. Rather than concepts having formal, well-bounded definitions, the examples indicate how we intend the concept to be taken. All of the examples of a concept that can be used in different contexts may therefore only bear family resemblances to each other, rather than having any features that are necessarily common to all. As the examples or instances of a category correspond to the meaning of that category in a specific context, concepts do not need to be well-defined or bounded to make them usable, though boundaries can be drawn for special purposes.

As found here, the meaning or sense that features are given can also be based on the instances and/or categories that are referred to in particular contexts. Along these lines, it is of interest that Wittgenstein did not use the feature "play" when illustrating the family resemblances of "games" (though he repeatedly referred to how we use words when we "play" the "language game"). This feature can be used to describe all types of "games". But the meaning that this feature has varies when being used to describe different "games". For example, how we "play" chess is different from how we "play" ring-around-the-roses. The different senses in which these games are "played" are related to the family resemblances of games (e.g., games played "competitively" or for "amusement"). Which games are referred to as being "played" can determine the sense in which the feature "play" is intended to be taken. In addition, all activities

that involve "play" do not necessarily have to be "games". Nor may there be any features that "play" could be combined with to provide sufficient criteria for determining fixed boundaries for the concept "game" (e.g., activities being "structured" or having "rules"). One may "play" while writing a computer program, but this does not necessarily make this activity a game.

While the feature "play" can be used to describe all types of games, this feature does not necessarily have to be true of all games in all cases. This is so because features are used as deontic "norms" for describing category members, and deontic norms are generic assertions rather than characteristics that must necessarily be the case. As described by Wright (1963), a generic proposition has "a truth-value only when coupled with an occasion for its truth or falsehood; that is, when it becomes 'instantiated' in an individual proposition" (p. 23). Given the generic norm relations of features to categories and instances, featural descriptions can therefore only be validated by noting their applicability to instances in particular contexts (or on particular "occasions") and the validity of a feature for a category can only be arrived through the feature's applicability to specific instance examples.

The feature "play" would therefore be a generic norm for "games", as this feature does not need to be true of all the individual cases of games. For example, it can be said that one does not always "play" chess, as one may "work" at

one's chess game rather than "play" a game. Such exceptions are related to the "exclusive disjunctions" that are generated when excluding instances from the featural descriptions. For example, it can be said that all "games" are not "played" because you "work" at some of them, just as all "tools" are not "used to build" because some are used to "destroy" things. But these exceptions do not invalidate the generic applicability of features to categories and their instances, as the features' norm relations to categories indicate their potential rather than necessary applicability to the categories' instances.

As the feature norms for categories can be adapted to fit particular contexts, they may also serve specialized functions. For one, the dynamic involved in applying feature norms can be used to work toward "ideals" (Blau, 1985). As noted by Wittgenstein (1953), definitional boundaries can be drawn around categories for special purposes, even though concepts do not have to be well-bounded to be used. For example, in science, features are used on a theoretical level as necessary and sufficient determinants of category memberships. This is done by specifying the features that provide ideal descriptions of the categories, as well as the contexts and conditions under which they should be true. These definitional specifications are then tested. But as we know, every assertion that is hypothesized is not empirically verified, or additional characteristics are found that cannot be dealt with by our definitions. So we alter the

specifications of our definitions and shift the boundaries of our categories, thereby refining the ideal that is being used to describe the world.

Deontic norms could provide the basis for this type of problem solving, as the features in scientific definitions are adapted by delimiting or extending their applicability to arrive at more suitable descriptions. While these processes are rigorously applied in science, similar processes may be used in everyday problem solving to arrive at definitions that are suitable for particular circumstances. But the processes involved in assigning analytic values to features to arrive at well-defined boundaries for categories should not be confused with features actually being analytic in any necessary or given sense. Along these lines, Rosch and Mervis (1975) noted that while they studied family resemblances in terms of discrete attributes, discrete attributes may be an analytic myth, "as the context in which an attribute occurs ... may always affect perception and understanding of the attribute" (p. 576). However, they studied attributes as if they were discrete "to show that it is not necessary to invoke attribute interactions or higher order gestalt properties of stimuli ... in order to analyze the prototype structure of categories" (p. 576).

Recent theories of representation, on the other hand, have focussed on the organization of features in terms of their relations within categories. In particular, it has been proposed that people use "intuitive theories" to

explain the structure and origins of categories, and that these theories are used to select, interpret and organize features when forming categories (Lakoff, in press; Murphy and Medin, 1985; Neisser, in press; Schank, 1985). These explanatory organizations are based on the relations between features (e.g., inferential or causal relations), with the sets of relations within a category constituting the basis for that category's "intuitive theory". These proposals therefore focus on how features are organized within categories to form meaningful wholes, rather than features being organized as a collection of defining, correlated or exemplary characteristics.

As found here, features are used as explanations (e.g., for explaining <u>why</u> instances are members of categories) and bear "norm" relations to categories and instances. Intuitive theories for categories would therefore be based on how features are used as norms to describe categories, as well as identify, explain and interpret memberships within categories. Contrary to the above proposals for intuitive theories, the explanatory relations between features cannot be predetermined, as features are adapted to fit the contexts they are used in. The relations between features in intuitive theories should therefore be based on how features are commonly-asserted as explanations in relation to each other. It was found that the meanings that features have relative to each other are altered for particular contexts. As such, features must bear "norm" relations to each other, so that

their use is adaptible.

The norm relations between features can best be seen in how features are used as "exclusive disjuncts". For example, all "tools" can be described as being "used to build". But when generating the features of "tools" that can be taken as "exclusive disjuncts" of "used to build" (e.g., "destroy" and "take things apart"), the relations between these features must be accessed. These relations must reflect the senses that the features can be asserted to have in relation to each other. As such, it is Permissible for things that are "used to build" to "take things apart", as using things to "build" can involve "taking things apart" and "putting things together". But "putting things together" is Obligatory for "building" and bears a sibling/contrasting relation to "taking things apart". So "used to build" can be contrasted to "taking things apart", if it is taken as being synonomous to "putting things together", thereby delimiting its sense (see Appendix 5 for further details on how these relations can be used). The relations between features must therefore be norm relations, so that the features' meanings can be adapted for particular contexts, and the intuitive theories for categories would be based on the feature norms used to describe the categories and the features' norm relations to each other.

In addition, the organization of people's "intuitive theories" for categories are based on the types of features they use as explanations. As was found here, primarily func-

tional features are used for defining category memberships and describing what is the same and different about instances. These features provide a meaningful "core" for categories (Nelson, 1974, 1978) that can be adapted for particular circumstances. Functional features are adaptable because they describe people's potential involvement with things and what things are expected to do, both of which are determined in specific contexts. For example, whether pieces of "clothing" are "worn" or "cover the body" depends on the context. (This specifically deontic characteristic of functional feature norms is discussed further on).

On the other hand, features such as the structural parts and physical characteristics of things may be selected, interpreted and fit into people's "intuitive theories" for things. The selection and interpretation of structural and physical characteristics may be carried out in terms of their functional relevance, as with Miller and Johnson-Laird's (1976) "functional paradigms". Along these lines, the perceptual salience of an object's structural parts may strongly influence the initial "goodness" that parts are perceived as having for an object. But within well-developed natural categories, the functional significance and perceptual salience of objects' parts may be too closely related to easily separate their contributions (Tversky and Hemenway, 1984).

People's "theories" for natural categories could therefore have a functional core that the parts of objects "fit

into" in terms of their functional significance. However, the relations between functional and structural features do not have to be explanatory relations (e.g., inferential or causal relations) as they may be asserted relations as well. For example, in the computer implementation (Appendix 5), parts were represented as having Obligatory and Permissible functions. Part descriptions of the object instances were then generated by noting the parts that have the function that is used to describe the instances in that context. When describing the differences between saws and scissors, they were described as having "1 blade" and "2 blades" for cutting because "cutting" is Obligatory for saws, scissors and blades, and "cutting" is used to compare saws and scissors. The role of structural parts in explanations could therefore be based on how they are used as specific descriptions of instances, in relation to the instances' functional norms.

Finally, functional features may be used as the core for natural category explanations because of how they can be used as deontic norms. Deontic systems of obligation and permission have most commonly been used as the basis for theories of action and change (Hilpinen, 1971; Wright, 1963). For example, the command "open the window" is a statement of what ought to be done that is based on people's generic ability to open windows (i.e., windows are things that can be opened). This command can only be invalidated in particular contexts (e.g., if a window is stuck). The generic proposition on its own is therefore neither true or

false. As functional features are applied in terms of specific actions, their truth or falsehood is also dependent upon their applicability in particular contexts. For example, all types of "clothing" are said to be "worn". But whether or not a piece of "clothing" is "worn" depends on the context. Based on these distinctions, borderline cases of "clothing" (e.g., "purses" and "handkerchieves") can be said to be "worn" or not, depending on whether or not a person wishes to assert that these instances are "worn" in specific contexts. In this way, functional features provide a basis for generating generic explanations that can be adapted to particular contexts.

In contrast, physical and structural characteristics are more closely related to individual instances or examples of a category in terms of the specific physical and structural characteristics of objects. However, these features can be used as generic descriptions of classes of instances. For example, chairs can be described as having "arms" even though all chairs don't have arms. Instances may or may not be described as having these features relative to the specific functions they are viewed as having in particular contexts. For example, counters and desks are both used to "hold things" and were described as the same because they both have "drawers". But they were also described as being different because counters don't have "drawers", and because counters are used to "keep things <u>on</u>" in contrast to desks being used to "keep things <u>in</u>". Similar to Wittgenstein's

(1953) description of the basis for "family resemblances", how things are described depends on how things are referred to in different contexts.

Natural category knowledge is therefore organized in terms of how things can potentially be described. Descriptions and explanations can be generated through analytic processes, but the relations between categories, instances and features cannot be analytically represented, as these relations must be flexibly adapted to meet the demands of particular contexts. The representation of natural category knowledge must therefore correspond to the different ways in which it can be used.

Appendix 1

Three Most Frequent Categorizations Received for Instances in Experiment 1, Task 1

Instance Categorizations

Most Typical Instances	Category	freq	Least Typical Instances	Category	freq
			Furniture		
Chair	Furniture	5	Clock	Timepiece	8
	Wood (Wood Object, Made of Wood)	5		(Time, Measures Time)	
	Used to Sit On (Seat, Sit)	4		Watch (Wristwatch)	4
				Numbers	2
Bed	Thing to Sleep on (Used for Sleeping & Resting)	6	Rug	Floorcovering (Covering, Floor)	9
	Furniture	5		Carpet	4
	Made of Wood (Made of Wood & Metal)	4		Wool (Synthetics & Wool What It Is Made Of)	4
Table	Furniture	6	Closet	Storage Place (For Storage)	5
	Wooden Object (Made of Wood)	5		Wood	3
	For Eating On (Eating or Dining)	4		Place To Hang Clothes (Place To Hang Objects)	3
Dresser	Wooden (Wood)	7	Stove	Used For Cooking (Cooking, For Cooking Food)	6
	Furniture	6		Hot (Heat, (Generates Heat)	4
	Stores Clothing (Clothes)	6		Appliance	3
Sofa	Furniture	10	Counter	Table	3
	Something to Sit On (Seat)	5		Top Surface (Top)	3
	Couch	3		Workspace (To Work On)	3
Desk	Furniture	7	Picture	Photograph (Photo)	3
	Workarea (Items Used For Work)	5		Frame	3
				Memory	2

	Table (Worktable)	3		(Remembrance)	

Vehicles

Car	Transportation (Mode of Transportation)	6	Skates	Metal (Metallic)	4
	Venicle	4		Toy (Playthings)	3
	Things With Wheels (Four Wheels)	3		Roller (Rollerskates)	3
Ambulance	Car (Automobile)	5	Blimp	Aircraft (Airvehicle)	4
	Transportation (Transport, Transporter)	5		Fat	3
	Vehicle (Vehicle of Transportation)	3		Transportation (Way of Transportation)	2
Truck	Vehicle	5	Wheel-barrow	Transporter (Mode of Transporting)	3
	Transportation (Transporter)	4		Tool	2
	Driven	2		Vehicle	2
Streetcar	Transportation (Transporter)	6	Sled	Toy (Plaything)	5
	Vehicle	4		Transportation (Transporter)	4
	Train (Trolley)	4		Snow (Something Used in Snow)	4
Motor-cycle	Vehicle	8	Elevator	Machine	4
	Transportation (Means of Transportation)	5		Transport (Transportation)	3
	Bicycle (Bike)	4		Height	2
Bus	Transportation (Used for Transportation)	7	Horse	Animal	10
	Vehicle (Transport Vehicle)	6		Four-legged (Four-legged Mammal)	4
	Ride	2		Ride (Riding, Something to Ride)	3

Clothing

Pants	Clothing (Clothes)	7	Purse	Bag (Bag Used For Carrying Items In)	4
	Men's Apparel (Menswear)	2		Pocketbook	3
	Dungarees (Jeans)	2		Leather Item (Made of Leather)	3
Skirt	Clothing (Article of Clothing)	6	Handker-chief	Cloth	6
	Feminine (Woman, Made for a Female)	4		Items to Blow Your Nose In (Blow Nose In)	3
	Wool (Woolen)	3		Cotton (Made of Cotton)	3
Coat	Clothing (Clothes)	6	Gloves	Something Used to Keep Warm (Warmth Item, Warm)	6
	Something Used to Keep Warm (Warmth)	5		Clothing (Clothes)	3
	Outergarment (Outerwear)	3		Material	3
Shirt	Clothing (Clothes)	8	Apron	Protection (Protective Device)	4
	Material	5		Cooking (For Cooking)	3
	Cotton (Something Made of Cotton)	3		Clothing	2
Jacket	Clothing	10	Necklace	Jewelry	7
	Warmth (Used for Warmth)	4		Chain	4
	Coat	3		Ornament	3
Dress	Clothing (Clothes)	7	Watch	Timepiece (Things That Measure Time, Time)	11
	Garment	3		Jewelry (Piece of Jewelry)	8
	Pretty (Attractive, Beauty)	3		Something Worn (Wearing It)	2

Tools

Hammer	Tool	6	Solder-ing Iron	Tool (Tools)	5
	Metal (Metal Object)	4		Metal	5

	Carpenter (Carpentry)	3		Hot (Must be Hot, Red Hot)	4
Tape Measure	Measure (Way of Measuring)	3	Slide Rule	Measurement (Use to Measure)	5
	Ruler	3		Calculator	2
	Tool	2		Tool	2
Saw	Tool (Tools)	5	Scissors	Cut (Cutter, Cutting Item, Cutlery)	6
	Cut (Cutter, Cut Things)	4		Tool (Tools)	5
	Sharp	3		Metal (Metallic)	5
Drill	Tool	7	Hatchet	Tool	6
	Machine (Machinery, Mechanical)	4		Weapon	4
	Instrument Used to Make Holes (Holes)	4		Sharp Instrument (Sharp-edged Object)	3
Ruler	Measurement (Measurer, Measuring Device)	9	Stapler	Tool	3
	Straightedge (Making Straight Lines, Lines)	5		Office Equipment	3
	Tool	2		Device to Hold Paper Together (Keeping Papers Together)	2
Nails	Sometning That Holds Things Together (Device to Hold Something on to Sometning Else)	4	Cement	Building Substance (Construction Materials)	4
	Tool (Tools)	3		Hard (Hard Substance)	4
	Body Parts (Part of Body)	2		Solid (Solid Things)	3

Appendix 2

Feature Definitions Received for Superordinate Memberships in Experiment 2, Task 1

Feature Definitions and Frequencies

CLOTHING

Most Typical Instances: Shirt, Jacket, Skirt, Pants, Coat, Dress
Least Typical Instances: Gloves, Purse, Necklace, Apron, Handkerchief, Watch
Most-Least Instance Pairs: Skirts & Gloves, Pants & Aprons, Coats & Handkerchieves, Dresses & Watches, Jackets & Necklaces, Shirts & Purses

Features	Frequency for Instance Types: Most Typical	Least Typical	Most-Least Pairs
Obligatory			
Worn (Wear, Worn on body, Worn by people, Made to be worn, Can be worn)	18	17	22
Cover (Cover body, Cover parts of body, Cover person)	13	5	7
Used by People (Used on body, Used for different purposes)	0	3	2
High Permissible			
Decorative (Decorate body, Adorn body, Pretty, Worn to make person more attractive)	7	10	6
Protect Body (Protect part of body, Protective covering for body, Worn to protect, Worn to shield)	4	5	5
Part of Outfit (Part of wardrobe)	0	4	3
Permissible			
Made of Cloth (Made of material, Made of fabric)	5	4	3
Fashionable (Style, Design popular)	5	2	1
Used for Warmth (Keep body warm, Wear to keep warm)	5	1	1
Worn to Keep Hands Warm	0	1	0
Protect from Weather (Protect body from weather, Protect from cold, Protect from sun and winter, Shelter from weather)	7	1	2
Cover from Weather	3	0	1
Essential in Cold Weather	0	0	1
Protect Clothing	0	1	0
Tradition (Socially accepted, We got used to it)	5	1	1
Women Wear	1	0	0
Cover From Each Other (Socially expected to cover up body,	4	3	2

Cover parts not to see, Hide body, Conceal/maintain privacy)			
Cover Lower Part of Body	2	0	0
Cover Hands (Worn on hands)	0	2	0
Worn Around Waist	1	0	0
Legs Get Fresh Air	1	0	0
Put Around Neck	0	1	0
Accessory	0	1	1
For Indoor Use	0	1	0
Easy to Put on	1	0	0
Personal Hygiene	0	1	0
Blow your Nose	0	1	0
Carried (Carried on body, Carry things around, Carried in pocket)	0	3	2
Used for Telling Time	0	1	0
Permissible Conjunctions (for most-least instance pairs)			
Worn for warmth & Carried (shirt and purse)			
Protect from cold & Inserted in pocket (coat and hankerchief)			
Shield from elements and society & from dirt and food (pants and apron)			

TOOLS

Most Typical Instances: Hammer, Saw, Ruler, Drill, Nails, Tape Measure
Least Typical Instances: Stapler, Cement, Scissor, Hatchet, Soldering Iron, Slide Rule
Most-Least Instance Pairs: Saws & Staplers, Rulers & Cement, Nails & Hatchets, Tape Measures & Soldering Irons, Drills & Scissors, Hammers & Slide Rules

	Frequency for Instance Types		
Features	Most Typical	Least Typical	Most-Least Pairs
Obligatory			
Its Use (Its usage, Useful, Function it performs)	6	3	4
Use to Certain End (Achieve desired effect, Perform specific action)	3	4	1
Do Something (Does something could not do without, Helps do sometning)	6	6	9
Helps do Work (Used to do work, Does Work)	7	2	3
High Permissible			
Helps do Job (Used to perform	6	8	6

task)			
Used to Make Things (Used to construct things, Used to build)	12	8	16
Enables You to Fix Things (Do repair jobs, Necessary in restoring things, Maintenance)	2	1	4
Used to Alter (Used to create)	1	1	1
Used Beneficially	1	1	0
Permissible			
Put Things Together	1	1	1
Join Things Together (Attach things together)	1	2	0
Hold Things Together (Keep things together)	4	2	0
Take Things Apart	0	1	0
To Destroy Things (Used to destruct objects)	1	2	0
Make injury (Help protect from enemies)	1	0	1
Manual Device (Mechanical instrument, Used to alter manually, Used mechanically)	3	3	4
Used in Workshop (Instrument carried in tool compartment)	2	0	1
Carpenters use it (Construction workers use, Used for trades)	1	0	2
Used to Cut Things (It cuts, Used to saw)	4	5	1
Used to Cut Wood (Chop wood, Can cut material)	0	3	0
Used to Measure Objects (Shows distance)	10	3	0
Measure Wood	1	0	0
Straight-edged object	1	0	0
Pound on Objects (Nail down objects)	2	0	0
Make holes	0	0	1
Shape to Any Form (Pour into Mold)	0	2	0
Connect Steel (Mold metal)	0	2	0
Staple (Keep papers together)	0	2	0

Permissible Conjunctions
(for most-least instance pairs)

Make holes & Cut things (drills and scissors, 2 listings)
Bind & Cut/chop (nails and hatchet)
Hammer & Slide; Bang/pullout & Measure; Nail & Measure (hammer and slide rule)
Cut & Hold together (saw and stapler)

VEHICLES

Most Typical Instances: Car, Truck, Ambulance, Streetcar,

Bus, Motorcycle
Least Typical Instances: Blimp, Horse, Elevator, Skates, Sled, Wheelbarrow
Most-Least Instance Pairs: Cars & Elevators, Buses & Sleds, Trucks & Blimps, Streetcars & Wheelbarrows, Motorcycles & Sleds, Ambulances & Horses

Features	Frequency for Instance Types: Most Typical	Least Typical	Most-Least Pairs
Obligatory			
Moves (It moves, Mobile, It can move, It moves from one place to another)	9	9	12
Transportation (Form of transportation, Used as transportation, Made for transportation)	7	2	3
Transport (Used to transport, Used as conveyor)	3	3	6
Travels (It travels)	2	0	1
Takes you places (Takes you somewhere)	2	3	5
Specific Utility (Duties it performs)	2	0	0
High Permissible			
Used to Transport People and Things (Carry people and things, Move people and things, Transport people or things)	2	8	6
Transports People (Carries people, Convey people, Transport people from one place to another)	17	6	10
Transportation for People	0	1	2
Moves You (Moves people, Moves you around)	3	5	3
Used to Travel (You travel, Help people to travel)	1	1	1
Used to Get From One Place to Another (Gets you somewhere)	2	6	3
One Rides it (Ridden)	0	3	0
Used to Transport Things (Transport objects, Carry things, Move things from one place to another)	8	9	1
Permissible			
Fast Transportation	0	0	1
Cover Large Distance (Move across a distance)	0	0	2
Holds Passengers (Carries	2	0	0

passengers)			
Transports Patients	1	0	0
Carry Big Things	0	0	1
Has Wheels (Moves on wheels, Has 4 wheels, Has tires, Move about on tires)	12	5	2
Has Engine (Has Motor, Has internal combustion engine)	7	1	0
Motorized (Self-motivated, Mechanical)	3	0	2
Body Made of Metal	1	0	0
Car that Transports People (Car that is a moving vehicle, Automobile with specific utility)	4	0	0
Driven (People drive in, Drive on the road)	2	0	1
Steered	0	0	1
Ride on (Carries rider, Ride smooth)	0	2	1
They Roll (You roll/don't walk)	0	1	2
Helps Walk Longer Distance Fast	0	1	0
Used to Pull	0	1	0
Glide in Sky	0	1	0
Permissible Conjunctions (for most-least instance pairs)			
None			

FURNITURE

Most Typical Instances: Chair, Bed, Dresser, Sofa, Desk, Table
Least Typical Instances: Clock, Counter, Picture, Closet, Rug, Stove
Most-Least Instance Pairs: Beds & Stoves, Chairs & Clocks, Sofas & Counters, Tables & Closets, Desks & Rugs, Dressers & Pictures

	Frequency for Instance Types		
Features	Most Typical	Least Typical	Most-Least Pairs
Obligatory			
Functional (Serves us, Performs function characteristic of furniture)	2	1	8
Man-Made Object (Manufactured)	1	2	2
Takes up Space (Takes up room, Takes up similar space)	1	2	1
Furnishes (Furnishing)	1	1	1
High Permissible			
Used in Rooms (Furnishes Rooms,	6	5	7

Takes up space in room, Sits in room, Belongs in room)			
Used in Houses (Used in home, Found in houses, Furnishes house, Used in house or apartment, Buy them to belong in house)	12	8	16
Used for Decoration (Decorative, Part of decor)	3	5	5
Decorates Room (Enhances house, Make apartment look nice)	6	8	6
Part of Furniture (Goes with furniture, Bought like furniture)	0	4	0
Used to Put Things On	2	4	1
Convenience (Help live easy life)	0	1	1
Permissible			
Comfort (Comfortable, Man-made for comfort, Permanent fixture which brings comfort, Used for comfort in living room)	5	0	3
Stationary Object (Stays put, Permanent fixture)	1	3	5
Interior Decorative Fixture (Interior fixture that makes room look nice)	0	1	1
Made of Wood (Made of wood or metal)	4	3	2
Used to Hold Things (Used in house to hold things)	3	0	0
Used to Hold Body (Used to hold people)	2	0	0
Rest Body Parts On	2	0	0
Sit On (Sit in, Can sit on, Used to sit on in living room)	10	1	0
Sleep on	2	0	0
Used to Store Things (Used in house to keep things in)	2	1	0
Store Clothes (Used in house to store clothes)	1	2	0
Used for Putting Food On	1	0	0
Write On	1	0	0
Used in House as an Appliance	0	2	0
Covers Floor	0	2	0
Covers Hole in Wall	0	1	0
Tells Time	0	2	0
Specific Purpose in Bedroom	1	0	0
Kitchen Decor	0	1	0

Permissible Conjunctions
(for most-least instance pairs)

Used to Sit on & Tell time; Sit on chair & Look at clock; For Comfort in room & Telling time (chair and clock)

Used in house to Sleep & Cook; Sleeping & Eating in house (bed and stove)

Appendix 3

Experiment 2, Task 2 Feature Classifications

Feature Classifications

Note: total scores for classifications (out of 9 possible) are given in parentheses, and the OTHER classifications are shown in quotes ("F.O.S." = Feature of State, and was used to refer to people's belief about the state of an object relative to themselves, rather than referring to its function, e.g., the feature "would hurt a person")

FUNCTIONAL

Use (9)
Serves people (9)
Protects (9)
Used to fix things (9)
Moves things (9)
Hold things (9)
Store things (9)
Used to blow nose (9)
Used to hit things (9)
Used to defend (9)
Assists in building (9)
Helps do work (9)
Hold things together (9)
Carries sick people (9)
Carry people (9)
Ride in (9)
Covers (9)
Decorates (9)
Chop things (9)
Cutting (9)
Used to alter (8 1/2)
Make holes (8 1/2)
Transports things (8 1/2)
Transports (8 1/2)
Used for purpose (7)
Necessary for restoring things (7)
To make something (9)
Used for many people (9)
Made for transportation (9)
Used to perform task (9)
Used to pull (9)
Sit on (9)
Protects clothing (9)
Used to keep warm (9)
Protects from weather (9)
Used to shape to any form (9)
Designed to measure objects (9)
Shows distance (9)
Used for connecting things (9)
Keep papers together (9)
Used for taking things apart (9)
To destroy things (9)
Used to keep clean (9)
Store food (9)
Tells time (9)
Build (8 1/2)
Helps do something (8 1/2)
Used to construct things (8 1/2)
Used for transportation (8 1/2)
Recreational purposes (8 1/2)
Covers from each other (8)

FUNCTIONAL - OTHER

For emergencies (9) - "Context"(1)
Used to cover body (9) - "Social/Normative"(1)
Used to join by heat (9) - "?"(1)
Inflict torture (9) - "Affective"(1), "Physical Pain"(1)
Used to obtain end (8 1/2) - "Personal"(1)
Performs action (8 1/2) - "Animate/Inanimate"(1), "?"(1)
Helps do job (8 1/2) - "Personal"(1), "Context"(1)
Useful (8 1/2) - "Personal"(1), "Cultural"(1)
Used Beneficially (8) - "Personal"(1), "F.O.S."(1)
Helps (8) - "Personal"(1), "Evaluative"(1)
Recreation (8) - "Cultural"(1), "?"(1)
Playing (7 1/2) - "?"(2)

Makes life easier (7 1/2) - "Affective"(1), "Personal"(1), "Evaluative"(1), "Cultural"(1)
Kill someone (7 1/2) - "Result"(1), "F.O.S."(1)
Used in winter (7 1/2) - "When"(1), "Context"(1)
Sit (7) - "Act"(2)
Look at (7) - "Size, Brightness"(1), "?"(1)
Buy/purchase them (7) - "F.O.S"(1), "?"(1)
Used by people (6 1/2) - "Requirement"(1), "F.O.S."(1)
Convenience (6) - "Affective"(2), "Personal"(1), "?"(1)
Essential (5 1/2) - "Affective"(1), "Personal"(1), "Evaluative"(1), "?"(1)
Enjoyment (5 1/2 - "Affective"(2), "Personal"(1), "Social/Evaluative"(1), "Result"(1)
Is acted upon (5 1/2) - "F.O.S."(1), "?"(1)
Pushed (5 1/2) - "?"(2), "F.O.S."(1)
Requires skill to use (5 1/2) - "Who"(1), "Context"(1), "F.O.S."(1)
Requires use of arms (5) - "Requirement"(1), "F.O.S."(1)
Practical (5) - "Affective"(2), "Personal"(1), "Cultural"(1), "F.O.S"(1)
Fun (5) - "Affective"(4), "Personal"(1), "Result"(1)

FUNCTIONAL - STRUCTURAL

Measures (9 - 1)
Measures inches (9 - 2)
Puts together (8 1/2 - 2 1/2)
Used to join things together (8 1/2 - 2 1/2)
Designed for travel (8 - 2)

FUNCTIONAL - STRUCTURAL - OTHER

Creates reaction (8 - 1 1/2) - "Result"(1), "Personal"(1)
Staple things (8 1/2 - 2 1/2) - "Act"(1)
Steered (7 - 1 1/2) - "?"(2), "Natural Forces"(1)
Operated by manual force (6 1/2 - 1) - "Requirement"(1), "F.O.S."(1)
Tradition (4 - 1 1/2) - "Cultural"(2), "Affective"(1), "Social/Normative"(1), "Why"(1)
Fashionable (4 - 1 1/2) - "Affective"(1), "Personal"(1), "Cultural" (1), "F.O.S."(1), "Physical by Social Definition"(1)

FUNCTIONAL - STRUCTURAL - PHYSICAL

Form of transportation (8 - 1 1/2 - 1 1/2)
Supports things (8 - 1 1/2 - 1 1/2)
Holds people (8 - 2 - 1 1/2)
Connect steel (8 - 2 - 2)
Buttons (5 1/2 - 5 - 2)

FUNCTIONAL - STRUCTURAL - PHYSICAL - LOCATIONAL

Carries one or two people (8 - 2 1/2 - 2 - 1 1/2)
Walk on (8-3-1 1/2 -1 1/2)
It moves on wheels (6-4-3-2)

FUNCTIONAL - STRUCTURAL - LOCATIONAL - OTHER

Driven (6 1/2 -1 1/2 -1 1/2) - "F.O.S."(1), "?"(1)

FUNCTIONAL - PHYSICAL

Cools (9-1)
Cooks food (9-1 1/2)
Drills (9-1 1/2)
Heats (8 1/2-2 1/2)
Man-made to cover from weather (8 1/2 - 2)
Rest body parts (8-2)
It moves (7 1/2-3)
Used to cut (9-1 1/2)
Cuts wood (9-1 1/2)
Melts things into shape (9-1 1/2)
Transports people (8 1/2-1 1/2)
Write on (8-3)
Absorbent (8- 5 1/2)

FUNCTIONAL - PHYSICAL - OTHER

Heats food (9 - 2) - "Context"(1)
Designed to measure objects (9 - 2) - "Context"(1), "Maker-Made Relation"(1)
Man-made for purpose of comfort (8 1/2 - 3) - "F.O.S."(1), "Maker-Made Relation"(1)
Made for body (8 - 1 1/2) - "?"(1)
Personal hygiene (8 - 1 1/2) - "Personal"(1)
Used for one or two people (8 - 2) - "F.O.S."(1)
Keep warm when cold (7 - 2) - "Context"(1)
Would hurt a person (7 - 3) - "Result"(1), "F.O.S"(1)
Handled by humans (6 1/2 - 1 1/2) - "F.O.S."(1), "?"(1)
Driven by trained personnel (6 - 2) - "Context"[1ℓ, "Who"(1), "F.O.S."(1)
Gets worn out (6 - 3) - "Result"(1)
Luxury (5 1/2 - 1 1/2) - "Affective"(1), "Personal"(1), "Social/Evaluative"(1), "F.O.S."(1), "Cultural"(1)
Dangerous (5 1/2 - 3) - "Affective"(2), "Result"(1)
Uncomfortable (4 -2) - "Affective"(2), "Personal"(1), "Result"(1), "F.O.S."(1)
Comfort (4 - 3) - "Affective"(1), "Evaluative"(1), "Personal"(1), "F.O.S."(1)
Lasts longer (4 - 3) - "Affective"(1), "Temporal"(1), "Result"(1)
Self-motivated (4 - 3) - "Personal"(1), "Animacy"(1), "F.O.S."(1)

FUNCTIONAL - PHYSICAL - STRUCTURAL

Have numbers to measure (7 - 3 - 2 1/2)
Mechanical (6 1/2 - 4 1/2 - 3)

FUNCTIONAL - PHYSICAL - STRUCTURAL - OTHER

Roll (8-2-1 1/2)-"Act"(2)
Ride (7-1 1/2-1 1/2)-"Act"(1)

Living (6-4-2) - "Dimension itself"(1), "?"(1)

FUNCTIONAL - PHYSICAL - STRUCTURAL - LOCATIONAL

Tranportable (5 - 4 1/2 - 1 1/2 - 1 1/2)

FUNCTIONAL - PHYSICAL - STRUCTURAL - LOCATIONAL - OTHER

Pour into mold (4 - 2 1/2 - 1 1/2 - 1 1/2) - "Act"(1)
Contains people (5 - 4 - 1 1/2 - 1 1/2) - "F.O.S."(1)

FUNCTIONAL - PHYSICAL - LOCATIONAL

Holds Passengers (9-2-1)
Lie on (7-2-1 1/2)
Flies (7 1/2-3-1)

FUNCTIONAL - PHYSICAL - LOCATIONAL - OTHER

Used by hand (7-2-2) - "F.O.S."(1)

FUNCTIONAL - LOCATIONAL

Moves you (9-1 1/2)
Gets you from one place to another (9-1 1/2)
Protects body (9-1 1/2)
Sleep on (9-2)
Eat on (9-2)
Put on (9-2 1/2)
Transports people from place to place (9-3)
Decorates body (9-3 1/2)
Covers hands (9-4 1/2)
Transports things from place to place (8-2 1/2)
It travels (8-3 1/2)
Used on body (8-4)
Used on wrist (7 1/2-6)
Sit at (7-3 1/2)
Worn to protect (9-1 1/2)
Worn by people (9-2)
Used to cook (9-2)
Covers body (9-2 1/2)
Covers parts of body (9-3 1/2)
Worn on hands (9-4)
Decorates room (9-5)
Worn on body (8-3 1/2)
Sitting (7 1/2- 2)
Put around neck (7 1/2-5 1/2)

FUNCTIONAL - LOCATIONAL - OTHER

Worn for special occasions (9-1 1/2) - "Cultural"(1), "Context"(1)
Play in snow (9-3 1/2) - "Context"(1)
Worn by women (9-3 1/2) - "Cultural"(1), "Context"(1), "Gender Specific"(1)

FUNCTIONAL - LOCATIONAL - STRUCTURAL

Covers from weather (9-1 1/2-1)
Covers floor (8-4-1 1/12)

FUNCTIONAL - LOCATIONAL - STRUCTURAL - PHYSICAL - OTHER

One person sits on (7 - 2 1/2 - 2 - 1 1/2) - "Context"(1)

FUNCTIONAL - LOCATIONAL - PHYSICAL

Can be worn (9-2 1/2-1 1/2) Worn to keep warm (9-3 1/2-2)
Transports people in building (9-4-1 1/2)
Many people sit on (8 1/2-2 1/2-1 1/2)

FUNCTIONAL - LOCATIONAL - PHYSICAL - STRUCTURAL

Put things on (8-4-2-1 1/2)

FUNCTIONAL - LOCATIONAL - PHYSICAL - STRUCTURAL - OTHER

Flies in air (6 1/2-6-3-2) - "Context"(1)

STRUCTURAL

(none)

STRUCTURAL - OTHER

(none)

STRUCTURAL - FUNCTIONAL

Part of outfit (8 1/2-3) Operates on wheels (8 1/2-5 1/2)
Have indicators (7 1/2-3) Accessory (5 1/2-3 1/2)

STRUCTURAL - FUNCTIONAL - PHYSICAL

Doors (7 1/2-1 1/2-1 1/2) Has engine (7 1/2-2-1 1/2)
Has wheels (7 1/2-3 1/2-3) Blade (7-3-3)
Tires (6 1/2-2 1/2-2 1/2) Have knobs to work (6-4-2)
Operated by electricity (4 1/2-4-4)

STRUCTURAL - PHYSICAL

Has two arms (8 1/2-2) Has five fingers (7 1/2-2)
Has walls (7 1/2-3) Motor (7-2 1/2)
Have legs (7-4) Come in pairs (5 1/2-3)
Number of wheels (6-4) Have definite shapes (5-5)

STRUCTURAL - PHYSICAL - FUNCTIONAL

Movable parts (7-2 1/2-2) Have numbers (5-2 1/2-2)
Has a flat surface (5-4 1/2-1 1/2)
One cutting edge (5-4 1/2-2)

STRUCTURAL - PHYSICAL - LOCATIONAL

Top surface (5-3-2 1/2)

STRUCTURAL - LOCATIONAL - FUNCTIONAL

Lapels (8 1/2-2-1 1/2)
Part of ensemble in a room (6 1/2-6 1/2-2)

PHYSICAL

Dense (9)
Rough (9)
Large (8)
Hard (9)
Soft (9)
Small (8)
Made of metal (9)
White (9)
Quiet (7 1/2)

PHYSICAL - OTHER

Hot (9) -"Figurative"(1)
Cold (9) -"Personal"(1)
Darker Color (8 1/2) -"Personal"(1)
Matter (7) -"?"(1)
Pretty (6) - "Affective"(2), "Personal"(1), "Evaluative"(1)
Heavy (9) -"Personal"(1)
Light (8 1/2) -"Personal"(1)

PHYSICAL - FUNCTIONAL

Colorful (8-1 1/2)
Bends (7-4 1/2)
Has to do with metal (8-1 1/2)

PHYSICAL - FUNCTIONAL - OTHER

Inanimate (6-2 1/2) - "?"(2)

PHYSICAL - FUNCTIONAL - STRUCTURAL

Unbreakable (8-3-2)

PHYSICAL - FUNCTIONAL - STRUCTURAL - OTHER

Noisy (6 1/2-1 1/2-1) -"Personal"(1), "Result"(1)
Not living (6 1/2-2 1/2-2 1/2) -"Dimension/Category itself"(1)
Durable (5 1/2-3-1 1/2) -"F.O.S."(1)
Man-made (5-2-1) -"Causal"(1), "?"(1)
Stronger (5-3 1/2-1 1/2) -"Relative State"(1)
Started out as living thing (4 1/2-3-1 1/2) -"Temporal"(1), "Existential"(1)

PHYSICAL - FUNCTIONAL - STRUCTURAL - LOCATIONAL - OTHER

Stays put (4-3-2 1/2-2 1/2) - "?"(1)

PHYSICAL - FUNCTIONAL - LOCATIONAL - STRUCTURAL

Mobile (4-3-2 1/2-2)

PHYSICAL - STRUCTURAL

Made of soft material (9-1 1/2)
Rigid (8 1/2-1 1/2)
Permanent (7 1/2-1 1/2)
Big (7-2 1/2)
Flat (7-2)
Way its made (6-5)
Full of air (9-4)
Made of wood (8-3)
Made of cloth (7 1/2-2 1/2)
Straight (7-2)
Have edges (6-3)
Has a surface (5-4)

PHYSICAL - STRUCTURAL - OTHER

Powered (6-1 1/2)-"Agency"(1)
Longer (6-2) -"Personal"(1), "Temporal"(1)
Handmade (3-2) -"F.O.S."(2), "Causal"(1), "?"(1)
Shorter (6-2)-"Personal"(1)

PHYSICAL - STRUCTURAL - FUNCTIONAL

Concrete (9-2 1/2-2)
Sharp edge (6-4-2)
Sharp (7 1/2-2-2)
Siren (4-3-3)

PHYSICAL - STRUCTURAL - FUNCTIONAL - OTHER

Have designs (4 1/2-4-2) - "?"(2)

PHYSICAL - STRUCTURAL - LOCATIONAL - OTHER

Propelled (3 1/2-1 1/2-1 1/2) - "?"(2), "State"(1)

PHYSICAL - LOCATIONAL

Stationary (5-3)

LOCATIONAL

In living room (9)
In department store (9)
Found in house (9)

LOCATIONAL - OTHER

Contact with body (7) - "?"(1)

LOCATIONAL - FUNCTIONAL

In houses/home (9-1)
Hung on walls (7 1/2- 5)
Used in houses (7-6)
Placed on walls (8-5)
For indoor use (7-5 1/2)

LOCATIONAL - FUNCTIONAL - OTHER

Put away when not being used (6-4) - "Context"(1)

LOCATIONAL - FUNCTIONAL - STRUCTURAL

Held in hand (6-4-1 1/2)

LOCATIONAL - FUNCTIONAL - PHYSICAL

Carried in pocket (8-2-1 1/2)
Tied around waist (6-3 1/2-2 1/2)

LOCATIONAL - STRUCTURAL - PHYSICAL

Are confined spaces (4-3 1/2-3 1/2)

LOCATIONAL - PHYSICAL - OTHER

Viewed from head on (3 1/2-2) - "?"(2), "Perspective"(1)

LOCATIONAL - PHYSICAL - FUNCTIONAL - STRUCTURAL - OTHER

Takes up space in room (5-2 1/2-1 1/2-1 1/2)
-"Antifunctional"(1)

Appendix 4

Same and Different Descriptions Generated for Instance Pairs in Experiment 3

What is the Same and Different about Instances

Note: taxonomic levels of responses are shown as "H" for Higher, "S" for Superordinate, "Su" for Subset, and "BS" for Below Subset. Mismatched levels for difference responses are shown in parentheses (e.g., "Su/BS" = Subset/Below Subset). "Meta" stands for instances' higher-level metaphorical similarities.

SAME	Frequency & response level	DIFFERENT	Frequency & response level
		Subset Pairs	
		Chair/Sofa	
Pieces of Furniture	1 S	Smaller/Bigger, for many people	2 H
Sit on (Used for sitting on, Furniture to sit on)	9 Su	Hard/Soft	1 H
		Seats, Sat on by: 1 person/2 or more people	5 BS
Sit or Recline (Sit & relax on)	2 BS	Sit on &: Uncomfortable, Hard/Comfortable, Soft	2 BS
		Sit on Only/Sit on & Lie on	1 BS
		Sit Upright/ Lie Down on	1 BS (BS/Su)
		Counter/Desk	
Used for Work Purposes	1 S	Not as Aesthetic/ ---	1 Su
Put things on (Have flat surface to put things on)	5 S	Eat on, For Cutting/ For Writing, Write on	2 Su
		Has no Drawers/Implies Work	1 Su (Su/S)
Put things on & Write	1 Su		
Write on (Paper work on)	2 Su	Work with Food on/ Educational Work at	1 BS
Work on	1 Su	Keep toasters, glasses on in Kitchen/Keep books, pencils in & Write on	1 BS
Have Drawers	1 Su		
Can be Written on or used as Worktable	1 BS	Has Legs/Doesn't, Raised	2 BS
		Sit at/Stand at	1 BS
		Non-Responses	3
		Stove/Refrigerator	
Requires Energy to Work (Mechanical objects that function by kinetic energy)	2 S	Hot/Cold	1 H
		Heats, Keeps things Hot/ Cools, Keeps things Cold	3 Su
Kitchen Appliance	4 Su	Cook Food on, Heats Food, Cook or Prepare Food/ Store Food, Put things in it to Keep Cool & Fresh, Keeps Food Cool	6 BS
Belong in Kitchen & Have to do with Food	3 Su		
Used in Preparation of Food	2 Su	Cook on/Take Food	2 BS

Food Passes in & out of	1	Su	out of, Keep Cool		(BS/Su)

Car/Ambulance

Vehicles (Used for transportation, Transports people, Transports people from one place to another)	7	S	For Everyday Reasons/ Emergency Reasons (For business/benefit)	2	H
			Carries Passengers/ Carries Sick People	1	Su
Vehicles you Ride in (You drive them, Automobiles)	3	Su	Carries People/ Carries Injured People	1	Su (S/Su)
			Pleasure Vehicle/Designed to Handle Accidents & Trauma	1	Su
Take you to Hospital	1	Su			
Non-Responses	1		Used for Pleasure, Business, etc. (for Many Purposes)/ Transport People to Hospital	1	Su (H/Su)
			Doesn't/Has a Siren	1	Su
			Driven by: Anyone, Any Individual/Medical Personnel, Specific Person with First Aid Training	2	BS
			Driven: Anywhere/ Primarily Back & Forth to Hospital with Sick People	1	BS
			Carry People To & From Where They're Going/ Carries Ill-Dying People to a Hospital	1	BS (S/BS)
			Non-Responses	1	

Truck/Wheelbarrow

Carry things (Transport things to destination, Hold items for purpose of transportation)	7	S	Vehicle for: People & Objects/Products & Objects	1	S
			Has an Engine/You Supply the Energy (Transport goods: by gas/by pushing)	2	Su
Construction Equipment	1	S			
Have Wheels	1	Su	Driven/Steered	1	Su
Contain (Carry) Cementing Materials	1	Su	Wheels: 8 to 16/ 3, Doesn't have Steering Wheel	2	BS
Non-Responses	2		Transportation to Carry Objects to Far Places/ Manual Force to Carry Objects Places	1	BS
			Is an Automobile & You Drive/You Push	1	BS (BS/Su)
			Non-Responses	4	

			Skates/Sled		
Used in Winter	2	H	Small, Personal/For Many	1	H
Sports Equipment,	3	S	People		
(Hobby Equipment,			Come in Pairs/One Unit	1	H
Recreational			Roll/Slide, Glide	1	Su
Purposes)			Winter Sports Equipment:	1	BS
Winter Sports	1	Su	Skating on Ice/ ---		
Equipment			Mobile Objects in Winter:	1	BS
Recreational	1	Su	on Feet/Carry 1 or more		
Transportation			People & Not Attached to		
Glide on them	1	Su	Person		
Used on Ice	4	Su	Worn in Skating Rink/	1	BS
(Used on water in			Ridden on in the Snow		
altered state, Used			Worn on Feet, Stand on,	5	BS
in wintertime on			Ride Upright/Sit on,		
the ground			Lay on		
			Wear on Feet/Ride on	1	BS
				(BS/Su)	
			Dress/Skirt		
Clothing	8	S	Whole Piece/The Bottom	3	H
(Article of clothing,			Piece of 2 (Has a top		
Worn, People wear)			part/doesn't)		
Worn by Women	2	Su	Whole, Full Outfit/	2	Su
(Worn by Females)			Part of Outfit, Bottom		
Show Off Legs	1	Su	Part of Dress		
Not Sewn Down the	1	BS	Whole (one) Piece/	1	Su
Middle to Distinguish			Worn with something	(H/Su)	
from Pants			Else: Second Piece		
			Worn: on Entire Body/	4	Su
			Halfway, With Tops		
			(Cover: upper body &		
			midsection, top & bottom		
			part of body/only		
			midsection, only bottom)		
			More Material to Cover	1	BS
			Torso & Lower Body/	(BS/Su)	
			Coverage for Lower		
			Part of Body		
			Has Sleeves & Collars/	1	BS
			Doesn't		
			Gloves/Coat		
Clothing	2	S	Come in Pairs/Singular	1	H
(Articles of			Made for, For: Hands/	2	H
Clothing)			Body, Upper Body		
Clothing, Worn, Used:	8	Su	Worn on, Cover: Hands/	4	Su
To Keep Warm, When			Body (Worn on, Protects:		
Cold, In Cold Weather,			hands/ body & arms)		
In Winter, For			Have: 5 Fingers/2 Arms	1	Su
Protection from Cold,			Small Enough to Fit in	1	Su
To Keep Part of Body			Pocket/ Too Big	(Su/H)	
Warm)			Worn on: Hands/ Body &	1	BS

Worn 1ogether	1 Su	Coat is Heavier	(Su/BS)
Worn by Both Sexes	1 Su	Non-Responses	1

Necklace/Bracelet

Worn (Something to wear)	2 S	For, Use Around: Neck/ Wrist	2 H
Jewelry (Pieces of Jewelry)	8 Su	Worn on, Worn around, Goes Around, Placed	8 Su
Adornment	1 Su	Around: Neck/Wrist,	
Non-Responses	1	Neck, Arm	
		Jewelry Worn on: Neck/ Wrist & Longer/Shorter	1 BS
		Worn Around: Neck & Longer/Wrist	1 BS

Ruler/Tape Measure

Used to Measure (Used to measure things, Used to measure with, Used to take measurements)	8 Su	Hard, Rigid, Straight, Inflexible, Small & Straight, Rigid & Made of Wood, Metal etc./ Soft, Malleable, Bends, Flexible,	6 H
Have Inches & Foot to to Measure Something (Means of measurement in inches)	2 Su	Long & Rolled up, Flexible & Made of Fabric	
		Measure: Wood/Cloth	1 Su
		Measures: 12 Inches/	2 BS
Have Numbers to Measure Things (Have Numbers)	2 Su	72 Inches (Foot long, 3 Feet)	
		Measures How Long Something: Is/Goes	1 BS
		Non-Responses	2

Saw/Scissors

Used to Cut (Used for cutting, You cut with, Used for cutting materials, Used to cut objects)	11 Su	Bigger/ ---	1 H
		Hardware Tool/ Sewing Tool (Used by: carpenter/seamstress)	2 Su
		Cuts: Wood/Paper	1 Su
Non-Responses	1	Has 1 Cutting Edge/2	1 BS
		Bigger & Stronger & Cuts Things Like Wood/ Cuts Things Like Paper	1 BS (BS/Su)
		Used to Cut: Objects/ More Fragile Materials (Thinness)	1 BS (Su/BS)
		Cuts: Big Thick Things/ Small Thin Things	1 BS
		Used to Cut: Wood or Metal, Wood or Trees/ Paper or Material, Paper or Cloth	3 BS
		Requires use of: Entire Arm & Shoulder/Mainly Fingers & Wrist	1 BS

Cement/Plaster

Harden (Get hard, Solidifying ability)	3 H	Harder & Last Longer, More Permanent/ ---	2 H
Same Results When Dry	1 H	Darker Color/ White	1 H
Made From Soft Material	1 H	Material Used for: Floors & Sidewalks, Floors & Pavement, To Hold Bricks in Place/ Walls, Walls & Ceilings, Smooth Walls	4 BS
Used in Construction	1 S		
Building Materials (Securing Materials)	2 Su		
Used in Masonry	1 Su		
Used in Fixing Walls	1 Su	Used Before Plaster/ After Cement	1 BS
Stick to Floors & Walls	1 Su	Non-Responses	4
Non-Responses	1		

Superordinate Pairs

Bed/Table

Used by 2 or More People	1 H	Soft/Hard	1 H
Cover Them (Bed spread & Table cloth)	1 H	Used to Sleep in/Eat on, You Eat off of (For sleeping/eating)	7 Su
Furniture (Pieces of Furniture	2 S	Made for: Sitting or Lying, Reclining/ Eating, for Settings	2 Su
Used in Home (Furniture most houses, apartments have)	2 S	People Rest or Sleep on/ Dishes & Silverware Placed on	1 Su
Surfaces Objects Placed on Top of (Furniture that supports something)	2 S	Rest Body on/ Used to Put Things on	1 Su (Su/S)
Made of Wood	1 Su		
Eat on	1 Su		
Places Where People Eat Dinner	1 BS		
Non-Responses	1		

Dresser/Clock

Used to Store Things (Clothing, Time)	2 H (Meta)	Bottom/Top	1 H
Used	1 S	Holds Clothes, Keep Clothing in, Where Keep Hairbrush-Makeup, Drawers, Used for Clothing/Tells Time, Used for Telling Time	6 Su
Used, Kept, Found in: Bedroom	3 Su		
Part of Dressing Room	1 Su		
Made of Wood	1 Su		
Clock Sits on Top of Dresser (Clock placed on dresser)	2 Su	Get into for Clothing/ Only Looked at	1 Su
Non-Responses	2	Furniture/Appliance (Furniture/Sits on Furniture)	2 Su (S/Su)
		Non-Responses	2

Rug/Picture					
Purchase Them	1	H	Viewed From: Above/ Head on (Walk on/Look at)	2	H
Can be Very Colorful	1	H			
Flat Things on Flat Surfaces	1	H	Covering for, Put on, Placed on: Floor/Wall	6	Su
Objects in Homes	1	S	Placed on Floor/Hung on Wall	1	Su
Kept Within Walls (Houses, Galleries)	1	S	Soft/Hung on Wall	1	Su
Decorate (Part of decoration, Decorate house (apt., office))	5	S			(H/Su)
			Walk on/Look at & Admire	1	Su
					(H/Su)
Livingroom Objects	1	Su	Non-Responses	1	
Found in Livingroom & Hung on Wall	1	BS			

Streetcar/Motorcycle					
Used for Transportation (Modes of Transportation, Used to Transport people, Vehicles of Transportation)	7	S	For Many People/1 Person or 2 at Most	1	H
			Vehicle which Carries, Transports: More than 2 People, Many People/ 1 or 2 People, 2 at Most	3	Su
Have Wheels (& used as transportation, & can be ridden)	3	Su	Ride in/Ride on	1	Su
			More than 2 Wheels, Has 4 Wheels/Has 2 Wheels	4	BS
Vehicles Mobilized by Energy & Wheels	1	Su	Similar to Tramway/ 2 Wheeled Form of Transportation	1	BS
					(Su/BS)
You Drive Them	1	Su	Many Passengers/2	1	BS
			Sit Inside & Keep Warm/ Feel the Breeze	1	BS
					(BS/H)

Elevator/Bus					
Used to Make Life Easier	1	H	Means of Transportation: Within Building/Outside, Operates on Ground Level	2	Su
Consist of 4 Planes	1	H			
Vehicles of Transport (Transport, Carry: people, people or things, from one place to another, Take you to destination)	8	S	Transports, Carries, Takes People: In Up & Down Fashion, To Different Floors in a Building/ From One Place to Another, From Place to Place (e.g., City to City)	3	Su
					(Su/S)
Have Motors	1	Su			
Carry Limited Amount of People	1	Su	Goes, Go: Up, Up & Down, Up & Down in/Forward & Back, In Any Direction, Travels Across, Ride Across Town, Stay on the Road in	6	Su
			Operates by: Electricity/ Fuel & Has Many Wheels	1	BS

Horse/Blimp

Large, Heavy, Big	5	H	Living, Alive/ Not Living, Isn't	2	H
Fly in the Air	1	H (Meta)	Animal/Thing, Man-made	2	H
Used for Transportation (Form of Transport, Travels)	4	S	Graceful/No Shape	1	H
			Shapes are Different	1	H
			Mammal/Inanimate Object	1	S (S/H)
Non-Responses	2				
			Animal/Full of Air	1	S (H/S)
			Large Animal with 4 Legs/ Large Object that Flies	1	Su
			Animal/Mechanical Machine	1	Su (H/Su)
			Non-Responses	2	

Jacket/Pants

Clothing (Articles of clothing, Worn, You wear, Worn by people, Clothing people wear)	9	S	Covers, Wear, Worn on: Torso, Upper Half of Body, Top Part of Body/ Lower Half of Body, Lower Part of Body, & Legs, From Waist Down, Legs	8	Su
Worn by Both Sexes	1	Su			
You Zipper Them	1	BS	Top Part of Outfit/Part Worn From Waist Down	1	Su
Non-Responses	1		Used for Warmth/Worn at All Times	1	Su
			Can be Taken off in Public/Can't	1	Su
			Has Lapels/Doesn't	1	BS

Shirt/Watch

Worn (You wear them, Worn on the body, Worn externally, Exterior apparel, Put on)	7	S	Worn on, over: Back, Chest, Upper Part of Body/Wrist, Not	3	Su
			Made of, Is: Cloth, Fabric, Cotton/Metal, Mechanism Comprised of Wire, Metal, Glass & Crystals	3	Su
Worn on the Body by Both Sexes	1	Su			
Worn on the Upper Body	1	Su	Made of: Cloth/ Mechanical Material	1	Su (Su/S)
Worn Together	1	Su	Clothing/Jewelry, Piece of Jewelry	2	Su (S/Su)
Cover Portion of Arm	1	Su			
Non-Responses	1		Worn on: Upper Body from Neck to Waist/Wrist & Tells Time	1	BS (Su/BS)
			Pinstriped/Isn't	1	BS
			Non-Responses	1	

Apron/Handkerchief

Garments to Wear (Worn as part of clothing)	2	S	For Females/Males	1	H
			Wear/Don't	1	S
			Wear/Used at Random	1	S

Made of Cloth (Made of: material, cotton, soft flexible cloth, & are used)	7 Su			(S/H)
		Is Worn/Fits in Pocket	1 Su	(S/Su)
		Tied Around Waist/ Put in Pocket	1 Su	
Use to Keep Clean (from cooking & nose)	1 Su	Worn when Cooking/Use for Nose Secretions	1 Su	
Made of Cotton & Checkered	1 BS	Use to Cook/Blow Your Nose	1 Su	(S/Su)
Non-Responses	1	Protect from Dirt/ Blow Your Nose	1 Su	
		Used for Getting Dirty/ Used for Keeping Clean	1 Su	
		Cover Clothing When Working/Ornament with Clothing	1 BS	(BS/Su)
		Worn Aroung Waist/ Carried in Pocket & Used to Blow Nose	1 BS	(Su/BS)
		Non-Responses	1	

Hammer/Drill

Tools (Tools used to construct something)	6 S	Quiet/Noisy	1 H	
		Hit Nail in, Hammer with Hit Down on/Drill Holes, Make Holes	3 Su	
Use in Fixing Things & Can Use to Make Holes	1 Su	Put Things (like Nails) Inside Holes/Makes Holes	1 Su	
Help Dig	1 Su	Used for Banging/Grinding	1 Su	
Carpenter's Tool	1 Su	Use: Manually/with Electricity, Electrical Power	2 Su	
Used in Workshop	1 Su			
Non-Responses	2	Push Nails in Manually/ Make a Hole (or Push Nails) Electronically	1 BS	
		Manual Force Applied to Nails/Electric Force	1 BS	(BS/Su)
		Drive Nails/Drill Holes in Preparation for a Screw	1 BS	(Su/BS)
		Non-Responses	1	

Soldering Iron/Nails

Made of Metal	4 H	Stronger/ ---	1 H	
Hard & Straight	1 H	Doesn't/Goes into Objects	1 H	
Have to do with Metal	1 H	Is Acting Upon a Metal, Creates a Reaction (Fuzing Metal), Powered by Energy/Acted Upon by a Hammer, Requires Something Done to it (Hammering)	3 Su	
Tools (Used to make things, Hardware instrument used for construction purposes)	3 S			
Hold Items Together	1 Su	Fuze Metal Together/ Hold Objects Together	1 Su	
Non-Responses	2			

		Hold Together: Metal/Wood	1 Su
		Melts Things into Shape/ Holds Things into Shape	1 BS
		Join Things with: Heat/ Force	1 BS
		Non-Responses	3

Hatchet/Stapler

Have Metal	1 H	Doesn't/Have Movable Parts	1 H
Have Sharp Ends	1 H	Takes, Slices, Splits, Breaks: Objects Apart, Things in Half/Puts, Holds, Connects: Things Together	6 Su
Tools (Tools needed to complete action, Manipulating or creating something)	5 S		
Connecting or Disconnecting: 2 Other Things (Pieces) are Involved	1 Su	Chop Things/ Staple Things	1 Su
		Kill Someone/ Inflict Torture	1 Su
Make Holes	1 Su	Non-Responses	3
Cut into (wood, paper)	1 Su		
Non-Responses	2		

Higher Pairs

Bed/Truck

Flat & Close to the Ground	1 H	Sleep in, on/ Ride Around in, Ride in	2 Su
"Bed" (Flat Bed Truck, Bed of Pickup Truck)	2 H (Meta)	Sleeping, Resting, Lie: on/You Drive, Used for Driving	3 Su
Used by People	1 H	Sleep on/Transportation of Products	1 Su (Su/S)
Help Do Something (Sleep, Get You to Destination)	1 H	Stays Where it is/Driven All Over	1 Su
Hold People	1 Su	Stationary/Transportable	1 Su (Su/H)
Supply Sleeping Area, Lie Down on, Sit on	3 Su	Designed for Comfort & Rest/Machine	1 BS (BS/Su)
Hold 1 or 2 People	1 BS	Comfortable & Warm/Cold & Uncomfortable	1 BS (BS/H)
Non-Responses	2	Has Pillow/Doesn't	1 BS
		Non-Responses	1

Handkerchief/Table

Started Out as Living Thing	1 H	Soft, Light/Hard, Dense	3 H
		Clothing/Furniture	1 S
Can be White	1 H	Uses Different	1 S (H/S)
Can Get Food on Them	1 H		
Serve Person	1 H	Used on, Wipe, Blow Your: Nose/For Eating, Eat off of, Where Put Setting to Eat	3 Su
Non-Responses	8		

		Cloth/Written on	1 Su
		Fits in Your Pocket/ Doesn't	1 Su
		Soft & Fluffy/Hard Decor	1 Su (H/Su)
		Non-Responses	1
	Stove/Elevator		
Dangerous to Play with or on	1 H	Doors Open: Horizontally/ Vertically	1 H
Are Confined Spaces	1 H	Appliance/Vehicle	1 S
Doors Open	1 H	Used for Cooking, Used for Cooking in House/ Get From Floor to Floor in Building, Get People Up & Down in Building	2 Su
Make Life Easier (Convenience)	2 H		
Made of Metal	3 Su		
Use Buttons or Knobs for Them to Work, Have Indicators to Go to Higher Levels	2 BS		
		Used for Heat & Making Things Hot/Getting from Place to Place	1 Su (Su/S)
Non-Responses	2	Stationary/Moves	1 Su (Su/S)
		Prepare Food (in or on)/ Can't	1 Su
		Gets Hot & Cooks Food/ Doesn't	1 BS
		Cooks Things, Cook Food in, Cook on/Get from One Floor to Another, Carry Things Up & Down, Ride in	4 BS (BS/Su)
	Bus/Shirt		
Used by People (People Ride, Wear)	2 H	Rough & Rigid/Soft & Flexible	1 H
Contain People (You get into, Have people in them, Able to encompass bodies-human form)	5 H (Meta)	Vehicle, Mode of Transportation, People Ride/Clothing, You Wear	4 S
		You Travel on/ Travels on You	1 S (S/H)
Have Sayings on Them	1 H	Hold People: Many/One	1 Su (Su/H-Meta)
Non-Responses	4		
		You Take to Work/ Worn to Work	1 Su
		Ride in as Passengers/ Worn by Men	1 Su
		Transport People in/ Wear	1 Su (Su/S)
		Made of: Metal/Material	1 Su
		Non-Responses	1
	Car/Scissors		
Skill to Use so as Not to Risk Injury	2 H	Big/Small	1 H
		Used for Driving, You	4 Su

(Dangerous if not handled properly)		Drive in/You Use to Cut things, Used for Cutting	
Move in Same Direction	1 H	Ride in/Cut with	1 Su
Cut things off	1 H (Meta)	Means of Transportation, Used to Travel, Takes People Places/Used to Cut, Used for Cutting	5 Su (S/Su)
Can be used as Weapons	1 S		
Made of Metal (Primarily)	5 Su	Objects, Made to Cut Places	
Non-Responses	2	Operates on Wheels/ Operated by Hand & Use for Cutting	1 BS (Su/BS)

Blimp/Apron

Man-made	1 H	Big/Small	1 H
Have Designs	1 H	Large/Cover	1 S (H/S)
Put Away When Not Working With & Work Above Ground	1 H	Holds People/Holds Kitchen Utensils	1 Su (S/Su)
Float in Air	1 H	Holds People: Many/ Only One	1 Su (Su/H-Meta)
Non-Responses	8	Flies in the Sky/ Cloth Worn	1 Su
		Propelled, Flies in the Sky/ Worn	2 Su (Su/S)
		Made of: Metal/Fabric	1 Su
		Large Object that can Fly/Women Wear to Cook	1 BS
		Non-Responses	3

Dress/Saw

Inanimate Objects	1 H	Clothing, You Wear/Tool	2 S
Concrete	1 H	Worn, To be Worn/	2 S
Have an Edge	1 H	Handled, Sharp Object	(S/H)
Handled by Humans	1 H	Something to Wear, Used	5 Su
Handmade	1 H	for Wearing, You Wear	(S/Su)
Can be Sharp	1 H (Meta)	it/Used for Cutting, Used to Cut Wood, or Metal	
Can Cut (Dress by its "Cut", Saw by its Cutting)	1 H (Meta)	Material to be Worn/ Machine to Cut Wood	1 BS (Su/BS)
Non-Responses	5	Non-Responses	2

Counter/Pants

Matter	1 H	Hard, Hard Surface/More	2 H
Can Get Worn Out	1 H	Elastic Surface, Can	
Useful Everyday Objects	1 H	Form to Body	
		Use to Put, Place,	4 S
Can be Seen in a Department Store	1 H	Placement of Things, Objects on/Clothing,	
Goes on Top of Something (Floors, Legs)	1 H	Clothing Person Wears, You Wear	
		Holds Goods/Holds People	1 Su

Put Something On or In (Legs)	1 H		(Su/H-Meta)
Hold Items (Put Something on, in Pockets)	1 Su	Eat on/Clothing, People Wear	2 Su (Su/S)
Non-Responses	5	Hard & Used to Chop things/Soft & You Wear them	1 Su (Su/S)
		To Keep Toasters, etc./ Clothes Men & Women Wear	1 BS (BS/Su)
		Non-Responses	1

Gloves/Hatchet

Contact with Hands (Hands necessary, Hands usually involved)	3 H	Soft/Hard	1 H
		Worn/Held	1 S (S/H)
		Article of Clothing	1 Su
Used by Hands (Need hands to use, Require use of hands, Implements designed to be used by hands)	4 H	Worn on Hands/Tool Held in Hand	
		Cover Hands/ Used by Hands	1 Su (Su/H)
		For Keeping Warm/ For Axing Things	1 Su
Can be used During Work	1 H	Worn on Hands, People	2 Su
Non-Responses	4	Wear on Hands/ Used for Chopping, To Open Things	
		Wear as Clothing, You Wear/Use to Chop, Chop Things up	2 Su (S/Su)
		Protect Hands from Cold, Worn to Keep Hands Warm/Chopping Wood, To Destroy Things	2 BS (BS/Su)
		Worn on Hands by Both Sexes/Tool	1 BS (BS/S)

Ruler/Chair

Are Hard & Have Definite Shapes	1 H	Small/Large	1 H
		Used to Measure,	10 Su
Can be Made of Same Materials (such as Wood, Metal, Plastic, etc.)	1 H	Measure Things, Measure with, Measurement, Means of Measurement/Used for Sitting, You Sit on, in,	
Made of Wood, Wood (Usually)	6 Su	& Doesn't Measure Things, Area to be Seated	
Measure for Purpose	1 Su	Non-Responses	1
Measure a Room with Either	1 BS		
Non-Responses	2		

Hammer/Sled

Lead Them to a Place or in a Direction for Action to be a	1 H	Made of: Metal/Wood	1 H
		Tool, Tool for Working, Used for Fixing things/	3 S

Success	
People Use for Purposes	1 H
Used for Driving	1 H (Meta)
Made of Wood	1 H
Made of, Consist of, Have Metal & Wood	3 H
Tools	1 S
Made of Metal	1 Su
Non-Responses	3

Toy, Toy for Playing, For Recreational Purposes	
Used to Put things into Perspective/ Used for Enjoyment	1 S (H/S)
Placing, Push, Drive Nails, into an Object/ Recreational Transportation, Used to Play in Snow, Travel Across Frozen Wastelands	3 Su
Strike/Glide	1 Su
Used for Working as a Tool/Used to Get Around in the Snow & for Playing	1 BS (S/BS)
Non-Responses	2

Soldering Iron/Closet	
Essential & Can be Used for Purpose	1 H
Can get Hot, Hot (Especially in Summer)	2 H
Pertain to Metal	1 H
Kept in Same Place	1 H
Put things Together (in Order)	1 H
Non-Responses	6

Tool/Not	1 S
Fuzes Metal/ Stores Clothes	1 Su
Used for Fixing things/ Store things	1 Su (S/Su)
Object to be Stored/ Place of Storage	1 Su (H/Su)
Metal/Has Clothes, Shoes, Dresses in it	1 Su (H/Su)
Held in Hand/ Holds Everything	1 BS (H/BS)
Doesn't/Holds Objects & Has Walls	1 BS
Used to Combine Metal Together/ Where Clothes Hang	1 BS (Su/BS)
Non-Responses	4

Appendix 5

A Computer Implementation of the "Same" and "Different" Responses Received in Experiment 3

Computer Implementation

A computer implementation was undertaken to further examine the type of taxonomic organization found in the experiments reported here. The goal of this implelentation was to generate responses to requests based on such an organization and the particular contexts of the requests. The responses received in Experiment 3 were used as the basis for this implementation. In that experiment, subjects were asked what is the same and different about instances and it was found that instances were compared in terms of their least-upper-bound shared memberships. The responses were related to four distinct taxonomic levels, the superordinate level, a subset level under the superordinates, a level below the subsets, and levels higher than the superordinates. It was also found that instances were included in or excluded from the description of certain features, based on whether a same or different comparison was being made. As such, the processes of extending and delimiting the sets of instances which features are applied to had to be accounted for, in line with the use of features as "norms".

For the implementation, instances of the superordinate "tools" were used. The instance pair comparisons that were implemented were for the subset level pairs "ruler - tape measure" and "saw - scissors", the superordinate level pairs "hammer - drill" and "nails - soldering irons" which were not found to share membership in a subset, and the higher level pairs "ruler - chair" and "saw - dress" which do not

share membership in a superordinate. Appendix 4 shows the responses that were generated for what is the same and different about these instance pairs.

For generating the responses to these pairs, a knowledge base was constructed in LISP using frames, and sets of retrieval functions were constructed which compared the instances. Examples of the knowledge-base frames are shown in Table 19. As in Experiment 3, the retrieval functions compared the instances in terms of their least-upper-bound shared memberships and the type of comparison being made (i.e., what is the same or different about the instances).

The highest level of retrieval functions initiated a same or different comparison. For example, the requests for what is the same or different about saws and scissors were made by calling the functions "WhatSame" or "WhatDif" for these instances (i.e., "WhatSame saw scissors" or "WhatDif saw scissors"). These functions identified the least-upper-bound shared membership of the instances. For example, saws and scissors were identified as sharing a subset membership by noting that they share a Permissible feature/subset distinction for "tools" (i.e., they both "cut"). The instance pairs were then passed on to one of the next set of retrieval functions, which made the same or different comparison in terms of the instances' shared membership. For example, the same and different comparisons for saw and scissors were made by the functions "Subsame" and "Subdif". In contrast, "hammer" and "drill" were identified as sharing

Table 19

Computer Implementation Frames
for Instances, Features and the Superordinate "Tools"

Superordinate

```
(Tools (Oblig ($Value (DoSomethingwith) (ActsUpon)
                      (HelpDoWork) (Build) (Fix) ))
       (Perm ($Value (UsedinWorkshops)
                     (PutThingsTogether) (HoldThingsTogether)
                     (Measure) (Hammering) (Nailing) (Cut)
                     (MakeHoles) (DrillHoles)
                     (Melts) (Fuses) ))
       (Sibs ($Value (BuildingMaterials) (Furniture)
                     (Clothing) ))
       (AKO ($Value (FunctionalArtifacts) )) )
```

Feature Frames

```
(Build (Oblig ($Value (PutThingsTogether) ))
       (Perm ($Value (TakeThingsApart) ))
       (Sibs ($Value (Fix) (Destroy) )) )

(PutThingsTogether (Sibs ($Value (TakeThingsApart) )) )

(Nailing (Perm ($Value (MakeHoles) )) )

(MakeHoles (Perm ($Value (DrillHoles) (Nailing) )) )

(DrillHoles (Oblig ($Value (MakeHoles) )) )

(Numbers (Perm ($Value (Measure) )) )

(Inches (Oblig ($Value (Measure) )) )

(Blade (Oblig ($Value (Cut) )) )

(Cut (Oblig ($Value (Sharp) )) )

(Worn (Sibs ($Value (Cut) )) )
```

Table 19 (continued)

Subset Instance Pairs

Ruler/Tape Measure

```
(Ruler (Oblig ($Value (Measure) (Build) ))
       (Perm ($Value (MadeofWood) (MadeofMetal) ))
       (AKO ($Value (Tools) ))
       (Part ($Value (Inches (num: 12)) (Foot (num: 1))
                     (Numbers) (StraightEdge) ))
       (Applied-to ($Value (Things) (Wood)
                           (Length) (HowBig) )) )

(TapeMeasure (Oblig ($Value (Measure) (Build) (Fix)
                            (MadeofCloth (ie: Bends)) ))
             (AKO ($Value (Tools) (SewingTools) ))
             (Part ($Value (Inches (num: 36))
                           (Foot (num: 3))
                           (Numbers) ))
             (Applied-to ($Value (Things) (Cloth)
                                 (Length) (HowBig) )) )
```

Saw/Scissors

```
(Saw (Oblig ($Value (Cut) (Build) ))
     (Perm ($Value (UsedbyCarpenter) ))
     (AKO ($Value (Tools) (HardwareTools) ))
     (Part ($Value (Blade (num: 1)) (Handle) ))
     (Applied-to ($Value (Things) (Wood) (Metal) (Trees)
                         (ThickThings) (Objects) )) )

(Scissors (Oblig ($Value (Cut) (Build) ))
          (Perm ($Value (UsedbySeamstress) ))
          (AKO ($Value (Tools) (SewingTools) ))
          (Part ($Value (Blade (num: 2)) ))
          (Applied-to ($Value (Things) (Cloth) (Paper)
                              (ThinThings)
                              (FragileMaterials) )) )
```

Table 19 (continued)

Superordinate Instance Pairs

Hammer/Drill

```
(Hammer (Oblig ($Value (Hammering) (Nailing)
                       (Build) (Fix) (UsedinWorkshops) ))
        (AKO ($Value (Tools) (CarpentryTools) ))
        (Part ($Value (HammerHead) (Handle (ie: Manually))))
        (Applied-to ($Value (Things) (Nails) (Wood) )) )

(Drill (Oblig ($Value (MakeHoles) (DrillHoles)
                      (Build) (Fix) (UsedinWorkshops) ))
       (AKO ($Value (Tools) (CarpentryTools) ))
       (Part ($Value (DrillBit) (Handle)
                     (MechanicalParts (ie: Electrically)) ))
       (Applied-to ($Value (Things) (Wood) )) )
```

Soldering Iron/Nails

```
(SolderingIron (Oblig ($Value (PutThingsTogether)
                              (Melts) (Fuses) (Build)
                              (MadeofMetal) ))
               (AKO ($Value (Tools) (Hardware
                                    (ie: Tools Instrument))))
               (Applied-to ($Value (Things) (Metal) )) )

(Nails (Oblig ($Value (HoldThingsTogether) (GointoObjects)
                      (Hammered) (Build) (MadeofMetal) ))
       (Perm ($Value (MakeHoles) ))
       (AKO ($Value (Tools) (BuildingMaterials) (Hardware)))
       (Part ($Value (NailHead) (Point) ))
       (Applied-to ($Value (Things) (Wood) )) )
```

Instances for Higher Pairs

Ruler/Chair

```
(Chair (Oblig ($Value (Sit) (MadeofWood) ))
       (Perm ($Value (MadeofMetal) ))
       (AKO ($Value (Furniture) ))
```

Table 19 (continued)

Dress/Saw

```
(Dress  (Oblig ($Value (Worn) (MadeofCloth) ))
        (AKO ($Value (Clothing) ))
        (Part ($Value (itsCut) ))
        (Applied-to ($Value (Body) (Skin) )) )
```

a least-upper-bound membership in the superordinate "tools", and not in a subset of "tools", so were passed on to the functions "Supersame" or "Superdif" for their same or different comparisons.

Each of the retrieval functions in this next set (e.g., "Subsame" or "Supersame") in turn called sets of more particular functions to make the specific comparisons related to the instances' least-upper-bound shared memberships. For example, for the difference comparisons of subset pairs, "Subdif" called functions that compared the instances in terms of differences in their parts, the different things they are applied to, differences in the physical qualities of the instances, and the instances belonging to different subsets other than the subset they share membership in. In contrast, "Superdif" called functions that compared superordinate pairs in terms of their different Permissible feature/subset distinctions (e.g. "nailing" for hammers and "make holes" for drills) and the different manners in which these Permissible features may be fulfilled (e.g. "nailing manually" versus "make holes electrically"). The functions that made these specific comparisons will be referred to here as the "strategies" used for comparing the instances. For example, comparing subset pairs in terms of their different parts or in terms of their different physical qualities are two different strategies for comparing subset pairs. The specific ways in which the strategies made the comparisons will be described below.

Descriptions derived from the specific comparisons of an instance pair were then returned. In this way, a list of descriptions was produced for each instance pair that corresponded to the responses received for these instances in Experiment 3. For example, for "WhatDif saw scissors", "(cut wood) (cut cloth)" and "HardwareTool SewingTool" were two of the descriptions generated by the retrieval strategies. These descriptions correspond to the Experiment 3 responses "one cuts wood and the other cuts cloth" and "one is a hardware tool and the other is a sewing tool". Each description corresponded to a response given by a single subject for an instance pair in Experiment 3, and the list of descriptions for an instance pair corresponded to the set of descriptions given by the different subjects that responded to that pair. The lists of descriptions generated for the instance pairs accounted for approximately 45% of the responses received for these pairs in Experiment 3.

The frames in the knowledge base had standard frame structures, each frame having a name and a substructure of slots, facets, and data (or values). Table 19 shows the frames for the superordinate "tool", the instances that were compared, and a few examples of feature frames. The frame substructures also included comments with the data, similar to those found in FRL (Roberts and Goldstein, 1977). Comments were only used when that information was related to a datum of a particular instance, and not to other instances that the datum was applicable to. For example, "blade" was a

datum for "saw" and "scissors", and "num: 1" and "num: 2" were comments used with these data to designate the number of "blades" that "saws" and "scissors" are expected to have. It should also be noted that the only kinds of facets used were Value facets. Default facets were not necessary as the knowledge base was used as a deontic system of representation. That is, whether an instance was taken as being described by a datum or not depended upon the context of the comparison being made. For example, a "saw" may or may not be said to be used to "build", depending upon the context. How such deontic uses of the knowledge base were accomplished will be described below.

The different types of slots were AKO slots, Obligatory and Permissible feature slots, Sibling slots, Part slots and Applied-to slots. The AKO slots indicated subsumption relations between the frames (e.g., a "hammer" is A-Kind-Of "tool"). The Sibling slots indicated sibling relations between category frames or between feature frames. For example, siblings of "tools" were "building materials" and "furniture", etc., and siblings of "build" were "fix" and "destroy". As can be seen in these examples, different types of siblings were used in the sibling slots. For example, while "destroy" is an opposite of "build", "fix" is a similar but alternative process to "building". The retrieval strategies distinguished between these different types of siblings within contexts, by accessing other relevant information in the features' and categories' frames (these strat-

egies will be described below). The Part slots indicated the parts of objects in the instance frames (e.g., a "blade" and a "handle" are parts of a "saw"). The Applied-to slots indicated the things that the instances are applied to when they are fulfilling their functions. For example, a "saw" is applied to "wood" or "metal" when it is being used to "cut", and a "dress" is applied to the "body" when it is "worn".

The Obligatory and Permissible slots indicated the relations of features to categories, instances and other features. These Obligatory and Permissible features were used by the retrieval strategies as the core information for describing instances and for deriving descriptions of the instances. For example, "cut" was an Obligatory feature for "saw" and "scissors" and was used to describe what is the same about them. In turn, "saw" and "scissors" were described as having "1 blade for cutting" and "2 blades for cutting" for what is different about them. This description was derived by noting that "cut" is also an Obligatory feature for "blade", and that "saws" and "scissors" have a different number of "blades". All of the Obligatory and Permissible features of the categories and instances were "functional" features (e.g., "used to build", "cut", etc.), with the exception of some material features (e.g., a "ruler" being "made of wood"). However, the retrieval strategies distinguished between the material and functional features and used them in different ways.

Two particular uses of the Obligatory and Permissible

features were important for the present implementation. One was the determination of the instances' most representative functions (e.g., a "saw" being used to "cut"). This was done by finding the features which are Obligatory for an instance but Permissible for the categories they belong to (e.g., "cut" being Permissible but not Obligatory for "tools"). As will be seen below, these features played a pivotal role in arriving at descriptions for instances and will be referred to here as the instances' "defining" features. Secondly, the features that had been identified in the experiments as "High Permissible" features for the categories were designated as Obligatory for the categories, in line with their potential to be taken as common to all members of these categories. For example, "used to build" can describe all "tools", though in certain contexts, some tools (e.g., a "saw" or an "ax") may be said not to be used to build because they are used to "take things apart" or "destroy" things. The "High Permissible" characteristic of not being applied to members of the categories in certain contexts can be identified in these contexts by noting the features' relations to other features (see the frame for "build" in Table 19). How these relations are used in these contexts will be described later on.

The initial retrieval functions, "WhatSame" and "WhatDif", used the same criteria for determining the least-upper-bound shared memberships of the instances being compared. If the instances shared a "defining" feature (e.g.,

"saws" and "scissors" being used to "cut") they were designated as sharing membership at the subset level, as the instances' defining features are Permissible features for their superordinate categories (e.g., "cut" in "tools") that are shared by some but not all members of these categories. If the instances did not share membership at the subset level but shared membership in a superordinate (e.g., "hammer" and "drill" in "tools") they were designated as sharing membership at the superordinate level. If the instances did not share membership in a superordinate (e.g., "dress" and "saw") they were designated as sharing membership at a higher taxonomic level.

As described earlier, the instances were then passed on to one of the next set of functions (e.g., "Subsame", "Supersame", or "DifSupersame" for what is the same about the instances) and the specific retrieval strategies were called for comparing the instances. The specific strategies fulfilled two functions, 1) determining which information should be reported in that context, and 2) determining which pieces of information should be combined when describing the instances. For example, for what is the same about instances that share membership at the subset level, their shared defining feature was reported alone and was also combined with the things that both of the instances are "applied to". As such, "measure" and "measure length" were reported for "ruler" and "tape measure", the "length" of objects being something that both of these instances are applied to when

measuring.

Similarly, for what is the same about instances that share a least-upper-bound membership at the superordinate level, the superordinates were reported, features that are Obligatory for the instances and the superordinates were reported (see Table 19), and the superordinates and these Obligatory features were combined. For example, "hammer" and "drill" were described as being "tools", as being used to "build", and as being "tools" that are used to "build". For what is the same about instances from different superordinates, their comparisons were made in terms of the higher level categories they share membership in (e.g., "dress" and "saw" being "inanimate objects" and "concrete"). Or they were compared in terms of their shared material properties and physical characteristics, which are shared across superordinates (e.g., "chairs" and "rulers" being "made of wood" and therefore having "definite shapes").

As can be seen in these examples, different types of information were reported based on the instances' shared memberships. In addition, there were special restrictions on how and whether this information should be reported. For example, the subset pair "ruler" and "tape measure" both have "numbers", "inches", and "feet" for measuring. For these instances, having "numbers" was reported alone and with "measure" (i.e., they "have numbers" and "have numbers to measure"), while "inches" and "feet" were only reported with "measure" (i.e., they "have inches to measure" and

"have feet to measure"). Having "numbers" was reported alone because "measure" is a Permissible feature of "numbers" (that is, "numbers" may also be used for purposes other than measuring), while "measure" was represented as Obligatory for "inches" and "feet" (see Table 19). In contrast, "have blades to cut" was not reported for "saw" and "scissors", even though "cut" was an Obligatory feature for "blades". This part was not reported because it is the only part of these instances that is associated with their defining feature "cut". As such, this part is synonymous with the defining function of these instances, and nothing is added by saying that they have "blades" if it is being reported that they are used to "cut".

These examples show how the "defining" features were used as "core" pieces of information when describing the instances. The other Obligatory and Permissible features of the categories and instances also played similar "core" roles when instances at the other levels of shared membership were being described. As these features were primarily "functional" features, the present implementation illustrates why dominantly functional descriptions were given in the psychological research reported here. As can be seen, these "core" functional features were used to organize the featural descriptions of instances through their relations to other features (e.g., "measure" being Obligatory for "inches" and "feet"). In addition, the descriptions were adapted to fit the particular contexts they were used in.

For example, not reporting "blades" for "saw" and "scissors" because it is the only part associated with their defining feature is in line with the characteristics of Grice's (1975) Cooperative Principle of being brief and not contributing more information than is required.

It should also be noted that the least-upper-bound shared memberships of the instances played a principle part in delineating the context of a comparison. Similar to the descriptions of what is the same about the instances, the types of information used to describe the differences between instances were related to their shared memberships. For example, the subset pairs' shared defining features were combined with the differences in their parts (e.g., a "ruler" having "12 inches for measuring" and a "tape measure" having "36 inches for measuring") and the different things they are "applied to" (e.g., a "saw" being used to "cut wood" and "scissors" being used to "cut cloth"). In contrast, superordinate pairs were compared in terms of their respective defining features, which are Permissible feature/subset distinctions under their superordinate (e.g., "hammer" and "drill" are used for "nailing" and to "make holes"). In addition, the "manner" in which they are used was also reported. For example, "hammer" and "drill" were reported to be used "manually"/used "electrically" and as "nailing manually"/"make holes electrically", and "nails" and "soldering irons" were described as different because one is "acted upon (hammered)" and the other "acts upon

(fuses)". As such, the least-upper-bound shared memberships of the instances served to delineate the types of information that should be used to describe the instances in the contexts of particular comparisons.

While it had been found in Experiment 3 that instances are primarily compared in terms of their least-upper-bound shared memberships, there were exceptions. For example, for what is the same about "hammer" and "drill", these instances were most often described in terms of their shared membership in the superordinate "tools", but they were also described as "carpentry tools" (a subset of "tools") and as being "used in workshops" (a Permissible feature of "tools"). However, in the present implementation, it was found that such exceptions can be generated based on the instances' least-upper-bound shared memberships. For example, "used in workshops" was not designated as a defining feature for "hammer" or "drill", as it was represented as an Obligatory (High Permissible) feature of "carpentry tools", in contrast to the defining features of "hammer" and "drill" (e.g., "nailing" and "making holes") which were Permissible features of both "carpentry tools" and "tools". As the instances' defining features were used to determine shared memberships at the subset level, these instances were not compared as a subset-level comparison (see the examples of the difference comparisons for these instances in the previous paragraph). However, other subset distinctions and Permissible features of the superordinates were reported in

such contexts (e.g., "carpentry tools" and "used in workshops") if they were not the instances' defining features.

The largest proportion of "exceptions" to the least-upper-bound hypothesis in Experiment 3 were for the difference comparisons of instances that are members of different superordinates (see Table 15). It had been predicted for Experiment 3 that these instances would be contrasted in terms of their different superordinates and the Obligatory features of these superordinates, but a larger number of Permissible features of the superordinates were received. For example, "ruler" and "chair" were described as being different because one is used to "measure" and the other is used to "sit on", rather than being described in terms of their respective superordinates, "tools" and "furniture". "Dress" and "saw" were described in terms of their superordinates (i.e., one being "clothing" that is "worn" and the other being a "tool"), but they were also described as different because one is "worn" and the other is used to "cut".

These apparent exceptions to the least-upper-bound hypothesis were also implemented in terms of the instances' least-upper-bound shared memberships, as their descriptions were generated relative to their taxonomically higher-level similarities. For example, "dress" and "saw" were compared in terms of their superordinates (i.e., "clothing", "worn", and "tools") because a higher category that subsumes their superordinates is used to describe what is the same about them (i.e., they are both "inanimate objects"). But the fea-

tural descriptions for these instances were also contrasted. Specifically, the defining feature for "saw" (i.e., it is used to "cut") was contrasted to a "dress" being "worn".

In the implementation, difference descriptions were generated from the contrasts between these features by noting that things that are "worn" have a sibling/contrasting relation to things that "cut", that "sharp" is Obligatory for "cut", and that a saw is applied to "wood" in contrast a dress being applied to the "body" (see Table 19). The resulting difference descriptions were that saws "cut", "cut wood" and are "sharp" in contrast to a dress being "worn". As "worn" is a superordinate-level feature and "cut" is a subset-level feature, the generation of these descriptions corresponds to the large number of "mismatched" levels received for the difference descriptions of higher pairs in Experiment 3, in which specific contrasts are generated through a characteristic of one of the instances (e.g., a saw's cutting) in contrast to a more general characteristic of the other instance (e.g., a dress being worn).

It was also found in Experiment 3 that the subset-level Permissible features are frequently used to describe instances despite the level they share a least-upper-bound membership at, these features therefore appearing to be "preferred" as descriptions of the instances. In line with this finding, "ruler" and "chair" were simply described as different in terms of their respective Permissible, defining features, "measure" and "sit on", without any specific con-

trast being made between these two features. For the present implementation, these descriptions were generated based on the instances being described as the same by a general, higher-level material characteristic (i.e., they are "made of wood") that is shared across a number of superordinates, but does not subsume the superordinates in the way that the category "inanimate object" does. As such, the Permissible, defining features played a principal role for comparing instances, but the strategies used for each of the comparisons were based on the least-upper-bound shared memberships of the instances.

The strategies also made extensive use of the deontic norm relations (i.e., Obligatory and Permissible relations) for generating descriptions. As illustrated above, norm relations between the characteristics of objects were used by the strategies along with the features' norm relations to categories and instances (e.g., noting that "cut" is Obligatory for "blades", or that it is Obligatory for something that can "cut" to be "sharp"). Through these relations, the strategies arrived at the descriptions that are applicable in specific contexts. In addition, shifts in the applicability of feature norm descriptions were also implemented by noting the relations between features that are relevant in particular contexts. Specifically, means were implemented for using a feature to describe an instance in one context, but excluding that instance from that description in another context. In Experiment 3, such deontic usages were seen when

the same feature was used to describe what is different and the same about two instances. For example, "hammer" and "drill" were described as different because one is used for "nailing" and the other is used to "make holes", but they were also described as being the same because they are used to "make holes". "Hammers" were therefore described as being used to "make holes" and were excluded from this description.

These different uses of a feature were implemented by noting the feature's relation to the other relevant feature, in the context of the particular comparison. For example, in the context of describing what is the same about "hammer" and "drill", it was noted that it is Permissible for something that is used for "nailing" (or "hitting" things) to be used to "make holes" (see Table 19). The defining feature for "drill", "make holes", was therefore extended to "hammer" as a description of what is the same about these two. However, for what is different about these two, their defining features were reported (i.e., "nailing" and "making holes"), as neither feature is Obligatory for the other. In fact, this extension of a defining feature only goes one way, as "drills" make holes by drilling ("drill holes" is also a defining feature for "drills"), and it is not Permissible for things used to "drill holes" to be used for "nailing".

As a result of these processes, a feature that is extended to include instances and delimited to exclude

instances has a different sense in the different contexts, each of which is based on relations within the knowledge base. As seen here, "make holes" has a broader sense when it includes a hammer's "nailing" through reference to the Permissible relation between making holes and nailing. But a narrower sense of "make holes" is referred to when it is contrasted to "nailing", and is delimited to a drill's being used to "drill holes". In this context, the sense of "make holes" is delimited to one of its Permissible features (i.e., drilling holes is Permissible , but not Obligatory for making holes; see Table 19). This is an important characteristic of a deontic system, as the Obligatory and Permissible relations are not "all-or-none" relations. What features are taken as referring to can therefore be flexibly adapted to meet the demands of particular contexts. This is done without explicitly representing default values, as the special applications of feature norms are arrived at by noting the relevant relations between features in particular contexts.

The same deontic processes can also be applied for determining how the feature norms should be used to describe a category and its members. In particular, "High Permissible" features for "tools" were designated as Obligatory norms for this category in the present implementation (i.e., "fix" and "build"; see Table 19). While these features can be used to describe all tools in an Obligatory fashion, they may also be said to not be applicable to some tools in cer-

tain contexts. For example, a "saw" and an "ax" may be said to not be used to "build" because they are used to "take things apart" or "destroy" things. While these exceptions and alternative descriptions were not implemented, they could also be generated by noting the relations between features. (These particular "exclusive disjunctions" were produced in Experiment 1, Task 2, and the present implementation only covered responses received in Experiment 3).

For example, taking things apart and putting things together can both be included in the process of building. "Take things apart" is therefore Permissible for "build". But "put things together" is Obligatory for "build", and "take things apart" bears a contrasting/sibling relation to "put things together" (see the frames for "build" and "put things together" in Table 19). Based on these relations, "build" could be taken as synonymous to "put things together", and "take things apart" could be contrasted to "build" through its sibling relation to "put things together". As such, the feature norms for a category could be adapted as descriptions of a category and its members through the relations that the features bear to each other. This, in turn, would provide the basis for their use as category norms, as it was found that the features' norm relations to categories reflected how the features are used to describe categories and instances in different contexts.

In summary, this implementation demonstrates that a deontic model of knowledge representation is clearly related

to how natural category information is organized and used. When constructing the knowledge base for this implementation, a number of the relations between features, instances and categories that were implicit in the responses in the psychological research were given an explicit status in the frames constructed for the implementation. Based on these relations, it was found that all the responses received in Experiment 3 could be generated in terms of the least-upper-bound shared memberships of instances, including the "exceptions" to the least-upper-bound hypothesis that had been noted in that experiment. But the implementation went beyond Experiment 3 by examining how retrieval strategies can derive and construct responses to fit particular contexts, rather than simply reporting information found at or below a least-upper-bound taxonomic level. In fact, one of the taxonomic levels identified in Experiment 3 (the "below subset" level) was not represented in the implementation as a distinct level, as all of the responses at this level were derived. For example, the "below subset" level responses, "cut wood" and "cut cloth", for the subset pair "saw" and "scissors" were arrived at by combining their defining feature with the different things they are "applied to".

This integration of the strategies with the knowledge base strongly suggests that natural category information is organized in line with how it is used. The specific relations within the frames allow a broad range of responses based on the comparison and combination of information in

particular contexts, with none of the relations needing to be absolute. Instead, features, categories and instances can be represented in terms of the relations they are commonly asserted as having to each other, so that their sense or applicability can be altered depending on the specific assertions an individual wishes to make. As such, by noting these relations, a deontic model of representation accounts for how people organize natural category information so that this information can be adapted for a variety of uses.

References

Barsalou, L.W., & Bower, G.H. (1980). A priori determinants of a concept's highly accessible information. Paper presented at the Meeting of the American Psychological Association, Montreal, September 1980.

Barsalou, L.W., & Sewell, D.R. (1984). Constructing representations of categories from different points of view. Emory Cognition Project Report # 2, Emory University.

Battig, W.F., & Montague, W.E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. Journal of Experimental Psychology, 80, (3, Part 2).

Blau, A.F. (1985). Personal communication, December 31, 1985.

Cohen, B., & Murphy, G.L. (1984). Models of concepts. Cognitive Science, 8, 27-58.

Collins, A., & Quilian, M.R. (1969). Retrieval time for semantic memory. Journal of Verbal Learning and Verbal Behavior, 8, 240-247.

Grice, H.P. (1975). Logic and conversation. In P. Cole and J.L. Morgan (Eds.), Syntax and semantics: Speech acts (Vol. 3). New York: Academic Press.

Hampton, J.A. (1979). Polymorphous concepts in semantic memory. Journal of Verbal Learning and Verbal Behavior, 18, 441-461.

Hemenway, K. (1981). The role of perceived parts in categorization. Unpublished doctoral dissertation, Stanford University.

Hilpinen, R. (1971). Deontic logic: Introductory and systematic readings. New York: Humanities Press.

Johnson-Laird, P.N. (1980). Mental models in cognitive science. Cognitive Science, 4, 71-115.

Katz, J.J. (1972). Semantic theory. New York: Harper and Row.

Keil. F.C. (1979). Semantic and conceptual development. Cambridge, MA: Harvard University Press.

Lakoff, G. (in press). Women, fire and other dangerous things: What categories tell us about the nature of thought. Chicago: University of Chicago Press.

Loftus, E.F., & Scheff, R.W. (1971). Categorization norms for 50 representative instances. Journal of Experimental Psychology, 91, 355-364.

McCloskey, M., & Glucksberg, S. (1979). Decision processes in verifying category membership statements: Implications for models of semantic memory. Cognitive Psychology, 11, 1-37.

Miller, G.A., & Johnson-Laird, P.N. (1976). Language and Perception. Cambridge, MA: Harvard University Press.

Murphy, G.L., & Medin, D.L. (1985). The role of theories in conceptual coherence. Psychological Review, 92, 289-316.

Neisser, U. (in press). From direct perception to conceptual structure. To appear in U. Neisser (Ed.), Concepts reconsidered: The ecological and intellectual bases of categories. Cambridge: Cambridge University Press.

Nelson, K. (1974). Concept, word and sentence: Interrelations in acquisition and development. Psychological Review, 81, 267-283.

Nelson, K. (1978). Explorations in the development of a functional semantic system. In W. Collins (Ed.), Child psychology (Vol. 12). Hillsdale, NJ: Erlbaum Associates.

Olson, D.R. (1970). Language and thought: Aspects of a cognitive theory of semantics. Psychological Review, 77, 257-273.

Osherson, D.N., & Smith, E.E. (1981). On the adequacy of prototype theory as a theory of concepts. Cognition, 9, 35-58.

Rips, L.J., Shoben, E.J., & Smith, E.E. (1973). Semantic distance and the verification of semantic relations. Journal of Verbal Learning and Verbal Behavior, 12, 1-20.

Roberts, R.B., & Goldstein, I.P. (1977). The FRL Primer. Report AIM-408, Artificial Intelligence Laboratory, Massachusetts Institute of Technology.

Rosch, E. (1975). Cognitive representations of semantic categories. Journal of Experimental Psychology: General, 104, 192-233.

Rosch, E., & Mervis, C.B. (1975). Family resemblances studies in the internal structure of categories. Cognitive Psychology, 7, 573-605.

Rosch, E., Mervis, C.B., Gray, W., Johnson, J., Boyes-Braem, P. (1976). Basic objects in natural categories. Cognitive Psychology, 8, 382-439.

Roth, E.M., & Shoben, E.J. (1983). The effect of context on the structure of categories. Cognitive Psychology, 15, 346-378.

Rumelhart, D. (1980). Schemata: The building blocks of cognition. In R.J. Spiro, B.C. Bruce, and W.F. Brewer (Eds.), Theoretical issues in reading comprehension. Hillsdale, NJ: Erlbaum Associates.

Schank, R.C. (1985). Looking at learning. In L. Steels and J.A. Campbell (Eds.), Progress in artificial intelligence. Chichester, UK: Ellis Horwood Ltd..

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

Smith, E.E., & Osherson, D.N. (1982). Conceptual combination and fuzzy set theory. Proceedings of the 4th Annual Conference of the Cognitive Science Society, Ann Arbor, MI.

Smith, E.E., Shoben, E.J., & Rips, L.J. (1974). Structure and process in semantic memory: A featural model for semantic decisions. Psychological Review, 81, 214-241.

Tversky, A., & Kahnemann, D. (1983). Extensional versus intuitive reasoning: The conjunction fallacy in probability judgement. Psychological Review, 90, 293-315.

Tversky, B., & Hemenway, K. (1984). Objects, parts, and categories. Journal of Experimental Psychology: General, 113, 169-193.

Wittgenstein, L. (1953). Philosophical investigations. New York: Macmillan.

Wright, G.H. von (1963). Norm and action: A logical enquiry. London: Routledge & Kegan Paul.

Zadeh, L. (1965). Fuzzy sets. Information and Control, 8, 338-353.

Zadeh, L. (1978). PRUF: A meaning representation language for natural languages. International Journal of Man-Machine Studies, 10, 395-460.