

INFORMATION TO USERS

The most advanced technology has been used to photograph and reproduce this manuscript from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book. These are also available as one exposure on a standard 35mm slide or as a 17" x 23" black and white photographic print for an additional charge.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

U·M·I

University Microfilms International
A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
313/761-4700 800/521-0600



Order Number 900039

The role of language in superordinate category formation

Kyratzis, Amelia, Ph.D.

City University of New York, 1989

Copyright ©1989 by Kyratzis, Amelia. All rights reserved.

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106



THE ROLE OF LANGUAGE IN SUPERORDINATE CATEGORY FORMATION

by

AMELIA KYRATZIS

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.

1989

© 1989
AMELIA KYRATZIS
All Rights Reserved

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

January 30, 1989
date

Katherine Nelson
Chairman of Examining Committee

January 30, 1989
date

Herbert D. Seitzstein
Executive Officer

Sylvia Scribner

Joseph Glick

Katherine Nelson
Supervisory Committee

The City University of New York

Abstract

THE ROLE OF LANGUAGE IN SUPERORDINATE CATEGORY FORMATION

by

Amelia Kyratzis

Adviser: Professor Katherine Nelson

This study examined the role of language, more specifically, the role of three linguistic mediators, in superordinate category formation. The mediators and their assumed roles were:

(1) linguistic specification of category criteria, highlighting superordinate functions (i.e., those specified in the meanings of superordinate words) and facilitating their detection in potential referents; (2) common descriptions of category instances, facilitating the generalization of superordinate functions to potential referents; and (3) knowledge of constraints on superordinate word meaning, establishing a relationship between superordinate functions and word meaning. The development of these mediators during the early school-age period was a major focus of the research.

Forty kindergarteners and forty first graders participated in a superordinate word learning study. The words were artificial labels designating three superordinate categories, gauges, accessories, and fasteners. Learning involved children in using three referents of each word in a woodworking activity and being given repeated exposure to their superordinate labels. There were four learning conditions.

These varied the availability of basis (definition) statements, (e.g., "gauges are things that measure") and inclusion statements, which specified the hierarchical-inclusion relation inhering between superordinate and basic level labels for the same object (e.g., "a level is a kind of gauge".) Whether individual objects were described in terms of the common, category functions (e.g., "measuring") by the experimenter was also varied. After learning, children had to generalize the superordinate labels and the superordinate functions (e.g., measuring) to additional objects.

Results indicated that children at both ages were able to generalize the superordinate functions and could benefit from linguistic mediators 1 and 2 (see above) to do so. However, only the first graders could generalize the superordinate labels, and only when given basis (definition) statements. It was concluded that first graders possessed a One-Feature Constraint on superordinate word meaning that enabled them to capitalize on information about the relationship between the superordinate functions and word meaning. This constraint designates that superordinate word meaning refers to single features. The constraint appeared not to be operative in kindergarteners.

The role of other word meaning constraints (e.g., the Mutual Exclusivity Hypothesis) was examined but was not significantly related to performance. Knowledge of the One-Feature Constraint appeared to undergo the greatest development during the period studied and may account for the onset of superordinate categorization ability during this period.

Acknowledgements

I would like to take this occasion to acknowledge and thank the people who, in various ways, made significant contributions to the research reported here and to my graduate education.

First and foremost, I wish to thank my family, especially my mother and father, for their unwavering love and support and for making my graduate education possible. They were both keenly interested in every nuance of my career, and their support gave me the courage to see my training through to its culmination. One of the greatest regrets of my life is that my father did not live to see this culmination.

Next, I wish to thank Katherine Nelson, my adviser, for the support and advice that she gave me throughout my training, and for undertaking the innumerable tasks that go into the shaping of scholars. Equally as important, I wish to thank her for the profound influence that she has had on my ideas and thinking. Her perspectives on concepts, categories, and language, and their interrelationships in development, have made a deep impression on me and influenced the present research. I'd also like to thank her for her encouragement and support of this dissertation, and for the many ways in which she contributed to seeing it to its fruition.

I wish to thank Joseph Glick and Sylvia Scribner, for their encouragement through the years, for the profound influence that they have had on my training and thinking in their capacity as my teachers, and for deepening my understanding of issues concerning the influence

of culture on cognition (among many other issues). I also wish to thank them for the many insights that they contributed to this dissertation, which deepened its perspectives.

I wish also to thank Harry Beilin and Barbara Landau, for serving as outside readers for the dissertation, and for their helpful and insightful comments, which did much to clarify the research.

Additionally, I'd like to thank my friend and colleague, Joan Lucariello, for her friendship, for the support, advice, and encouragement she has given me throughout the years, and for the constructive criticism that she has extended to me on all my research endeavors.

Finally, my deep appreciation goes to the students, teachers, and staff at P.S. 3 in Manhattan and at the Fieldday School in the Bronx, New York for participating in the present research and making it possible.

Table of Contents

Title page.....	i
Copyright page.....	ii
Approval page.....	iii
Abstract.....	iv
Acknowledgements.....	vi
Table of Contents.....	viii
List of Tables.....	xi
List of Figures.....	xii
Introduction.....	1
The Structure of Taxonomic Categories.....	1
Evidence from Non-Verbal Tasks.....	11
Free Recall Tasks.....	17
Children's Knowledge of Class-Inclusion Relations.....	26
Direct Tests of Children's Superordinate Category Knowledge....	29
Summary of Research on Children's Superordinate Knowledge.....	32
Theories of Superordinate Category Knowledge Development.....	34
Language-Cognition Interaction Models of Superordinate Categorization.....	39
Purposes and General Procedure of Present Research.....	57
Predictions for Present Research.....	67
Method.....	74
Subjects.....	74
Design.....	74
Learning Session Procedure.....	75

Procedure for Generalization Sessions.....	78
Stimuli.....	81
Tasks and Measures.....	82
Results.....	86
Superordinate Word Learning.....	86
Superordinate Label Generalization.....	88
Superordinate Function Generalization.....	93
The Relationship between Superordinate Function Generalization and Label Generalization.....	96
The Role of Experimenter-Provided Superordinate Function- Generalizing Statements.....	100
Determinants of None-of-Those-Things Responses.....	101
Sorting.....	104
Levels of Knowledge of the One-Feature Constraint on Superordinate Word Meaning.....	107
Children's Self-Generated Definitions in the No-Basis (Ostensive) Condition.....	112
General Summary.....	114
Discussion.....	120
Summary of Results.....	120
What Develops During the Early School-Age Period?.....	131
Comparison with Previous Theory and Research.....	137
Implications.....	145
Tables.....	148
Appendix A.....	157
Appendix B.....	162

References..... 163

List of Tables

Table 1. Mean Number of Learning Exemplars to Which Superordinate Labels Were Learned by Grade, Inclusion Condition, and Basis Condition.....	148
Table 2. Mean Number of Superordinate Words Learned to Two or More Exemplars by Grade, Inclusion Condition, and Basis Condition....	149
Table 3. Mean Non-Hierarchical and Hierarchical Label Generalization Scores by Grade, Inclusion Condition, and Basis Condition.....	150
Table 4. Mean Number of Superordinate Labels Generalized by Grade, Inclusion Condition, and Basis Condition.....	151
Table 5. Mean Non-Hierarchical and Hierarchical Function Generalization Scores by Grade, Inclusion Condition, and Basis Condition.....	152
Table 6. Mean Percentage of Non-Hierarchical and Hierarchical Function-Generalized Transfer Objects that were also Label-Generalized by Grade, Inclusion Condition, and Basis Condition.....	153
Table 7. Mean Label-Generalization Scores for Experimenter-Generalized and Non-Generalized Transfer Objects by Grade, Inclusion Condition, Basis Condition, and Generalization Object Type.....	154
Table 8. Mean Frequency of "None-of-Those-Things" Responses for Non-Hierarchical and Hierarchical Transfer Objects by Grade, Inclusion Condition, and Basis Condition.....	155
Table 9. Mean Non-Hierarchical and Hierarchical Sorting Scores by Grade, Inclusion Condition, and Basis Condition.....	156

List of Figures

Figure 1. Design..... 65
Figure 2. Tasks and Measures..... 66

Introduction

The Structure of Taxonomic Categories

The structure and development of taxonomic categories has received considerable theoretical and empirical attention. A taxonomic structure is best portrayed as a tree structure, where a term or concept at the top dominates and includes terms lower down. Thus, "clothes" includes "pants", "shirt", "dress", etc. Taxonomies can have many levels. The different levels are related to one another through relations of class inclusion. The greater the inclusiveness of a category within a taxonomy, the higher the level of abstraction. Each category within a taxonomy is entirely included within one other category, (unless it is the highest level category), but is not exhaustive of that more inclusive category, (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976).

According to Horton (1983), object taxonomies are organized according to at least two principles. The first principle is the hierarchical principle. This refers to the fact that categories within a taxonomy are hierarchically organized by the principle of class inclusion. Understanding this principle helps one understand the relevant similarities among objects in the same taxonomy. For example, from knowing that dogs and cats are both animals, one can infer a number of features which these objects share. The second principle is the contrastive principle, and has been noted by Lyons (1977) for semantic tree structures. This principle refers to the fact that within a taxonomy, categories at a given level are mutually

exclusive or contrastive. For example, from knowing that an object is a dog and not a cat, one can infer that they contrast along particular dimensions, (e.g., characteristic sound made; characteristic food eaten).

Categories within taxonomies exist at different levels of abstraction or inclusiveness. According to Rosch et al. (1976), categories are defined as a number of objects that are considered equivalent. This, however, constitutes only the extension of a category. According to the classical view, concepts are defined in terms of their intension as well as their extension (Smith & Medin, 1981).

The intension or definition of a category specifies the criteria that elements must satisfy in order to be regarded as members of the category. According to the classical view, these criteria are in the form of necessary and sufficient features. The assumptions of the classical view are that: (1) the representation of a concept is a summary description of an entire class, rather than a set of descriptions of various subsets or exemplars of that class and (2) the features that represent the concept are singly necessary and jointly sufficient to define that concept (Smith & Medin, 1981). The summary representation is thought to be the result of an abstraction or induction process from concept instances, and is thought to apply to all possible test instances. Several problems with the classical view have been noted, such as the fact that it excludes or cannot account for disjunctive concepts and unclear cases, and for the fact that it is often difficult or impossible to specify defining features

for many concepts.

Rosch & Mervis (1975) have proposed an alternative view of how concepts or categories are represented. After Wittgenstein (1953), they have proposed that categories are organized in the form of a family resemblance structure. According to this model of organization, each instance of a category has at least one, and probably several, elements in common with one or more other members, but no, or few, elements in common with all members. Categories are represented in the form of a prototype. A prototype is the idea or image of the meaning of a category name. It is an "ideal" category member, or the category member(s) to which subjects compare items when judging category membership. Rosch & Mervis (1975) found that members of a category come to be viewed as prototypical of the category as a whole in proportion to the extent to which they bear a family resemblance to (have attributes which overlap those of) other members of the category, evidence that the prototype or representation of the category formed on the principle of family resemblance structure.

We perceive natural semantic categories, or networks of overlapping attributes as Rosch and her colleagues view them, because we are biologically structured so as to detect such networks. Some networks are more difficult to detect than others, because they are less overlapping. In this case, their members have low cue validity, which renders them poor models of the category as a whole. The validity of a cue is defined in terms of its total frequency within a category and its proportional frequency in that category relative to contrasting categories. Such is the case with categories that exist

at higher levels of inclusiveness within an object taxonomy - members have low cue validity for the category as a whole. Therefore, these categories are more difficult to learn or acquire.

According to Rosch et al. (1976), taxonomies of concrete objects are structured such that there is generally one level of abstraction at which categories possess the highest category cue validity. Rosch et al. examined categories at three levels of inclusiveness in object taxonomies. Basic level categories are the most inclusive level at which there are attributes common to all or most members of the category. At the next lower level, the subordinate level, category instances share many attributes in common with instances of other categories at the same level. Thus, their cue validity is less than that of basic level category instances. At the next highest level to the basic level, the superordinate level, categories have lower cue validity than do basic level categories because their members have fewer attributes in common with one another. Rosch et al. tested these and related hypotheses concerning categories at the three levels of abstraction. They found that basic categories are the most inclusive categories whose members: possess significant numbers of attributes in common; have motor programs that are similar to one another; have similar shapes, and can be identified from averaged shapes of members of the class. The level of specificity of a category had implications for cognitive processing. Basic objects were found to be: the most inclusive categories for which a concrete image of the category as a whole could be formed; to be the first categorizations made during perception of the environment; to be the

earliest categories sorted and earliest named by children; and to be the most well encoded in language. Subsequent research revealed that this was the level at which objects were most frequently named for young children, (Anglin, 1977; Blewitt, 1983; Shipley, Kuhn, & Colby Madden, 1983; Wales, Colman, & Pattison, 1983; White, 1982).

To summarize Rosch's model, categories are viewed as organized composites of attributes with greater and less degrees of cue validity, which determine the ease of categorization at the different levels. Rosch and Mervis (1975) liken the structure of categories, especially superordinate ones, to "complexive classes". Complexive classes are classes in which items are related to each other by attributes not shared by all members of the class, (Bruner, Olver, & Greenfield, 1966; Vygotsky, 1962). Rosch differs from these theorists in positing that complexive groupings appear to be one of the structural principles in the composition of superordinate classes themselves, and thus, one of the structural principles in adult classification. In contrast, Bruner et al. (1966) and Vygotsky (1962), consider complexive grouping to be a logically more primitive form of conceptual representation.

Most models of conceptual structure, in contrast to Rosch's, conform to the classical view. These models assume that concepts are represented in the form of a summary of perceptual and functional features, (Bloom, 1970; Bruner, Olver, & Greenfield, 1966; Clark, 1973; Inhelder & Piaget, 1964; Rescorla, 1980; Vygotsky, 1962). Developmental differences are thought to inhere in whether the complete summary has been acquired, (Bloom, 1970; Clark 1973) or in

how it is applied and utilized as a basis of extension, (Anglin, 1977; Inhelder & Piaget, 1964).

Most models of conceptual structure emphasize perceptual features to a greater extent than functional features. According to Smith and Medin (1981), perceptual features are those corresponding to outputs of the perceptual system. Functional features are more "abstract" because they have minimal connection to perceptual experience. According to Smith and Medin (1981), perceptual features are preferred in structural accounts such as the classical view because perceptual features greatly simplify the analysis of how people categorize objects and are also much easier to vary systematically in categorization experiments. Refuting this claim, Miller and Johnson-Laird (1976), systematically reviewing what is known about the possible outputs of the perceptual system, found that trying to represent concepts in terms of these outputs was a fruitless endeavor. Miller and Johnson-Laird use the example of trying to define a concept such as table. Trying to represent the concept by such perceptual features as "is connected and rigid", "has a flat and horizontal top", and "has vertical legs" presents serious problems. For example, some of these features are not true of all things we call tables. Moreover, some non-instances, such as tree stumps, may be perceived as tables if they are used as surfaces which afford support. These problems cannot be reconciled, according to Miller and Johnson-Laird, unless functional features are included in concept descriptions.

Nelson's (1974) Functional Core Model incorporates functional information in concept specification. According to this model,

children construct concepts on the basis of their experience with objects in functional situations. These concepts include information about actions and reactions of objects in relation to people, especially the child herself. This functional information is thought to constitute the core of the concept, with other information, such as perceptual features used for identification of concept instances, lying outside the core. The isolation of perceptual features was thought to constitute a secondary process and to occur subsequent to the isolation of the functional core. The internal structure of the concept was hypothesized to be hierarchical, with function dominating perceptual information.

The relative merits of assuming the predominance of perceptual vs. functional features in conceptual representation have been addressed in a great deal of empirical research. Studies that have examined the information on which children rely in generalizing words to novel referents have typically found that perceptual information is more often utilized than functional (Anglin, 1983; Bowerman, 1977; Gruendel, 1977; Rescorla, 1980). However, Nelson (1979) claims that this does not argue against the Functional Core Model. The model predicts that generalization will occur on the basis of the identifying features associated with the concept. As long as core actions and relations are not violated, concept generalization will occur on the basis of perceptual features. Therefore, studies that have purported to disclaim the FCM through generalization data have misunderstood the predictions of the model.

Support for the FCM comes in other forms. The functional basis

of children's first concepts was thought to be indicated by the kinds of things which children chose to name in the early word-learning phase, the vast majority of which were dynamic, not static, objects, (Nelson, 1973). Moreover, it was found that pre-verbal infants tend to remember and attend to actions and reactions of objects, rather than their static properties, (Nelson, 1979; Nelson, Kessen, & Platt, 1978).

A study by Lucariello (1986) also indicated the importance of functional features to concepts in the early word-learning phase. She examined 16-20 month old infants' concept acquisition in a novel, sequential activity. She found that children often generalized on the basis of function. The importance of functional information was also demonstrated by an analysis of the type of information mothers chose to emphasize in teaching the novel concepts to their infants. Functional information was specified much more frequently than perceptual information.

The centrality of functional information in conceptual representation has also been demonstrated in research with older children. Prawat & Cancelli (1977) found that for 4-5-year-old children, functional features of objects afforded faster reaction times on a semantic retrieval task than perceptual features. A study by Nelson (1978) that examined 3-5-year-old children's concept definitions revealed that both single-objects and taxonomic categories were predominantly defined in terms of function. On Word Association Tasks, when children specify features or attributes of target objects, these tend to be functional rather than perceptual ones (Moran, 1966;

Heidenheimer, 1978; Kyratzis, Lucariello, Nelson 1988).

This issue of whether functional features are difficult for young children to perceive is a central issue to the study of superordinate category development. According to Rosch, Bruner, Tversky, and other investigators (Olver & Hornsby, 1966; Rosch et al., 1976; Tversky, 1986), superordinate categories have a basis in such features. Rosch argues that since perceptual features do not correlate highly at the superordinate level, this basis is not available for perceiving equivalence among objects, and therefore functional features must be relied on instead (Rosch et al., 1976). Taking the argument further, Bruner and Tversky have claimed that the fact that superordinates have a basis in functional features underlies their difficulty for young children.

An alternative account of the relative difficulty of basic level and superordinate categories has been proposed by Nelson (1982, 1985). According to this account, basic level concepts are stable cognitive wholes, with structure, but without individuated members, while superordinate categories are collections of already-individuated, equal members. A concept is not a collection or category of equal members. For example, a concept such as "dog" may be applied to different instances of the dog class, but as a mental unit it is not a collection of dogs but a single whole. The cognitive whole which comprises the basic concept is the intension of the concept, which specifies the conditions under which the concept applies, its functions, properties, and relationships. Superordinate categories combine two or more basic concepts into a higher order collection of

mental objects. The individual basic concepts which make up the collection maintain their individual identity as part of the mental representation, and there is no structured whole or intension which applies to the category as a whole. An intension for the category may be abstracted in a post-hoc manner by the child through analysis of the similarities of the basic concepts subsumed by the hierarchical term, but this is not necessary for the category to become established. According to Nelson, then, a superordinate category is a combinatorial, relational structure rather than a wholistic one.

In summary, taxonomic categories are based on the abstraction of common properties among instances and are organized into hierarchies based on inclusion relations. The degree to which features are shared among the exemplars of a category determines the informativeness and therefore the relative ease of acquisition of categories at different hierarchical levels. Members of superordinate categories share few features in common, and for this reason, broad, functional features are thought to serve as the basis for their acquisition. There is controversy over whether such features are difficult for young children to represent, although many studies show that that they are readily utilized by preschool children. The hierarchical component of superordinate categories may also pose a difficulty for young children.

There is no question that there is some component of superordinate categories that poses a difficulty for young children. A great deal of developmental research has indicated that knowledge of superordinate categories is either not available or is not easily

utilized by children prior to 7 or 8 years. This difficulty with superordinates has been demonstrated across a range of different cognitive tasks, including classification, free recall, word association, definition tasks, and others. This research is reviewed in the following sections.

Evidence from Non-verbal Tasks

Classification studies present children with arrays of objects from different taxonomic categories and have them group objects into sets of things that "belong together" or "are the same kind of thing". A variant of this procedure is the match-to-sample or forced choice response task, which presents children with a standard object and requires them to specify which of a set of choice items either "belongs with" or "is the same kind of thing" as, the standard.

Two lines of evidence suggest that superordinate categories are not readily utilized by preschoolers as a classification basis. The first of these demonstrates that younger children, in contrast to older children, have greater difficulty classifying at the superordinate level than at the basic level (Horton & Markman, 1980; Rosch et al., 1976). The age at which the superordinate level "catches up" with the basic is under dispute. Blewitt (1983) found that even as late as 4-5 years, basic level categorization still exceeded superordinate, and Horton & Markman (1981) found that this was the case for kindergarten and second grade children. On the other hand, Mervis & Crisafi (1982), examining 2-, 4-, and 6-year olds' categorization of artificial stimuli, observed equivalent performance

at the two levels by 4 years. The subordinate level proved to be the most difficult, with equivalent performance to the basic level not being achieved until 6 years of age.

The second line of research pits alternative, non-categorical bases of association to the superordinate (Inhelder & Piaget, 1964; Olver & Hornsby, 1966; Vygotsky, 1962). This line of research has typically shown that preschoolers fail to classify according to a single set of criteria. Rather, these children form "complexive groupings". Complexive grouping involves using attributes of an array so as to form local rather than universal rules for grouping. In this way, the structure of preschoolers' groupings differs from that of older children. The content of their groupings also differs. Preschool children tend to classify according to thematic rather than superordinate bases of association. Thematic relations - or functional, syntagmatic, or complementary relations as they are also called - are relations between objects and other objects that appear together in the same spatio-temporal context and share a functional relation. For example, when asked to group objects, a children might group a dog with a bone (thematic) rather than a dog with a horse (superordinate).

Several accounts of these developmental differences have been put forth. Vygotsky accounted for the shift from complexive to class grouping by positing an increasing reliance on culturally-imposed linguistic structures in the concept-formation process. According to Vygotsky, for older children, "a concept is formed, not through the interplay of associations, but through an intellectual operation which

is guided by use of words as the means of actively focusing attention, of abstracting certain traits, synthesizing them, and symbolizing them with a sign, (p. 81)."

Inhelder & Piaget (1964) posited a different explanation of complexive grouping in younger children. They claimed that truly conceptual grouping could not occur prior to the onset of concrete operations because it involves the ability to coordinate the intension of a concept or class with its extension, and pre-operational children would be incapable of this due to their lack of reversible operations.

This account is ruled out by the fact that preschool children readily classify "conceptually", that is, according to a stable set of criteria, when classifying at the basic level (Rosch et al., 1976). Rosch claims that superordinate categories are not utilized by preschool children as a grouping basis because, due to their low cue validity, these categories are difficult to acquire and represent. The shared similarity among members of superordinate categories is low and members possess many distractor stimuli (stimuli not pertinent to category membership). Therefore, the shared features among exemplars are difficult to detect.

Olver & Hornsby (1966) claimed that the shift from reliance on thematic relations to reliance on superordinate relations indexes a shift in conceptual representation, from a predominantly "iconic" mode to a symbolic mode. In the symbolic mode, "abstract", functional features are used because linguistic structures increasingly guide how and what things are judged alike. In the iconic mode, perceptual, thematic bases of association are used because this mode is

characterized by a reliance on the visual world as a basis for organizing object relations.

This account views the shift from a thematic to a superordinate basis of response in terms of a shift in conceptual representation. A similar account is the schematic-to-taxonomic-shift view (Mandler, 1979). Schemas are part-whole structures that include variables that fill slots that are instantiated in specific contexts (Rumelhart & Ortony, 1977). Taxonomies are analytic structures based on relations of similarity and contrast (see previous section). It is well established that young children prefer to rely on part-whole, contextual, and causal-temporal relations that form the basis for schematic structures on many cognitive tasks (Gelman & Baillargeon, 1983; Mandler, 1983; Nelson & Gruendel, 1981). Thematic relations are a type of part-whole, schematic relation and children's reliance on them on classification tasks may therefore be a reflection of this shift.

Alternatively, it has been proposed that the thematic-to-superordinate shift in classification basis does not reflect a change in underlying cognitive structures but indexes a shift in preference for one type of conceptual relation over another (Smiley & Brown, 1979). That is, children represent both types of relation but merely prefer one over the other. Smiley & Brown (1979) provided support for this hypothesis. They found that although kindergarteners responded on the basis of thematic relations on a match-to-sample task, they could nonetheless justify the alternative basis of response, superordinate relations. In a study using the same procedure as

Smiley & Brown's, however, it was found that preschool children could not justify non-chosen superordinate relations (Kyratzis, Lucariello, & Nelson, 1988).

A related proposal is that children represent both types of relation but use thematic relations on certain kinds of tasks because they perceive them as being more related to the goal of the task. For example, Markman, Cox, and Machida, (1981) found that when children sorted objects into bags, rather than on a spatially extended surface, the preference for thematic over superordinate relations was reversed. Eliminating the spatially extended surface may have led children to perceive that the task no longer concerned making inductions about spatial relationships.

Markman and Hutchinson (1983) were able to obtain a similar reversal for preschoolers on a match-to-sample task. They found that preschoolers could be coaxed to respond according to superordinate relations when they perceived that inductions about word meaning had to be made. When they were asked to "find the other dax", rather than to "finding the other one that is like this one", they chose the superordinate associate of the standard.

These three studies suggest that preschoolers fail to utilize superordinate relations, not because they do not have knowledge of such relations, but because such relations are not salient for them or because they do not perceive them as appropriate to certain kinds of tasks (i.e., do not perceive that they have to do with what the task is about). However, developmental differences in classification style and basis may nonetheless be indicative of underlying conceptual

differences for the following reasons. First, contrary to the results of Smiley and Brown, there does exist some evidence that preschoolers cannot justify non-chosen superordinate relations on a match-to-sample task (Kyrtziz et al., 1988). Second, although there are ways of eliciting use of superordinate relations by preschoolers on non-verbal tasks such as sorting and match-to-sample, such use often cannot be elicited on verbal tasks, as will be seen in the following sections. One possible account of this task difference is that non-verbal tasks make available to children perceptual bases of response that are not available on verbal tasks. For example, if a child groups a lion together with a dog (superordinate associate) rather than with a cage (thematic associate) on a classification task, this may have nothing to do with the child's understanding of the conceptual relation between dog and lion, that is, that they share features common to all animals. The child may be responding purely on the basis of the fact that lion and dog look more alike than lion and cage. Thus, the fact that superordinate responding can be induced in preschoolers on non-verbal tasks does not necessarily constitute evidence that they have a conceptual understanding of these categories. A more rigorous test of conceptual understanding is children's performance on verbal tasks, on which perceptual bases of response are not available. Although such tasks confound children's conceptual knowledge with verbal ability, it does not appear to be possible to test whether children have knowledge of the conceptual relation underlying superordinate categories by other than verbal means.

Free Recall Tasks

Children's superordinate category knowledge can be assessed by seeing how well they are able to utilize such knowledge as a memory organizer for lists of to-be-remembered words. Typically, studies using this paradigm find that when items from familiar superordinate categories are included in a list of to-be-recalled words, these items tend to be remembered better than unrelated items and tend to be clustered together in recall. The results of such studies have been difficult to interpret, inasmuch as two distinctly different patterns of developmental findings have been obtained, (Lange, 1978; Ornstein & Corsale, 1979; Hagen, Jongeward, & Kail, 1975). Most investigators have found that clustering increases with age in a gradually linear fashion (Vaughn, 1968; Moely et al., 1969; Bousfield, Esteran, & Whitmarsh, 1968; Cole, Frankel, & Sharp, 1971), although surprisingly high levels of clustering and recall have been observed in children as young as 2-5 years (Rossi & Rossi, 1965; Perlmutter & Myers, 1978). However, another body of research has indicated that age-related trends in clustering are not linear and that, in fact, substantial clustering is not observed until late in the elementary school years (Lange, 1973; Furth & Milgram, 1973; Cole, Gay, Glick, & Sharp, 1971).

Lange (1973; 1978) has argued that the discrepancy between these findings is to some extent a function of the to-be-remembered items, and that inter-item association, rather than hierarchical categorical association, may be a factor. According to Lange (1978), "when associative relatedness is a factor, as it appears to be in studies by Rossi and Rossi (1965) and Vaughn (1968), all age groups of children

cluster some category stimuli, (p. 106)." Two studies compared the relative effects of associative and categorical (superordinate) relations. Haynes and Kulhavy (1976) presented 7, 9, and 12-year-old children with exemplars of superordinate categories having both high and low inter-item association. At all age levels, recall was higher for the high-associate than the low-associate list. Corsale (1978; cited in Ornstein & Corsale, 1979) obtained higher degrees of clustering on a list of taxonomic items which had high inter-item association than on a list of taxonomic items having low inter-item association.

Some recent studies have explored the interaction between age and ability to capitalize on hierarchical vs. inter-item association on the free recall task. Frankel and Rollins (1985) constructed four recall lists that varied in terms of categorical relatedness (high versus low) and inter-item associativity (high versus low). They reported relatively high levels of clustering and recall for 4th and 10th grade subjects when either associative or categorical relatedness was high. In comparison, for kindergarten children, levels of organization were high only when inter-item association was high, with degree of categorical relatedness not influencing their performance. Bjorkland and Jacobs (in press) assessed free recall performance in children in grades 3, 5, 7, and 9, and adults on a list of categorically related words constructed so that some items within a category were highly associated with one another and interitem associations were low among other items. Analysis of the correlation between recall and clustering indicated that organization in recall

was based on both associative and nonassociative categorical relations for older subjects (7th and 9th graders) but that it was based only on associative relations for 3rd and 5th graders.

Thus, Lange's (1978) claim that discrepancies concerning the relative age at which children can utilize categorical (superordinate) relations in recall tasks may be partially accounted for in terms of a confound between inter-item and categorical or superordinate association has received some empirical support. Children in the preschool and early elementary school years may benefit only or primarily from inter-item associations rather than from superordinate category organization.

Another type of relation that may give the appearance of a superordinate relation but that is not one are slot-filler categories (Lucariello & Nelson, 1985; Nelson, 1982; 1985). Slot-filler categories are categories of objects that share the same slot or function in an event structure across different occurrences of the same event (e.g., on one night, chicken and peas can be served for dinner; on another night, steak and potatoes can fill the same "slots" in a dinner event). The basis of the establishment of such categories is the relation of substitutability or shared function in an event schema; in other words, contextually-restricted functions serve as the basis of such categories. In contrast, the basis of superordinate categories resides in functions that are not contextually-restricted. A study by Lucariello and Nelson (1985) tested the hypothesis that slot-filler categories provide a closer match to preschool children's semantic memory structures than superordinate categories (or thematic

categories). Higher rates of clustering and recall were obtained on the slot-filler list than on either the superordinate or thematic list.

Thus, slot-filler category organization, like inter-item association, may serve as a confound of children's ability to use superordinate category organization as a memory organizer on free recall tasks. In fact, an examination of the types of "superordinate" or categorical relations that been used in studies that show a facilitative effect of superordinate categories indicates that many of these have been slot-filler categories (Huttenlocher & Lui, 1979; Rossi & Rossi, 1965; Kobasigawa & Orr, 1978; Perlmutter, Sophian, Mitchell, & Cavanaugh, 1981). Sets of items such as apple-orange, pants-shirt, car-bus-train, and spoon-fork-cup are frequently used, and these represent slot-filler relations rather than superordinate relations. Such categories as fruits and vegetables are also frequently used in this type of research, and these represent slot-filler categories as well. It is important to control for this potential confound in assessing whether and at what age children are able to utilize superordinate relations on free recall tasks.

The ability to use superordinate relations as a memory organizer on free recall tasks requires the deployment of the following strategies. Items must be tagged categorically (i.e., according to the superordinate category to which they belong) at input. Moreover, children must link the items sharing a common label or common category membership into clusters. Finally, they must use the category labels as cues at retrieval time in order to retrieve the clusters. Failure

to deploy any one of these strategies would result in poor recall and clustering scores.

It is possible that young children are less well able to utilize categorical structure in list recall because they fail to deploy strategies. Nelson (1969) tested children's use of organizational strategies with lists of categorically related items and unrelated lists. Improvement over trials for younger children (5-year-olds) matched older children's (8-year-olds') only on the unrelated lists. Nelson claimed that this suggests that it is not that younger children fail to utilize an organizational strategy per se, but that they fail to do so on categorical (superordinate) lists. Also, she claimed that an S-R type of cognitive organization (similar to what other investigators are calling inter-item association) was indicated for younger children, with a shift towards hierarchical (superordinate) organization for older children. Thus, children do not appear to use an organizational strategy based on superordinate categories until after age 5.

Bjorkland (1980) investigated the possibility that young children fail to organize categorical items because they do not tag individual items categorically at input. He found that this was not the case; providing category cues at input did not facilitate children's ability to recall categorically related items over a condition in which such cues were not provided. Only cueing categories at retrieval had a facilitative effect. These findings suggest that individual items are tagged categorically but that the category (superordinate) label is not used by young children as a basis for linking individual items

into clusters.

The fact that items are tagged categorically at input but that these categories are not serving as the basis of an organizational strategy may account for findings obtained by Halperin (1974). She found that providing category cues at recall was very effective in improving the number of categories recalled in children as young as 6 years. However, this condition did not improve within-item recall for these children. Even though items were tagged categorically at input such that the retrieval cues could be effective in eliciting individual items, the young children were not able to use the category (superordinate) labels as a basis for linking items within the category together.

In summary, prior to 8 years of age, children do not use superordinate category membership as a basis for linking items together or as a basis for the deployment of an organizational strategy (Bjorkland, 1980; Nelson, 1969). Even though they appear to tag individual items according to their superordinate category at input, this step does not serve as the basis for the deployment of an organizational strategy, as it appears to do in older children. Moreover, many of the positive effects that have been obtained with preschool children regarding the effects of superordinate category organization may be confounded by inter-item and slot-filler category effects.

Evidence from Word Association Studies

One of the most time-honored approaches to the study of

organization in semantic memory has been the word-association task. A developmental progression or shift from syntagmatic to paradigmatic responding on this task has been widely observed (see Nelson, 1977 for a review). Traditionally, the shift has been characterized in terms of sentential/syntactic relations. Younger children (5-year-olds) have been found to give associations that can occur later or earlier than the stimulus word in a sentence (i.e., words from a different form class), while older children (7-year-olds) provide associations that can occupy the same position in a sentence as the stimulus word (i.e., words from the same form class).

The shift has also been looked at in terms of analyses of the conceptual basis of responding rather than the syntactic basis (Moran 1973; Penk, 1971; Riegel, 1970). These studies have shown that preschool children's responses are functional in nature while older children's responses are categorical, with this difference possibly accounting for the shift in form class so widely observed (Nelson, 1977). Function responses reflect functional relations into which objects enter. For example, when the stimulus is an object referent word, such responses consist of: specifications of the functions of the object referent (e.g., dog-barks); specifications of typical spatial-temporal contexts in which the object referent may be found (e.g., lion-zoo); and thematic associates of the referent (e.g., dog-bone). Categorical responses specify words that share a categorical relation with the stimulus word. For object referent words, these are responses that name other object categories from the same superordinate category as the object referent. Categorical responses

for object referent words consist of: superordinate responses, which are responses that name the superordinate category of which the object referent is a member (e.g., lion-animal); coordinate responses, which specify a member within the superordinate category of which the object referent is a member that occurs at the same hierarchical level (e.g., dog-cat; pants-sweater); and subordinate responses, which specify an object category that is a member of the category designated by the object referent word (e.g., dog-poodle).

According to Nelson (1982; 1985) and Petrey (1977), the shift in the conceptual basis of responding from functional to categorical is a reflection of an increasing attention or sensitivity to relations that are defined in the language and a decreasing reliance on relations that are defined in the real world. Categorical relations are defined in the language; there is no functional, real-world relation between an object and its superordinate, coordinate, or subordinate. Along similar lines, Kyratzis, Lucariello, and Nelson (1988) found evidence that children's responses on a word association task reflected an increasing differentiation of the constraints that children perceive on verbal-semantic organization (verbal-semantic organization pertains to relations that are possible between words) from constraints on real-world organization. Although four year olds appeared to understand that the word association task was an occasion for making inductions about verbal-semantic organization, indicated by the fact that they used different relations on this task than they did on a non-verbal, match-to-sample task, their responses still carried real-world entailments. Older children's (7 year olds') responses

were comparatively much freer of such entailments.

In addition to the developmental shift from functional to categorical relations, another important shift that occurs is within the categorical responses themselves, from superordinate relations to coordinate ones (Nelson, 1977; Riegel, 1970; Steinberg & Anderson, 1965). According to Nelson (1977), this shift reflects a developmental progression from responses related to vertical relations between concepts to horizontal relations between concepts, in which concepts included in the same superordinate category will be related to each other in terms of a contrast along a common dimension. Nelson notes that this "implies building coordinate relations through the superordinate relation rather than bottom-up, on the basis of shared features (Nelson, 1977, p. 110)."

This shift from vertical to horizontal is reminiscent of a shift that occurred on the free recall task. Children were able to tag items according to their superordinate category before they could use the superordinate as a basis for building a relation between exemplars.

Thus, the word association findings corroborate the proposal that knowledge of the superordinate is acquired before it can be used as a basis for linking items at the same hierarchical level. An increasing attention to relations that are defined in the language, also evident on the word association task, may possibly have something to do with the ability to link items through the superordinate term. This proposal will be examined in the present research.

Children's Knowledge of Class-Inclusion Relations

According to Inhelder and Piaget (1964), complete mastery of superordinate classification is not indicated until the mastery of the class-inclusion relation, which is not obtained until the age of concrete operations. The traditional class-inclusion problem involves a number of objects belonging to a superordinate class (e.g., animals), which can be divided into two subordinate classes (e.g., 5 dogs and 3 cats). The child is asked "Are there more dogs or more animals?" Prior to 8 or 9 years, the majority of children respond by naming the larger subordinate class. According to Inhelder and Piaget, pre-operational children respond inappropriately because they lack the reversible operations of class addition and class subtraction. When they execute class subtraction, the superordinate class is mentally destroyed, and only the subcategories remain.

Markman and Siebert (1976) proposed an alternative explanation of children's failure on the class-inclusion task, arguing that two components are involved - the ability to represent the hierarchical-inclusion relation underlying the superordinate and the ability to operate on that relation, and that it is on the representational component rather than the operational component that young children fail.

Markman reasoned that if children do not represent the hierarchical-inclusion component underlying the superordinate, they might interpret it as a collection structure rather than as a class inclusion structure. Collections are referents of count nouns such as forest, pile, family, and army. Collections are thought to be more

coherent than superordinate classes because they are comprised of part-whole relations while superordinate classes involve the hierarchical relationship of subclass to class (the "is-a relation"). Moreover, in order to determine the membership of subclasses within a class, analysis of the intrinsic properties of the subclass must be conducted. In contrast, in order to determine the membership of elements in a collection (i.e., if a soldier is part of an army), only the extrinsic properties of the elements need be analyzed - that is, their relationship to one another, and part-whole comparisons are thought to be more easy for children to execute than analytic ones.

Several studies supported Markman's claim, showing that when young children were left free to impose their own interpretation on a superordinate structure, they interpreted it as a collection structure rather than as a class inclusion hierarchy. The test of whether children are making the collection interpretation is whether they will resist applying the superordinate name to any single member of the class and apply it only to groups of members of the class. For example, a child making the collection interpretation will deny that a dog is an animal and at the same time will say that a dog and a cow considered together are an animal. Preschool children are especially susceptible to this interpretation error (Callanan & Markman, 1982); however, even children as old as 14 years will make the error when confronted with a novel superordinate (Markman, Horton, & McLanahan 1980).

Inclusion statements, statements that explicitly refer to the inclusion relation existing between hierarchical levels within the

superordinate (e.g., "Dog and cat are kinds of animals.") have been shown to be effective in facilitating making the class inclusion interpretation rather than the collection one (Markman, Horton, & McLanahan, 1980). This research indicates that the hierarchical-inclusion relation encompassed within superordinates is not well represented by young children, and that they require external support in order to perceive the relation.

Markman & Siebert (1976) pitted their hypothesis, that it is in representing the hierarchical-inclusion relation that young children fall short, against Piaget's hypothesis that the difficulty resides in operating on the relation. Preschool children were much more successful at answering the question when it referred to collections than they were at answering it when it referred to class inclusion hierarchies, supporting Markman's claim over Piaget's.

The class inclusion or "is-a" relation has been shown to be difficult for young children on other tasks. Anglin (1977) tested 2-6-year-olds' ability to answer class-inclusion type questions in the form "is a dog an animal?" He found that younger children had difficulty grasping this relation; they would respond in the negative. MacNamara (1982) obtained similar findings to those of Callanan & Markman (1982) with 2-3 year olds; he found that these children were resistant to applying superordinate terms to single members of the class that had their own names: they would consent that two toys were toys but not that a single toy (e.g., doll) was a toy.

Children do not fail on class inclusion tasks because they do not know the superordinate category to which individual objects belong.

For example, on tasks on which they are asked to produce members within categorical fields, they are well able to do so (Nelson, 1974; Saltz, Soller, & Sigel, 1972). Children in the language-learning phase will frequently overextend a basic level term to groups within a categorical field, such as animals or vehicles, (Rescorla, 1980). However, once these members become individuated, the child cannot coordinate the inclusion relation between the set and its elements, that is, see that a dog is an animal. These findings demonstrate that children's difficulty resides in the hierarchical-inclusion component of the superordinate relation, rather than in knowledge of the category membership of individual exemplars. Young children do not appear to be able to coordinate the two levels of a class hierarchy simultaneously and apply the superordinate term in its sense of specifying a hierarchical-dominance relation.

The research summarized in this section examined children's performance on tasks which explicitly query their knowledge of class-inclusion relations and showed that young children have difficulty encoding this relation. It is in representing this relation, rather than in operating on it, that the difficulty for young children resides. In the following section, we will see the effect of this deficit on the breadth and organization of children's categories.

Direct Tests of Children's Superordinate Knowledge

According to Nelson (1985), the most direct tests of children's knowledge of a superordinate are to ask them to produce its members or to define it (Nelson, 1974, Nelson, 1978). Nelson (1978) asked 4-5-

year-old children to define superordinate category terms and compared their definitions to dictionary definitions of the same terms. Children included many of the same elements in their responses as the dictionary definitions. Both the children's responses and the dictionary entries were defined primarily in terms of function. For example, in the dictionary, "clothes" is defined as "articles, usually of cloth, designed to cover, adorn, or protect the body," and "tools" are "implements used or worked by the hand". Children's definitions differed only in that they represented less complete entries of functional attributes. These findings confirm the claim that superordinates are defined primarily in terms of function (Bruner et al. 1966; Nelson, 1982; 1985; Rosch et al., 1976) and that children's representations of these categories reflect the adult basis.

Nelson (1974) examined children's knowledge of superordinate categories by having them produce exemplars in response to category labels. Five- and eight-year-olds' responses were compared. The similarities across developmental levels far outweighed the differences. Five year olds produced fewer category members; however, there was a high degree of consistency within this group as to typical category members, as was the case with the older children. Categories of younger children were not more restricted; in fact, they produced a greater diversity of responses than the older children. What seemed to be lacking was a degree of hierarchical differentiation within each category: within each superordinate, only certain subcategories were fleshed out. For example, a large proportion of younger

children's responses for the animal category were confined to four-footed animals or mammals; members of other subcategories, such as fowl, were not enumerated to as great an extent. The same was the case for the clothing category: subcategories such as jewelry, accessories, and headware were not fleshed out. Saltz, Soller, & Sigel (1972), obtaining similar findings, described young children's category knowledge as more "fragmented", and claimed that young children fragment adult concepts into several sub-concepts and that the general category term denotes a more restricted concept than it does for the adult. Nelson saw the same failure, not as fragmentation, but as a lack of hierarchization and articulation. Children could supply some members of peripheral subcategories, which argues against fragmentation; what appeared to be lacking was the ability to combine the subcategories together into a higher order unit.

A category production experiment with somewhat younger children, 4-year-olds (Kyratzis, Lucariello, Nelson, & 1988), indicated that 4-year-olds' superordinates were restricted to a single slot-filler category within each superordinate (e.g., zoo animals for the animals category) while older children, 7-year-olds, combined several slot-filler categories into a higher order unit. As discussed in the section on the research on free recall, the basis of slot-filler categories, contextually-restricted functions, may carry greater conceptual coherence for young children than the basis of superordinate categories, which consists of context-free functions. Therefore, individual slot-filler categories constitute discrete

cognitive wholes, in the sense used by Nelson (1982; 1985), and their combination into a higher order unit may require the deployment of a combinatorial operation, as through the use of the hierarchical-inclusion (is-a) relation. As we saw in the previous section, young children's representation of such relations appears to be quite weak. This may account, therefore, for the "fragmented" quality of their superordinates.

In conclusion, it appears that young children do not lack knowledge of superordinate categories per se. They can define these in the adult-like fashion, and enumerate appropriate and typical instances. It appears that what develops is the ability to combine together subsets of these categories which constitute more psychologically coherent units together into a higher order unit via combinatorial operations.

Summary of the Research on Children's Superordinate Knowledge

The research reviewed in the preceding sections indicates pervasive deficits in preschool children's knowledge of superordinate categories. Although children have impressive knowledge of the functions underlying superordinate categories, know the superordinate categories to which many basic level objects belong (evident in their ability to tag items according to superordinate category on the free recall task), and produce members within superordinates, they are sorely lacking in knowledge of other components of superordinate knowledge. One very pervasive deficit was in the ability to use category membership as a basis for linking items at the same

hierarchical level (as in using it as a basis for deploying an organizational strategy on the free recall task or using it as a basis for establishing a link between coordinates to serve as a basis for word association).

A second pervasive deficit is in representing hierarchical-inclusion relations. These relations are necessary in order to combine conceptually discrete elements together into higher order units; therefore, children's lack of ability to encode these relations may account for the hierarchical-restrictedness and fragmented nature of their superordinates that was evident on the category production task.

A third deficit, evident on the word association and classification tasks, was in the relative reliance on superordinate-categorical relations in comparison to functional relations. This shift in relative preference for relations may reflect an increased attention to relations that are language-defined (i.e., relations that organize words and word meaning) and a decreased attention to relations that organize real-world phenomena. An increased attention to language-specific types of organization may account for the increased ability of older children to encode hierarchical-inclusion relations, which are a type of word meaning relation.

Thus, preschoolers appear to lack knowledge of several components of superordinate category knowledge, with this lack seemingly accounting for many of the specific difficulties that preschoolers have on different cognitive tasks. It should be noted here that some of the positive results that have been obtained with preschoolers in

some studies may be artifacts of tasks and materials used in the research. Some of these include non-superordinate bases of association, such as slot-filler and inter-item associations; and classification tasks, which may afford a perceptual basis for responding unrelated to conceptual knowledge of the superordinate.

Theories of Developmental Differences in Superordinate Category Knowledge

In the previous section, we saw that preschoolers had pervasive deficits in knowledge of superordinate categories and that the approximate age at which children could begin to utilize superordinate structure on cognitive tasks is around 7 or 8 years. In this section, we explore the theoretical accounts of these developmental changes. We begin with an account which posits no underlying structural change and that improvement with age "is one of degree, not of kind (Gelman & Baillargeon, 1983, p. 206)." Gelman & Baillargeon interpret deficits in the preschool period in terms of deficits in information processing skills, competing behavioral tendencies, and competing bases of organization rather than unavailable ones. As evidence of information processing failure, they cite the finding that children often will not utilize a particular feature or set of features as a basis of executing an exhaustive sort even when they detect the feature (Horton & Markman, 1980). However, the interpretation that this is an information processing problem is not adequate, in that it appears to be the nature of the features involved, rather than information processing constraints per se, that present the difficulty. Children readily execute exhaustive sorts

when the set of features involved pertain to the basic level (Rosch et al., 1976). But even though children may detect the features underlying superordinates, they may not readily perceive these features as a basis for conceptual coherence. Thus, an account in terms of information processing constraints is not sufficient to explain the data.

It is not difficult to argue against Gelman and Baillargeon's second explanation either. Although it is the case that competing behavioral tendencies do operate in certain tasks that have been used in this research, such as the classification, word association, and category production tasks, competing response tendencies do not operate in other tasks that have been used, (e.g., classification tasks that do not employ competing bases of organization; class inclusion tasks; category production tasks), and therefore do not constitute an adequate account of the general deficits.

A different account of the developmental findings is the perceptual argument implicit in Rosch's theory: that what increases with development is the ability to perceive less correlated clusters of features in the perceptual world. This is thought to underlie the increasing ability with age to categorize at the superordinate level. For basic level categories, many features are highly correlated with or are criterial for the category, and all of these bases are available for the child to use in categorizing at this level. For superordinate categories, in contrast, few features are correlated with the category, and consequently there are many more stimulus dimensions that must be ignored in sorting categorical items at this

level. Investigators who have worked within Rosch's model (e.g., Horton & Markman, 1980; Mervis & Crisafi, 1982) cite findings from traditional concept-learning experiments which have shown that adding irrelevant stimulus dimensions increases the difficulty for adults (Haygood & Stevenson, 1967; Walker & Bourne, 1961) and for children (Osler & Kofsky, 1965).

This account of development appears to be overstated, inasmuch, as noted by Nelson, Bruner, and Rosch herself, functional features are what are defining for superordinate categories, and thus the ability to detect less correlated perceptual structure would not effect processing of superordinate categories. Moreover, there are certain components of superordinate category knowledge, such as the class-inclusion component, that cannot be accounted for in terms of difficulties in detecting the similarity among the exemplars involved. Finally, as noted by Horton & Markman (1980), feature-detection does not appear to be the problem; rather, it resides in ability to use the features as a basis for classification or word extension.

A third developmental account that has been advanced is Piaget's argument that the ability to think in terms of classes and class inclusion relations is a result of the onset of the stage of concrete, reversible operations. Reversible operations are necessary for classifying because the child must coordinate the intension of a class with its extension. It is necessary for class inclusion because class addition and class subtraction must be coordinated in the course of solving a class inclusion problem (Inhelder & Piaget, 1964). However, as the results of Rosch's studies reveal, the difficulty for young

children is not in classifying according to a stable criterion: children readily do so when classifying at the basic level. Neither is it in executing addition-subtraction operations; as Markman and Siebert (1973) demonstrated, young children readily execute these operations on collections. It is the nature of the hierarchical structure upon which children are operating that makes the difference, not the operations themselves.

A fourth explanation of developmental differences, formulated by Bruner, Greenfield, and Olver (1966), argues that there is a developmental shift from an iconic to a symbolic mode of representation. Earlier in development, objects are encoded in terms of their perceptual attributes and later on, objects are encoded in terms of their functional attributes. Since superordinate categories are defined by functional features, preschool children would be expected to have difficulty representing such categories. These claims are contradicted by a great deal of developmental research indicating that preschool children do encode functional features of objects, even as early as the first word-learning period of development (e.g., Nelson, 1973; Nelson, Ross, Wetston, & Tanouye, 1985). Functional features are defining of basic level and superordinate concepts for preschool children as they are for older children and adults (Nelson, 1978). Several of the word association studies with preschool and young elementary school children have shown that children often respond in terms of functional features of objects, (Moran, 1966; Heidenheimer, 1978; Kyratzis et al., 1988). Thus, the lack of superordinate category knowledge that has been

demonstrated for young children cannot be attributed to their lack of ability to encode functional features.

Another dimension of cognitive change that has been posited is the "wholistic-to-analytic" shift. According to this approach, young children do not encode objects in terms of features but rather in terms of the part-whole relations into which they enter. This account is ruled out by findings showing that even infants classify objects according to features (Nelson, 1973; Ricciuti, 1965; Sugarman, 1981). With particular reference to superordinate categories, it has been well demonstrated that children encode the functional features underlying these categories (Nelson, 1978). It is in using these features as a basis for organizing objects together on cognitive tasks that the difficulty resides for preschool children, rather than in detection of the features.

Another developmental account is the schematic-to-taxonomic shift (Mandler, 1979). According to this account, there is a change in the types of knowledge structure represented by children at different ages. This account has been widely abandoned (Mandler, 1983), in light of evidence indicating that developmental differences are not as broadly defined as this model assumes. For example, the fact that preschool children represent certain types of taxonomic structures, such as basic level categories and slot-filler categories, rules out this account.

In summary, none of these accounts adequately explains the nature of the deficits in superordinate category knowledge that preschool children have been shown to have. In the next section, we

consider an additional model that views development in terms of an increasing ability of language to assume a mediational role in the categorization process.

Language-Cognition Interaction Models of Superordinate Category Formation

Developmental Language-Cognition Interaction Models Relevant to Superordinate Category Formation. As we saw in the previous sections, several accounts have been put forth to explain why young children do not utilize superordinate categories on cognitive tasks. None of these seemed to adequately account for what develops to enable the onset of superordinate categorization ability in school-aged children. There is one additional type of model of superordinate categorization that has not been reviewed previously. This model claims that language, in various forms and in various ways, facilitates or "mediates" superordinate categorization. Some proponents of this approach have considered the developmental implications of this claim, viewing category development as a changing ability of language to assume a "mediational" or regulatory role on the categorization process.

Vygotsky (1962) studied the role of language in concept formation. He had children of different ages learn the meanings of novel words, referring to classes of artificial, geometric stimuli, by giving them feedback as to the correct extension of the words. He observed that this type of extension feedback had a different effect on children's classifications at different ages. Prior to adolescence, words led children to unite diverse objects into complexive groupings, in which

objects were related to one another in terms of varying criteria. The power of the word in helping children abstract criteria and form generalizations was still not very great at this point, and children were still largely influenced by concrete connections among the objects. For older children, the extension feedback led children to single out common attributes among the extension objects, that is, served as a basis for discovering to which characteristics of the blocks the nonsense words refer. As soon as the words came to stand for kinds of objects designated by these criteria, the child could complete the task of separating the four kinds of blocks designated by the words.

The concept formation process culminated in the word guiding the synthesis of the abstracted features, and in their symbolization via the word. That is, even when children grouped objects according to unitary criteria, true concepts were not formed, and the task could not be completed, unless the word came to stand in for these criteria. At all developmental levels, "use of the word is an integral part of the developing processes (p. 81)", and served as the means of "actively centering attention, of abstracting certain traits, synthesizing them, and symbolizing them by a sign (p. 81)". The results of these experiments suggest that the role of words is very important in the process of concept formation. Moreover, they indicate that word meaning and the significative function of the word themselves develop, thus affecting the role of the word in the concept formation process.

While Vygotsky studied the role of language in concept formation,

other Soviet investigators studied the mediational role of language in object perception (Luria, 1961). For example, Ruzkaya had 3 to 7 year olds form differentiated reactions to two shapes, a quadrilateral and a triangle. They were to press a button with their right hand on seeing a triangle, and another with their left hand on seeing a square. She found that children had great difficulty developing completely generalized reactions to all triangles with one hand and all quadrilaterals with another. As soon as the experimenter offered a quadrilateral in the form of a rhombus or a trapezoid, the effect of acute angles was enough to cause the wrong reaction. Adding the figure's generalizing name (e.g., "quadrilateral") did not effect children's perception, which "remained as immediate and independent of speech as previously." Only in children aged 5 to 7 did speech begin to play a generalizing role, with perception of the figure being refracted through the generalizing function of the label. Thus, the influence of language on perception was found to be a late-occurring development.

The development of the ability of language to mediate object perception and enter into the process of object-generalization might be an important prerequisite of the ability to form superordinate categories. The reader might consider what is involved in forming a new superordinate. Potential exemplars would have to be conceptualized in terms of the feature or function designated by the superordinate. For example, in forming the category "food", children would have to perceive diverse items in terms of the function, "can be eaten". In other words, the superordinate function would have to be

generalized to diverse exemplars of the superordinate. If, as the Soviets claim, language embodies a generalizing function, and common reference to category instances generalizes their perception, then the extent to which one's perceptual processes are mediated by language could be an important determiner of the ability to form superordinates. The Soviets argue that the extent to which perception is mediated by language is limited in young children, and therefore this may account for superordinate utilization failure in young children.

Another way in which language mediates superordinate categorization has been suggested by Horton and Markman (1980). These researchers found that linguistic specification of category criteria (features) facilitated the extension of novel words designating artificially-constructed superordinate classes. This effect obtained for second graders but not for kindergarteners, and it obtained for superordinate words but not for basic level words. Horton and Markman reasoned that because exemplars of superordinate categories share few features in common, these features are difficult to detect and language is required in order to render them more salient. In other words, language may facilitate superordinate categorization through its highlighting function.

Horton and Markman claimed that younger children could not benefit from this potentially mediational function of language due to information processing constraints. They reasoned that in order to use the linguistic information effectively, children would have to evaluate each potential referent against a list of criteria. "This

systematic comparison of exemplars against a memorized list may strain the processing capacity of young children...(p. 717)."

Another account of what develops to account for the onset of superordinate categorization ability in school-aged children has been put forth by Nelson (1982; 1985). Nelson claims that an independent semantic system becomes differentiated from conceptual knowledge during the preschool years. According to this model, children's initial level of conceptual representation is in the form of event schemas. The spatial-temporal organization of these structures is thought to underlie young children's knowledge of the functional relations into which objects enter, and of the thematic relations existing between objects. Semantic structures, that is, structures that define relations between verbal referents, are thought to derive from cognitive analysis of this initial conceptual level.

Categorical structures, a type of semantic structure, are formed in the following way. Children abstract the paradigmatic relations existing among components of their event representations. An early form of paradigmatic relation to be abstracted is the relation existing among the different objects that alternatively occupy the same slot or action in an event structure across different occurrences of the same event. The abstraction of this relation is the basis for the establishment of the first categorical structures in semantic memory, slot-filler categories. Slot-filler categories are higher-order categories of objects that occupy the same slot or function in an event schema across different occurrences of an event and are contextually-restricted subsets of superordinate categories (e.g.,

foods that can be eaten for dinner; foods that can be eaten for lunch).

A later-occurring paradigmatic analysis of event knowledge consists of the abstraction of the relation existing among objects that occupy the same or similar functions in different event structures. The abstraction of this relation is the basis of the establishment of context-free, superordinate categories in semantic memory. A superordinate category is a category of objects that serve the same function in different event schemas (e.g., food; clothing). The abstraction of this relation is thought to represent a more difficult cognitive move than the abstraction of the relation underlying slot-filler categories, because it involves abstraction across diverse mental structures. Moreover, the same or a similar function in different event structures may not be recognized as such by the child.

For this reason, it is thought that this move necessitates linguistic mediation, in the form of the hierarchical-inclusion or "is-a" relation. Via this relation, the child subsumes all the slot-filler subsets for which a particular category term is the general term into a single unit with the general term applied to the entire, composite unit, thus yielding a context-free, superordinate category. The is-a relation, in effect, affords a combinatorial operation to be performed on conceptually discrete elements, the slot-filler categories. The different slot-filler sets are conceptually discrete because their role of sharing the same function in a single event structure carries greater psychological coherence for the young child

than the function uniting the objects of the entire superordinate.

According to this model, what enables language, in the form of the is-a relation, to have this facilitatory role around 7 to 8 years is that a new system of word meaning evolves during the preschool years to form a system separate from the conceptual system. In this system, termed the "semantic system", words are related to other words through abstract relations of similarity and contrast. Once this system is established, words can access perceptual images and conceptual contents, but also exist as free elements that can operate autonomously of conceptual contents and can recombine to produce novel conceptualizations. The semantic system, therefore, presents a new and potentially powerful tool of thinking in a de-contextualized mode that can establish its own contexts independent of the child's real-world experience. It has the advantage of not being embedded in conceptual structures such as event schemas that imply additional contingencies and thus constrain meaning. Rather, it is purely relational, consisting only of labels and relations such as "is a type of", "belongs to", "has", "is the opposite of". Thus, the possibility for manipulating such elements and constructing new rearrangements is greater.

One implication of the establishment of this "free-elements" system is the mastery of the "is-a" relation, which frees children's category knowledge from various entailments of the conceptual system. For example, "the 3-year old child may know that you wear coats and pajamas and may identify 'clothes' as things you wear, but still not include coats and pajamas in the clothing category because 'clothes'

refers in his or her conceptual system to those things you put on in the morning (p. 355)." The freeing of conceptual relations from perceptual and conceptual context allows the child to combine conceptually discrete items into a relational, composite structure, the superordinate category, and also allows the child to generalize the category in a way that is not dependent on his or her real-world, actual experience.

The Role of Children's Knowledge of Word Meaning Constraints on Superordinate Categorization. Nelson's model is a developmental account of superordinate categorization implicating the role of children's knowledge about word meaning relations. Recently, a new approach to the study of language learning and categorization has emerged that, like Nelson's model, implicates the role of children's knowledge about word meaning or sense relations, but that, unlike Nelson, is not a developmental model. This is constraints theory. Constraints are defined as "formal restrictions that limit the class of logically possible knowledge structures that can normally be used in a given cognitive domain. Constraints reduce such a class toward a limited class of naturally learnable concepts (Keil, 1980)."

Several word meaning constraints, that is, constraints that limit the class of logically possible word meanings, have been proposed. These are thought to be available to the child early and to even be innate, and are thought to render the word learning process more manageable for the child, because they limit the possible hypotheses that can be made about what novel words mean in ostensive

learning situations. An ostensive learning situation is one in which children hear words referring to objects but are given no information as to what the words mean, and thus have to infer their meaning from their extension. It should be noted at this point that the necessity for such constraints would be decreased in situations in which word meaning is explicitly stated to the child. However, in word meaning constraints theory, there is an implicit assumption that the word learning situation is basically an ostensive one.

Some of the constraints that are particularly relevant for the acquisition of superordinate word meaning are the Similarity Constraint, the One-Feature Constraint, the Mutual-Exclusivity Hypothesis, the Broad-Meaning Constraint on Hierarchical-Inclusive Word Meaning, the Contrastive Hypothesis, and the Basic Level Object Class Hypothesis. The Similarity Constraint is the hypothesis that words refer to similarity relations among referents, rather than to other types of relations that are possible (e.g., thematic relations) (Markman, 1984; Markman & Hutchinson, 1984; Waxman & Gelman, 1986). For example, a child who knows that the word "animal" applies to dog and cow (and who relies on this constraint) would extend the label to potential referents in accordance with whether they were similar to dogs and cows.

Evidence that preschoolers may have such a constraint comes from recent studies utilizing classification or match-to-sample procedures (Markman & Hutchinson, 1984; Waxman & Gelman, 1986). Typically, when preschool children are requested to match items on a forced-choice match-to-sample task ("find the one that is like this one") and the

choice is between a superordinate associate and a thematic associate of the standard, preschoolers choose the thematic associate because of the salience of such relations for young children (Smiley & Brown, 1979). However, when these children are instructed to choose the object that shares the same linguistic label as the standard (e.g., "find the other dax"), preschoolers choose the superordinate associate (Markman & Hutchinson, 1984). Markman and Hutchinson claim that this finding indicates that when children perceive that inductions about word meaning have to be made, they rely on similarity rather than thematic relations because they perceive a Similarity Constraint on word meaning. Similarly, Waxman & Gelman (1986) found that a Label Condition improved children's performance on a classification task involving superordinate categories over a No-Label Condition.

The facilitory effect of the Label Condition over the No-Label Condition obtained only for superordinate categories, and not for basic level categories, in both studies. This was thought to be because the similarity relations among exemplars of basic level categories is so salient that children readily utilize the relation on cognitive tasks, so that the intervention of word constraint knowledge is not necessary.

These theorists claim that the Similarity Constraint operates in a similar way when children are exposed to novel words in ostensive learning situations and have to deduce their meaning. Children are thought to maintain a representation of the initial set of referents of the novel word and extend the word to other objects that are similar to the original referents.

I am proposing an alternative to the Similarity Constraint, one that I think more closely approximates what the child would need to know in order to form a representation for a superordinate sufficient for appropriate extension. In order to form such a representation, children would need to single out what the basis of similarity among the first-encountered referents is. Since the similarity among referents of superordinate categories is difficult to detect, as a great deal of classification research with young children has indicated (e.g., Rosch et al., 1976), children would require an additional constraint specifying what the similarity among members of superordinate categories consists of. Consistent with the claim of many theorists that the basis of superordinate categories resides in one (or a few) broad, functional features, such a constraint would have to designate that superordinate word meaning refers to single features (or to small numbers of features). This constraint will henceforth be referred to as the One-Feature Constraint.

It is being proposed here that this constraint is necessary for learning superordinate, but not basic level, words. The members of basic level categories share many features in common, and their similarity is consequently readily detectible. For this reason, a further constraint designating what the "similarity" among members of basic level categories consists of is not necessary.

Another way of saying this is that we may be constrained by our perceptual and/or conceptual systems to view objects that share many features (i.e., basic level categories) as "similar" but are not constrained by these systems to view objects sharing only one feature

(i.e., superordinate categories) as "similar". It is language that confers similarity or sameness on groups of objects sharing only one feature, by calling them by the same name. Thus, the ability to perceive similarity at the superordinate level may depend on knowledge about language, (in the form of the One-Feature Constraint on superordinate word meaning), while the ability to perceive similarity at the basic level may not do so.

It is possible that children require even further constraints, in addition to the One-Feature Constraint, for superordinate word learning. Useful would be a constraint specifying what form the single, shared feature should take (e.g., that it should be a broad, functional feature). However, before this additional constraint could be invoked, children would first have to invoke the One-Feature Constraint.

If children had the One-Feature Constraint on superordinate word meaning, they would know that a novel word whose initial referents consisted of a set of widely dissimilar objects (as would be the case with superordinate words) refers to one feature, and that in order to deduce its meaning, they would have to abstract the one feature that was common to all of the initial referents, or acquire this information about a criterial feature in some other way (e.g., have it specified for them by someone already knowing the meaning of the word).

Another constraint that is thought to facilitate word learning at all levels, including the superordinate, is the Contrastive Hypothesis (Clark, 1983). This constraint posits that words contrast in meaning.

Knowledge of this constraint leads children to search for meanings of new words that are different from the meanings that they have designated for known words. This constraint is useful because it limits the degrees of freedom possible for new word meaning. If a feature or set of features is defining of an already-known word, the child knows that it cannot constitute the entire meaning of a new word.

Another important constraint that has been proposed is the Mutual Exclusivity Hypothesis or MEH (Clark, 1983; Markman, 1984). This constraint posits that any one referent can be designated by only one label at any one hierarchical level within a taxonomy. This constraint is thought to be especially facilitative of non-basic-level word learning. It can facilitate the perception that inductions about hierarchical or inclusive word meaning have to be made. When children have a basic level term for a particular referent (e.g., "dog") and hear a different word ("animal") applied to the same referent, the Mutual Exclusivity Hypothesis determines that "animal" cannot refer to the same intension as "dog" and must therefore refer to either a more inclusive or less inclusive level of the category structure to which dog belongs.

Markman (1984) claims that young children utilize an exaggerated form of the Mutual Exclusivity Hypothesis that actually inhibits superordinate word learning and extension. This exaggerated form designates that any one referent can have only one label; unlike the MEH, it does not allow for different words to designate different hierarchical levels of the same taxonomy. A child using this

exaggerated form of the MEH would treat "animal" in the example given above as an extraneous term and would not extend it to any potential referents.

Another constraint that may operate in superordinate word learning is the Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning. The operation of such a constraint is implied in recent research that has indicated a facilitory effect of hierarchical-inclusion statements on superordinate word learning (Callanan, 1985; Horton, Markman, & McLanahan, 1980). Inclusion statements are statements that refer to the hierarchical-inclusion relation that inheres between the basic and superordinate levels of a category (e.g., "a dog is a kind of animal"). Callanan (1985) and Markman, Horton, & McLanahan (1980) found that when novel superordinate words were defined ostensively for children using such statements (e.g., "This is a frog; a frog is a kind of amphibian"), young children were better able to learn and generalize the words.

Callanan (1985) claims that such statements help children learn superordinate words by indicating that broader-than-basic-level-meanings are called for. Although the mechanism by which inclusion statements may work is not spelled out by Callanan, it may be something as follows. Inclusion statements may help children perceive that inductions about hierarchical-inclusive, rather than basic level, word meaning have to be made, and children may have implicit knowledge that hierarchical-inclusive word meanings are broad. This implicit knowledge would be in the form of a Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning.

Inclusion statements, acting in concert with a reliance upon the Broad Meaning Constraint, increase the likelihood that children will arrive at a definition for a new superordinate word that is based on one or a small number of features. The Broad Meaning Constraint tells kids to look for similarity that is broadly defined, rather than being based on many shared features. Word meaning based on single features is a type of broad meaning. Even though there are other kinds, such as a prototype-based meaning (i.e., a best-exemplar representation that incorporates features that are shared by many, though not all, members of the category), inclusion statements may nonetheless increase the likelihood that children will utilize that particular kind.

Another working hypothesis of superordinate word meaning that young children may have is the Basic-Level Object Class Hypothesis. This hypothesis posits that superordinate words refer to specific basic-level object classes rather than to features or similarity relations. Consider the situation of a child learning that a set of discrete objects, cow, dog, and elephant are "animals". If the child invokes the Basic-Level Object Class Hypothesis, this may lead him to extend the term only to other members of the cow, dog, and elephant classes but not to other kinds of animals. As can readily be seen, this constraint would be inhibitory of superordinate word learning, because it would prevent the child from generalizing to the full set of basic object classes that compose the superordinate class.

All of these constraints constitute hypotheses that children may have about word meaning that are thought to have an impact on superordinate categorization. Certain claims are made, either

explicitly or implicitly, by constraint theorists, some of which have already been mentioned: (1) that the constraints may constitute an innate form of knowledge; (2) that they operate in ostensive learning situations; (3) that these constraints constitute working hypotheses that children deploy during the language-acquisition period of development; and (4) that if very young children fail to use constraints productively in forming new categories and extending new words, it is because of information processing capacity restrictions. These claims will be addressed in the present research.

In summary, three linguistic mediators of superordinate category formation have been proposed in or suggested by the literature: (1) linguistic specification of category criteria; (2) common descriptions of category instances that generalize the functions underlying the meanings of the superordinate words to its referents; and (3) word meaning constraint knowledge. It should be noted that there is a major difference between Mediators 1 and 2 on the one hand, and 3 on the other. Mediators 1 and 2 are linguistic mediators in the sense that they are verbalizations that are thought to facilitate category formation. According to Soviet mediation theory, they are signs that can be provided by members of the child's culture that can be internalized and used autonomously by children in guiding their object perception and categorization. In order for children to be able to make use of Mediators (1) and (2), they would have to have mastered the highlighting and generalizing functions of language, respectively. In contrast, the third type of mediator, word meaning constraints, is a linguistic mediator in a different way. Word meaning constraints

are not the type of mediator typically referred to in Soviet mediation theory, in that they are not themselves verbalizations, signs, or symbols. However, because they constitute knowledge about language, and therefore have to do with linguistic phenomena, and because they are also thought to mediate or facilitate category formation, they are being considered as linguistic mediators for the purposes of the present study.

The fact that two of the mediators involve having mastered mediational functions of language, while the third type involves having mastered knowledge of or rules about language, may have important developmental implications. This issue is one focus of the present research.

In the present research, the impact of the three linguistic mediators in the formation of superordinate categories is examined in children who are in the "transitional" period with respect to onset of ability to categorize at the superordinate level. This research contrasts with the previous research on language-cognition interaction models that was reviewed in this section in the following ways. First, in contrast to the Markman & Hutchinson (1984) and Waxman & Gelman (1983) studies, and to the studies reviewed in Luria (1961), the impact of language is examined in terms of superordinate category formation rather than in terms of superordinate category use. Second, in contrast to previous studies that have examined the impact of language on the formation of artificial, perceptually-based categories (e.g., Horton & Markman, 1980; Vygotsky, 1962), this research focuses on real, function-based, superordinate categories (e.g., gauges). The

categories used here are in keeping with the claim of several investigators (e.g., Bruner et al., 1966; Nelson, 1982; 1985; Rosch et al., 1976)) that superordinates, rather than being perceptually-based, are defined in terms of broad functional features. Moreover, the use of real categories may facilitate the detection of underlying features due to the greater psychological validity and conceptual coherence of the categories.

Purposes and General Procedure of Present Research

The purpose of the present research was to study the role of language in superordinate category formation and extension, and, more specifically, to study the role of the three types of linguistic mediator that were discussed in the previous section: (1) the role of linguistic specification of category criteria in highlighting superordinate functions and thus facilitating their detection in potential referents; (2) the role of common descriptions of category instances in generalizing the functions underlying the meanings of superordinate words to the instances; (3) the role of knowledge of word meaning constraints in learning and extending superordinate categories. The issue addressed was the question of whether language in any of these forms serves as a facilitator of the acquisition of superordinate categories.

A second purpose of the present research was to address the question of what develops during the early post-preschool period to account for the onset of ability to utilize superordinate categories on cognitive tasks. More specifically, the question of whether one or all of the above mediational functions of language develops during this period, was addressed.

In order to address these issues, two groups of children learned three novel, superordinate categories (gauges, fasteners, and accessories) under conditions varying the availability of two linguistic mediators, Basis Statements and Inclusion Statements, and had to generalize them to new objects. One group was comprised of children at the presumed age of "onset" of superordinate

categorization ability - first graders. The second group was comprised of children at the immediately preceding age - kindergarteners. The three functions that underlay the meanings of the three superordinates (measuring for the gauges category; attaching things together for the fasteners category; and making something better, like more pretty, more safe, or more fun, for the accessories category) were termed the "superordinate functions".

During the first (Learning) Session, each subject interacted with three exemplars of each of the categories in an arts-and-crafts activity (Activity Phase) and subsequently received intensive training in applying the superordinate labels to these objects (Trials-to-Criterion-Learning Phase). There were four learning conditions; these differed in terms of the availability of two linguistic mediators, Basis Statements and Inclusion Statements, during this session. Basis Statements were statements that defined the meaning of each superordinate word (e.g., "Gauges are things that measure"). Children in the Basis Condition heard such statements during the prelude statements and trials-to-criterion phase of the Learning Session (see Method Section for description of prelude statements). Children in the No-Basis Condition were not given such statements during these phases of the Learning Session and heard alternative statements (see Method section).

The availability of Basis Statements was varied in order to assess the role of linguistic specification of category criteria (i.e., Linguistic Mediator 1) and the role of knowledge of the One-Feature Constraint (Linguistic Mediator 3) on superordinate categorization.

As discussed in the previous section, it was reasoned that basis statements, by highlighting the superordinate functions, would facilitate their detection in potential referents. Also, as discussed in the previous section, it was reasoned that if children utilize the One-Feature Constraint at this age, then statements that establish the relationship between the superordinate functions and word meaning should enable children to utilize the superordinate functions as a basis for category extension.

Inclusion Statements were statements that referred to the hierarchical-inclusion relation that inhered between each training object and the superordinate term (e.g., "this [level] is a frap; a frap is a kind of gauge). Children in the Inclusion Condition heard such statements during the prelude statement, object-label statement, and trials-to-criterion phase of the Learning Session (see Method Section for description of prelude and object-label statements). Children in the No-Inclusion Condition were given alternative statements during these parts of the Learning Session. For these children, a basic level name for each training exemplar was not given, and thus, the hierarchical-inclusion relation inhering between the basic-level and superordinate labels could not be referred to. The statements heard by children in the No-Inclusion Condition were in the form "this [level] is a gauge".

The availability of Inclusion Statements was varied in order to assess the role of knowledge of the Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning in superordinate category learning and extension (Linguistic Mediator 3). As discussed in the previous

section, it is proposed that the involvement of hierarchical-inclusion relations may help children perceive that inductions about a specific kind of word meaning, hierarchical-inclusive word meaning, have to be made. If children utilize the Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning, this perception may enable them to utilize or come up with definitions for the superordinate words based on one feature.

It should be noted that the difference between the Inclusion and No-Inclusion conditions was not only the provision of the hierarchical-inclusion relation between terms; these conditions also differed in terms of the number of labels that were given for each training exemplar. The possible confound presented by this additional difference (i.e., that Inclusion children heard more labels and thus may have become more confused than No-Inclusion children) will be dealt with in the discussion of results.

In two sessions subsequent to the Learning Session, children had to generalize the superordinate words (e.g., "gauge") and the superordinate functions (e.g., measures), to two types of transfer objects, Hierarchical Generalization Objects and Non-Hierarchical Generalization Objects. Generalization sessions were the same for all children, regardless of Basis or Inclusion Condition. Each Generalization Session dealt with only one of the two types of generalization object, and the order of the two sessions (Hierarchical Generalization Session and Non-Hierarchical Generalization Session), was counterbalanced across subjects. Hierarchical Generalization Objects were objects for which children already knew the basic level

names (e.g., scale for the "gauge" category). Non-Hierarchical Generalization Objects were objects which were unfamiliar to children and for which they therefore did not know the basic level names (e.g., chalkline tool for the "gauge" category).

During each Generalization Session, the child interacted with 4 exemplars of each superordinate (and 4 foil objects) in an arts-and-crafts type activity (Activity Phase) and subsequently had to generalize the superordinate labels (Label Generalization Task) and superordinate functions (Function Generalization Task) designated by the categories to these objects. For example, on these tasks, the child would be required to generalize the appropriate superordinate label ("gauge") and appropriate superordinate function ("measures") to the generalization object, chalkline tool. Also, children had to sort pictures of the objects into their respective superordinate categories on a Sorting Task. Tasks were administered during the Test Phase of the Generalization Sessions.

Type of generalization object, hierarchical vs. non-hierarchical, was treated as a within-subjects factor. This factor was varied in order to assess the role of the Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning in superordinate category learning and extension (Linguistic Mediator 3). As discussed in the previous section, the involvement of hierarchical-inclusion relations may help children perceive that inductions about a specific kind of word meaning, hierarchical-inclusive word meaning, have to be made. Through their knowledge of the Broad Meaning Constraint, this perception may enable children to utilize definitions for the

superordinate words based on one feature.

The reader should note that this variable, in its proposed effect, is similar to Inclusion Statements. However, the situation of having to make inductions about hierarchical-inclusive word meaning is constituted in a different way by the two variables. In the case of Inclusion Statements, this situation is constituted explicitly, that is, through explicit reference to the hierarchical-inclusion relationship existing between the basic level and superordinate level. In the case of Type of Generalization Object, it is constituted implicitly, that is, in the object array itself. For example, in the case of Hierarchical Generalization Objects, the child knows the basic level name to each object and hears an additional name for it, such that the hierarchical-inclusion relation between levels is implicitly constituted.

It should be noted that there is a potential confound in the Type of Generalization Object variable, the relative familiarity of Hierarchical vs. Non-Hierarchical Transfer Objects. For example, children not only know the label for the Hierarchical Transfer Object, scale, but are also more familiar with its function, than they are, say, with the function of the Non-Hierarchical Transfer object, chalkline tool. The effect of this potential confound will be addressed in the discussion of results.

During the Activity Phase of each Generalization Session, the way in which the experimenter described the functions of the individual transfer objects to the child was varied. Half the objects for each session were related to the superordinate functions by the

experimenter via Experimenter-Provided Superordinate Function-Generalizing Statements. For example, the Experimenter-Provided Superordinate Function-Generalizing Statement for chalkline tool was "it measures where the exact middle is". This statement explicitly generalizes the superordinate function, "measuring", to the specific transfer object, chalkline tool. The other half of the transfer objects for each session were not related to the superordinate functions by the experimenter. These objects were referred to via Non-Generalizing Statements. For example, the Non-Generalizing Statement for chalkline tool was "it tells you where the exact middle is". Non-generalizing statements did not generalize the superordinate functions (e.g., measuring) to the individual transfer objects.

The availability of Experimenter-Provided Function-Generalizing Statements was varied in order to examine the effect of common descriptions of category instances (Linguistic Mediator 2) on the ability to generalize the superordinate functions to the category instances, and to examine whether children could invoke their own generalizing mediators for each object. In Vygotsky's mediation theory, it is proposed that one aspect of mediated thought that develops is that children become increasingly able to invoke and construct their own mediators with age (Vygotsky, 1978). Therefore, one potential cause of young children's inability to generalize superordinate categories may be that they are not able to invoke or construct a generalizing mediator for potential referents of the categories. For example, they may not be able to invoke a generalizing description for chalkline tool that represents the

function of this object in terms of the superordinate function, measuring. This hypothesis is examined here through contrasting the situation in which such generalizing descriptions are already provided for children (by the experimenter) to one in which they are not provided and children have to invoke them spontaneously.

In summary, the variables in the present study related to the three linguistic mediators of superordinate categorization that were proposed in the previous section in the following ways. The Basis Condition variable was a test of Linguistic Mediators 1 and 3; the Inclusion Condition variable and Type of Generalization Object variable were tests of Linguistic Mediator 3; and the availability of Experimenter-Provided Function-Generalizing Statements was a test of Linguistic Mediator 2.

The design, tasks, and measures of the present study are presented schematically in the figures below.

Figure 1: Design

	<u>Condition</u>			
	Basis		No-Basis	
	Inclusion	No-Inclusion	Inclusion	No-Inclusion
Kindergarten	5 boys 5 girls	5 boys 5 girls	5 boys 5 girls	5 boys 5 girls
1st Grade	5 boys 5 girls	5 boys 5 girls	5 boys 5 girls	5 boys 5 girls

Figure 2: Tasks and Measures

<u>Session</u>	Learning	Hierarchical Generalization	Non-Hierarchical Generalization
<u>Tasks</u>	Trials-to-Criterion for Labels	Label Generalization	Label Generalization
	Trials-to-Criterion for Bases (for Basis Condition Only)	Function Generalization	Function Generalization
		Sorting	Sorting
<u>Measures</u>	Learning Score	Label Generalization Score	Label Generalization Score
	Trials-to-Criterion for Bases Score	Function Generalization Score	Function Generalization Score
		Sorting Score	Sorting Score

Predictions for Present Research

Hypotheses Pertaining to the Role of Language in Object Perception and Generalization of Superordinate Functions to Category Exemplars

A. The Role of Basis Statements. It is predicted that language, in the form of Basis Statements, will facilitate children's generalization of the superordinate functions (e.g., measuring, attaching things together) to the transfer objects on the two Function Generalization Tasks. By highlighting the superordinate functions, Basis Statements will help children detect these functions in individual transfer objects on these tasks.

(1) Therefore, children's Function-Generalization Scores will be higher in the Basis Condition than in the No-Basis Condition.

B. The Role of Experimenter-Provided Superordinate Function-Generalizing Statements. It is expected that language, in the form of Experimenter-Provided Superordinate Function-Generalizing Statements, will facilitate children's generalization of the superordinate functions to the transfer objects on the two Function Generalization Tasks. These statements provide a mediator that generalizes each transfer object to the appropriate superordinate function, (e.g., as when the statement "it measures where the exact middle is" generalizes the function "measures" to the individual transfer object, chalkline tool) and eliminates the necessity for children to invoke their own generalizing mediators.

(2) Therefore, Function-Generalization Scores will be higher for

Experimenter-Generalized Objects than for Non-Generalized Objects.

Hypotheses Pertaining to the Role of Word Constraint Knowledge

C. The Role of the One-Feature Constraint on Superordinate Word Meaning. It is being argued here that knowledge about word meaning, in the form of knowledge that one feature (or function) underlies superordinate word meaning, mediates superordinate word learning and generalization. To the extent that children have this knowledge, have abstracted the feature or function that is shared by a group of objects, know that the feature is a word meaning basis, and appropriately generalize the feature to potential extension items, they will generalize the superordinate label appropriately. When the sense of the constraint is very strong, children will be able to deduce that the feature is a word meaning basis from object-label pairings that were made by the experimenter during the Learning Session (i.e., ostensibly). When the sense of the constraint exists but is not very strong, the link between the label and the feature will have to be made explicit, as through Basis Statements. Such statements establish a link between a feature (function) and a word, thus presenting the feature as a basis for word meaning.

It is expected that most children in the age range being studied will possess, at best, the weaker form of the constraint, and will therefore require Basis Statements in order to generalize the superordinate labels on the Label Generalization tasks. Moreover, it is expected that even when children appropriately generalize the superordinate functions (e.g., measuring; attaching things together)

to potential extension items, they may still be unable to generalize the appropriate superordinate labels to these objects, due either to: (i) lack of the link between the function and word meaning having been made explicit through Basis Statements, such as is the case in the No-Basis Condition; (ii) lack of knowledge of the One-Feature Constraint, which is expected to be the case for most kindergarteners.

These expectations map onto the following hypotheses:

(3) Label Generalization Task scores will be significantly higher in the Basis Condition than in the No-Basis Condition. That is, there will be a main effect of Basis condition on superordinate label generalization.

(4) Moreover, a Grade X Basis Condition interaction is predicted, such that the Basis-Condition difference on the Label Generalization Scores will only be significant for first graders. This prediction is based on the claim that kindergarteners lack productive knowledge of the One-Feature Constraint. Only for children who have productive knowledge of the One-Feature Constraint (i.e., first graders) will statements that relate the superordinate functions to word meaning facilitate superordinate word extension.

(5) Function Generalization Task scores will exceed Label Generalization Task scores. More specifically, the proportion of transfer objects to which children appropriately generalize the superordinate functions that are also objects to which children appropriately generalize the superordinate labels will be less than 1.

(6) This proportion will be much lower in kindergarteners than first graders.

(7) Function Generalization Scores will correlate with Label-Generalization Scores only in the Basis Condition. That is, only when children understand the role of the superordinate function in underlying word meaning (as most children here will only do in the Basis Condition), will they be able to utilize information that individual objects embody the function in generalizing the superordinate labels.

(8) Finally, it is proposed that kindergarteners, children in the "transitional" phase of superordinate category knowledge development, will have a non-productive level of knowledge of the One-Feature Constraint. This level of knowledge will be manifested in the following way. Children will be able to refer to the superordinate functions as justifications for the superordinate labels (subjects were required to justify the labels they had extended to six of the objects on each Label Generalization Task; see Method Section for description of Justification Tasks) even though they will not be able to use the superordinate functions correctly in superordinate label extension (i.e., on the Label Generalization Tasks). In contrast, it is expected that first graders will respond correctly on both tasks, Justification and Label Generalization.

(D) The Role of the Basic Level Object Class Hypothesis and the Exaggerated Form of the MEH. Knowledge of other word meaning constraints, the Basic Level Object Class Hypothesis, and the exaggerated form of the Mutual Exclusivity Hypothesis, are expected to have an impact on superordinate label generalization as follows.

(9) On the basis of the claim that young children harbor the

Basic Level Object Class Hypothesis, it is predicted that children will evidence high rates of "none-of-those-things" responses on the Label Generalization Tasks (see Method Section for a description of these responses). Moreover,

(10) A Grade effect is predicted on the rate of "None-of-Those-Things" Responses - kindergarteners will give more "None-of-Those-Things" Responses than first-graders.

(11) On the basis of the claim that young children harbor the exaggerated form of the Mutual Exclusivity Constraint, it is predicted that children will evidence higher rates of "None-of-Those-Things" Responses on the Hierarchical Label Generalization Task than on the Non-Hierarchical Label Generalization Task.

(12) Moreover, a Grade by Generalization Type interaction is predicted in that the inflationary effect of Hierarchical Generalization Objects on "None-of-Those-Things Responses" will be greater for kindergarteners than first graders.

(E) The Role of the Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning.

13) On the basis of the claim that inclusion information, through children's knowledge of the Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning, constrains broader word meaning (Callanan 1985; Markman, Horton, & McLanahan 1980) , and through so doing possibly enhances use of word meaning based on one feature, it is predicted that performance on the Label Generalization Tasks in the Inclusion Conditions will exceed performance in the No-Inclusion

Conditions.

(14) Moreover, a Basis Condition X Inclusion Condition interaction is predicted, such that the facilitory effect of inclusion information on performance on the Label Generalization Tasks will be greater in the Basis Condition than in the No-Basis Condition. The Basis Condition is the condition that will more likely involve word meaning based on the superordinate functions, and since inclusion information is thought to enhance use of word meaning based on one feature, it should be more effective in this condition.

(15) The Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning, by enhancing children's use of word meaning based on one feature, may counter the effects of the Basic Level Object Class Hypothesis. On the basis of this claim, it is predicted that levels of "None-of-Those-Things" responses will be lower in the Inclusion Condition than in the No-Inclusion Condition on the Label-Generalization Tasks.

(16) On the basis of the claim that increasing children's sense that inductions about hierarchical-inclusive word meaning have to be made constrains broad word meaning or word meaning based on one feature, (again, this is through their knowledge of the Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning), it is expected that the implicit constitution of hierarchical-inclusion relations in the Hierarchical Transfer Objects will enhance use of word meaning based on the superordinate functions, and consequently, will improve superordinate word learning and extension. (The reader should recall that hierarchical-inclusion relations are implicitly constituted in

the Hierarchical Transfer Objects). More specifically, an interaction between Generalization Type and Basis Condition is predicted, such that performance on the Hierarchical Label Generalization Task will exceed performance on the Non-Hierarchical Label-Generalization Task in the Basis Condition. It is in this condition that word meaning based on the superordinate functions is more likely to be being used.

Hypothesis Pertaining to the Effect of Language on Non-Linguistic Superordinate Categorization (Classification)

(17) On the basis of the claim that word constraint knowledge, especially the One-Feature Constraint on Word Meaning, mediates superordinate category formation and extension, it is predicted that the children who are better word-generalizers (i.e., perform better on the Label Generalization Tasks) will be the ones who are better sorters (i.e., perform better on the Sorting Tasks). Therefore, a correlation between performance on the two tasks is expected.

Method

Subjects

Forty kindergarteners and 40 first graders, with an equal number of boys and girls at each age, participated. Children attended various public and private elementary schools in the New York City area, representing a mixed socio-economic population. In an attempt to limit the range of linguistic and metalinguistic skills represented in the subject population, only monolingual English speakers were included in the sample.

First graders were included because they represent the earliest demonstrated age of ability to utilize superordinate categories (Nelson, 1969). Kindergarteners were included because they represent children who are "transitional" with respect to acquiring superordinate categorization ability.

Four groups were formed at each age. Each group represented a different linguistic mediation condition, constituted by one of the two values of each of the following variables, Basis Condition (Basis, No-Basis), and Inclusion Condition (Inclusion, No-Inclusion). The four groups were: No-Inclusion, No-Basis; Inclusion, No-Basis; No-Inclusion, Basis; and Inclusion, Basis.

Design

The design of the study was a 2 (Grade) X 2 (Inclusion Condition) X 2 (Basis Condition) X 2 (Generalization Object Type) X 2 (Generalization Status) Repeated Measures Analysis of Variance with Generalization Object Type (Hierarchical vs. Non-Hierarchical) and

Generalization Status (Experimenter-Generalized vs. Non-Generalized) treated as the trials (within-group) factors. Grade, Inclusion Condition, and Basis Condition were the between-groups factors.

Learning Session Procedure

Subjects were seen individually. Prior to participating in the Activity Phase, which involved a woodworking activity consisting of assembling a wagon, children were read a Prelude Statement. The Prelude Statement alerted children to the fact that they would be learning about three new things, gauges, daxes and fids. ("Daxes" was an artificial label designated for fasteners; "fids" was an artificial label for accessories; "gauges" designated measuring things). The Prelude Statements were different for each of the four Linguistic Mediation Conditions and varied in terms of whether they included Basis and Inclusion Statements (see Purposes and General Procedure Section for a description of Basis and Inclusion Statements). The Prelude Statements for each of the four conditions are given in Appendix A.

Then followed the Activity Phase, during which the experimenter and child went through a 12-step wagon-building activity. During this activity, the child was given the opportunity to interact with each of the training objects. Each step corresponded to one of the 12 training objects. The training objects were as follows: there were 3 exemplars of each of the three superordinate categories and 3 foils (see Appendix B for a complete listing of the training objects). The activity included such actions as: measuring out lines to show where holes go on the bottom of the wagon for the wheels (surface gauge);

drilling the holes (brace); attaching the side pieces to the bottom piece (dowels); measuring to see if the sides were on straight (level); adding something to make the wagon more fun (glides, as make-believe "head-lights"); attaching the corners of the wagon together (corrugated faster); and adding something to make the wagon look more pretty (numbers).

As each training object was used, the Experimenter provided the following types of information about it: the name of the act or step in the sequence that they dyad was up to (Part of Event Statement); an object label statement; and a specific function statement. The object label statement named the object for the child and varied depending on whether the Linguistic Mediation Condition was Inclusion or No-Inclusion. The specific function statement described the specific function of the training object. Specific Function Statements were in the form of Experimenter-Provided Superordinate Function-Generalizing Statements (see section on Generalization Session Procedure). That is, they related the specific function of the object to the general function of its corresponding superordinate category (e.g., the dowel was described in terms of the function of fasteners, "holding things together"). Part-of-event statements, object-label statements, and specific-function statements are exemplified below for the training object, surface gauge.

(Part of Event Statement)

We have to find where the holes go on the bottom for the wheels.

(Object Label Statement for No-Inclusion Condition)	We need to use this. It's a guage.
(Object Label Statement for Inclusion Condition)	We need to use this. It's a sug. A sug is a kind of gauge.
(Specific Function Statement)	It measures out lines that have the right number of inches.

Following the Activity Phase of the Learning Session, (which lasted 30 minutes), each subject received intensive training in the superordinate labels (and, in case of children in the Basis Condition, in the superordinate definitions) during the Trials-to-Criterion Learning Phase. This phase was composed of two sub-parts or tasks, the trials-to-criterion-for-labels task, and the trials-to-criterion-for-bases task. For the trials-to-criterion-for-labels task, each child went through 12 (or fewer) label-trials. During each "label-trial", children viewed photographs of each of the training objects. (Actually, they viewed 10 of the 12 training objects. During each label-trial, all 3 exemplars of each superordinate but only one of the three foil items were viewed by the child). Children were asked to name each object. In the No-Inclusion Condition, they were asked to say whether it was "a gauge, dax, fid, or none-of-those-things". In

the Inclusion Condition, children were given an artificial, basic-level label for each training object (e.g., "this [level] is a frap") and were asked to say whether it was "a kind of gauge, dax, fid, or none-of-those-things."

Children in the Basis Conditions also participated in a trials-to-criterion-for-bases task, which was administered intermittently with the trials-to-criterion-for-labels task. That is, after each basis-trial (see below), children were administered a label-trial. This task was composed of 12 (or fewer) basis-trials. During each basis-trial, children were requested to give the meaning of each of the three superordinate terms. Children in the No-Basis Condition participated in control-trials, during which they were requested to reiterate the three superordinate words ("What are the three things we're learning about again?") Control-trials were included so that children in the No-Basis Condition received as much exposure to the superordinate labels as children in the Basis Condition received during the trials-to-criterion-for-bases task.

The number of objects that were correctly named during each label-trial, and the number of superordinate terms that were correctly defined during each basis-trial, were recorded for each child. Criterion was defined as getting the superordinate labels for all 10 training objects correct in two consecutive label-trials. Children went through trials until either criterion was reached or a total of 12 label-trials had been presented.

Procedure for Generalization Sessions

There were two generalization sessions, each corresponding to one

of the two types of generalization object, hierarchical and non-hierarchical. The order of the two generalization sessions was counterbalanced across children. The first generalization session was spaced between 2 and 5 days after the learning session and the second generalization session was spaced between 2 and 5 days after the first generalization session.

The Non-Hierarchical Generalization Session involved an Activity Phase and a Test Phase. Each phase lasted about 40 minutes. During the Activity Phase, children used the generalization objects in a leatherworking activity during which they assembled a shoulder bag, working together with the experimenter. During this phase, children were given the opportunity to use and interact with each generalization object. The assembling activity involved 16 steps; each step corresponded to one of the generalization objects. The steps involved such actions as: measuring out a line to show where the middle of the strap was (chalkline tool); punching holes on this line (hole punch); attaching two pieces of leather together on the end of the strap to hold a dee ring (rivet); measuring whether the edge of the sidepiece was straight or not (t-bevel); putting on a clasp and seeing how it works (clasp); adding an Indian claw to the bag to make it more fun (Indian claw); adding corners to the bag to make it more safe (corners) and attaching the strap to the bag (swivel snap).

As each object was used, the experimenter named it (i.e., gave it an artificial basic level name) and described its function. As described in the section on Purposes and General Procedure, half of the generalization objects for each session (Experimenter-Generalized

Objects) were described in terms of Experimenter-Provided Superordinate Function-Generalizing Statements. These described the functions of each object in terms of the general function corresponding to the superordinate category to which the object belonged. For example, the Experimenter-Provided Superordinate Function-Generalizing Statement for the generalization object, chalkline tools, was "it measures where the middle of the strap is". The other half of the objects (Non-Generalized Objects) were described in terms of Non-Generalizing Statements. These statements did not relate the specific functions of the objects to the superordinate functions. For example, the Non-Generalizing Statement for chalkline tool was "it marks a line to show where the middle of the strap is". Whether each generalization object was described in terms of an Experimenter-Provided Superordinate Function-Generalizing Statement or in terms of a Non-Generalizing Statement was counterbalanced across the subjects in each linguistic mediation condition.

After the experimenter described each object to the child as it was used in the activity, the child was asked to repeat the experimenter's description.

The Hierarchical Generalization Session had no Activity Phase, because objects were already familiar to children. Therefore, children did not have to interact with the objects in order to learn their functions. Instead of an Activity Phase, and in order to control for exposure to reference to the functions of these objects by the experimenter, experimenter and child went through photographs of the

objects and the experimenter asked the child to name each object and describe its function. After the child described the function of each object, the experimenter re-described it. As in the Non-Hierarchical Generalization Session, the experimenter described half of the generalization objects in terms of Experimenter-Provided Superordinate Function-Generalizing Statements and described the other half in terms of Non-Generalizing Statements. After the experimenter re-described the function of each object, the child was asked to repeat the experimenter's description.

The Test Phases of both Generalization sessions were the same. During this phase, children were administered the following tasks: Sorting, Label-Generalization, Justification, and Function-Generalization, in that order.

Stimuli

Learning and generalization objects were objects from three superordinate categories, gauges (measuring devices), accessories, and fasteners. "Superordinate categories" were defined in the present study as defined by Rosch (1979). Superordinate terms were terms that subsumed at least five other terms in common usage in the English language, (i.e., "common terms" were defined as terms with a word frequency of 10 or greater from the Kucera and Francis [1967] sample of written English). In other words, superordinate terms were terms that subsumed objects we commonly label at a lower level of specificity. Thus, "gauge" is a superordinate category because it subsumes ruler, scale, thermometer, etc., all terms in common usage in

the English language. "Thermometer", on the other hand, is not a superordinate term because the terms that it subsumes (e.g., baby thermometer; oral thermometer) are not terms in common usage in the English language.

Eleven exemplars of each of these categories was used in the experiment. Three were used as training objects in the Learning Session, four were used as Hierarchical Generalization Objects in the Hierarchical Generalization Session, and four were used as Non-Hierarchical Generalization Objects in the Non-Hierarchical Generalization Session. The exemplars used in the Learning and Non-Hierarchical Generalization Sessions were obscure objects that were unfamiliar to children of this age (e.g., surface gauge; contour pattern gauge; divider). The exemplars used in the Hierarchical Generalization Session were common objects that were familiar to children (e.g., clock; scale; thermometer). In addition, there were eleven foil objects, that is, objects that were not members of any of the three superordinates. Three of these were used in the Learning Session and four of them were used in each of the Generalization Sessions (see Appendix B for complete listing of all training and generalization objects).

The actual objects were used in the Activity Phases of the Learning and Non-Hierarchical Generalization sessions. Color photographic representations (3 1/2 in. X 5 in.) of the objects were used during the trials-to-criterion phase of the Learning Session, the Test Phases of both Generalization Sessions, and during the control phase of the Hierarchical Generalization Session.

Tasks and Measures

Learning Measure. The learning measure was based on the number of training objects that children learned the superordinate labels to during the trials-to-criterion-for-labels task. How learning was scored is described in the Results Section.

Label-Generalization Tasks. These tasks were administered during the test phases of each of the Generalization Sessions. Children viewed photographs of the 16 generalization objects that had been used during the Activity Phase of the session (4 exemplars of each of the three superordinates plus 4 foils). They were requested to specify the superordinate names of the objects. The specific instructions were: "For each one, tell me if it's a guage, dax, fid, or none-of-those things." Children went through the pictures twice. A photograph was counted as correctly labelled only if the child labelled it correctly both times. The Label Generalization Score for each session consisted of the number of items out of the total of 16 that were correctly labelled.

Justification Tasks. A justification task succeeded each Label Generalization Task. For this task, children were asked to justify the label they had applied to six of the 16 generalization objects for the session. The specific instructions were: "You said that this was a dax. That was right! But why is it a dax?"

Which of each child's responses on the Label Generalization Task were subsequently queried on the Justification Task varied across children. An attempt was made to query three correct and three

incorrect responses for each child. If this criterion could not be met (because children had either too many or too few correct responses on the Label Generalization Task), then which responses were queried was selected at random. Despite the fact that different responses were queried across children, and that some children were queried about more correct responses than incorrect responses, while others were queried about more incorrect than correct responses, this could not have affected performance on this task because, as can be seen below, justification responses were coded independently of whether the object had been labelled correctly on the Label Generalization Task.

Justifications were coded as correct if children designated one of the three superordinate functions as the justification for their label (e.g., it's a dax because it holds things together; it's a gauge because it measures), regardless of whether the function given was the one designated by the correct label to the queried object. The Justification Score for each session was the number of queried items, out of 6, that were correctly justified.

Function-Generalization Tasks. The Function-Generalization Task succeeded the Label Generalization Task in each Generalization Session. Here, children were requested to specify the functions of the 16 generalization objects for the session. The specific instruction was, "For each one tell me what it does. Tell me, what does it do?"

Responses were coded into two categories, Generalized and Not-Generalized. "Generalized" meant that the child had generalized the correct superordinate function (measuring; holding or attaching things

together; making something better, like more pretty, more safe, more fun) to the object. "Non-Generalized" meant that the child had not extended the superordinate function to the object, but had described the object in terms of a different, more specific function (e.g., the zipper "zips up your coat"; the divider "makes lines") or in terms of an incorrect function (e.g., the pliers "measure").

The Function-Generalization Score for each Generalization Session was the number of objects out of the total of 16 that were "Generalized".

Sorting Task. This task was administered prior to the Label Generalization Task in each session.

Children were required to sort objects into 4 envelopes. One envelope corresponded to each of the three superordinates, which was placed over it. There was also an extra envelope that did not correspond to any of the three superordinates. Children were instructed as follows: "Put all the pictures in the envelope where they belong. Put all the ones that go together with this one in this envelope. Put all the ones that go together with this one in this envelope. Put all the ones that go together with this one in this envelope. If there are any pictures that don't go together with this one or this one or this one (E pointed to the marker for each envelope in turn), then put it in this envelope (E pointed to the extra envelope). This envelope is for left-over things."

The Sorting Score for each Generalization Session consisted of the number of objects that were incorrectly sorted into the envelopes out of a total of 13 (16 minus the three "marker" pictures).

Results

Superordinate Word Learning

Superordinate word learning was assessed by computing the number of objects out of the total of 9 training objects that were learned on the Learning Session Task. The subject was coded as having learned all 9 objects if he or she labelled all 9 objects correctly on two consecutive trials. If the subject did not reach this criterion after 12 trials, then for any single object to have been counted as having been learned, it would have to have been labelled correctly in the last three trials. Moreover, the object would only be counted if the child did not have an exaggerated propensity to label all objects by its corresponding superordinate label in the last three trials, that is, if the child's probability of labelling any given item three consecutive times by that label, given the child's overall use of the label in the last three trials, was $< .05$. Mean learning scores for each grade, inclusion condition, and basis condition are presented in Table 1.

Mean learning scores for each group were entered into a 2 (Grade) X 2 (Inclusion Condition) X 2 (Basis Condition) Analysis of Variance. There were main effects of grade, $F(1,72) = 16.48$, $p < .05$, and Inclusion Condition, $F(1,72) = 4.34$, $p < .05$, and no significant interactions. First graders learned the superordinate labels to more objects than kindergartners, and inclusion information decreased the number of objects to which superordinate labels were learned.

Thirty kindergartners and 36 first graders learned the superordinate label to at least one object. This meant that many children had at least a one-exemplar representation for at least one of the superordinates being trained. If generalization proceeds through matching potential extension items to an already-represented exemplar, then 70% of children had the basis for such generalization. However, it has been argued in the literature that in order to be able to generalize superordinates, the child must possess a multi-exemplar representation, and must submit this to cognitive-feature analysis. Therefore, the frequency with which subjects formed multi-exemplar representations for the to-be-trained superordinates was also examined.

Table 2 presents the average number of categories with at least two exemplars by grade, inclusion condition, and basis condition. Twenty-one kindergartners, and thirty-one first graders, formed a multi-exemplar representation for at least one of the superordinates. If this is an important prerequisite for generalization, then sixty-five percent of subjects were in possession of this prerequisite and should have generalized. However, it should be noted at this point that it was possible for children to generalize the superordinates without first having formed a multi-exemplar representation of the category. This was indicated by the fact that 9 of 29 , or 31%, of subjects who generalized the superordinates had not formed multi-exemplar representations of them during the Learning Session.

Summary. Two criteria for whether children had learned the to-be-trained superordinates were examined. Seventy percent of subjects

met the one-exemplar criterion and sixty-five percent met the multi-exemplar criterion. The number of training exemplars to which children learned the superordinate labels was influenced by the grade level of the child and by whether or not inclusion information had been given. The presence of inclusion information depressed superordinate word learning.

Superordinate Label Generalization

Children's Label Generalization Task scores were a measure of the extent to which they could generalize the three superordinate labels, "gauge", "dax", and "fid", to the 16 generalization objects on each Label Generalization Task. There were two label generalization tasks (and consequently, two label generalization scores), hierarchical and non-hierarchical, each corresponding to one of the two types of generalization object. The highest possible score on each task was 16.

The means of the scores are listed by Grade, Inclusion Condition, and Basis Condition, and Generalization Object Type in Table 3. These scores were entered into a 2 (Grade) X 2 (Inclusion Condition) X 2 (Basis Condition) X 2 (Generalization Object Type) Repeated Measures Analysis of Variance in which generalization type (hierarchical or non-hierarchical) was treated as a trials factor. There was a main effect of Grade, $F(1,72) = 16.32, p < .001$, with first graders' generalization scores exceeding kindergartners'. There was a main effect of Basis Condition, $F(1,72) = 20.20, p < .001$. Generalization performance in the Basis Conditions exceeded that in the No-Basis Conditions. There was also a main effect of generalization object

type, $F(1,72) = 3.11$, $p < .05$, with label generalization to hierarchical generalization objects exceeding label generalization to non-hierarchical generalization objects.

The following interactions were significant: Grade X Basis Condition, $F(1,72) = 187.06$, $p < .001$, Basis Condition X Generalization Object Type, $F(1,72) = 7.14$, $p < .01$, and Generalization Object Type X Grade X Inclusion Condition X Basis Condition, $F(1,72) = 6.10$, $p < .05$.

The Grade X Basis Condition relation was examined through use of an a priori test, since it was an a priori hypothesis that the basis condition difference would be significant at the first grade level but not at the kindergarten level. Two 2 (Basis Condition) X 2 (Grade) Repeated Measures Anovas were conducted, one at each grade level. As predicted, the Basis Condition difference was significant at the first grade level, $F(1,38) = 22.95$, $p < .001$, but not at the kindergarten level, $F(1,38) = 1.44$.

The Basis Condition X Generalization Object Type interaction was also examined via an apriori test, since it was an apriori hypothesis that generalizing labels to hierarchical objects would be more likely to involve use of the superordinate functions than generalizing labels to non-hierarchical objects. Four 2 (Generalization Object Type) Repeated Measures Anovas were conducted, one for kindergartners in the Basis Condition, one for kindergartners in the No-Basis Condition, one for first graders in the Basis Condition, and one for kindergartners in the No-Basis condition. The trials factor, Generalization Object Type, was significant only in the Basis Condition, as predicted, and

only for kindergartners, $F(1,19) = 7.12$, $p < .01$ in the one-tailed test. This finding indicates that when hierarchical-inclusion relations are constituted in the set of potential referents of superordinate terms, this facilitates generalization based on single functions or features for kindergartners.

The other interactions were tested via Newman-Keuls post-hoc tests. The effect of Grade level was significant, at the .01 level, in the Basis Condition and not in the No-Basis Condition. First graders exceeded kindergartners in label generalization only in the situation of having been given basis information. Even though kindergartners in general did not benefit from basis information, there was one situation in which they did benefit (and this was significant at the .01 level); in the context of generalizing labels to hierarchical transfer objects in the Inclusion Condition. Thus, basis information could benefit kindergartners only when reinforced by inclusion information and the implicit constitution of hierarchical-inclusion relations in the extension objects .

There were significant Inclusion Condition differences at the .05 level - kindergartners were less able to generalize non-hierarchical transfer objects in the Inclusion Condition, and first graders were less able to generalize hierarchical transfer objects in the Inclusion Condition. This inclusion condition difference occurred only in the No-Basis Condition. Thus, in the No-Basis Condition, inclusion information could be inhibitory of superordinate label extension.

The Non-Hierarchical and Hierarchical Generalization Task Scores just discussed, as overall test scores, give little information as to

whether children were able to generalize individual superordinate words. Therefore, a second measure of superordinate label generalization, the total number of superordinate words which were generalized, was computed for each child. This score was based on a differentiation score that was computed for each superordinate for each child. The differentiation score for each superordinate was the difference between the number of objects out of the test set to which the label for the superordinate was correctly generalized minus the number of objects to which the label was incorrectly generalized. Since there were four exemplars of each superordinate in the test set, the highest score was a 4. Since there were 12 non-exemplars of each superordinate, the lowest score was a -12. A differentiation score of +1 meant that the child could generalize the label to at least one correct exemplar while excluding all non-exemplars, indicating some ability to discriminate correct from incorrect extension items, and was thus adopted as the criterion for whether children were able to generalize the superordinate.

The average number of superordinate labels that were generalized are presented in Table 4 by Grade, Inclusion Condition, and Basis Condition. Only 3 of the 20 kindergartners in the No-Basis Condition, and only 5 of the first-graders, could generalize even one of the superordinate words. Five of the 20 kindergartners in the Basis Condition, and 16 of the 20 first-graders, could generalize at least one superordinate word. These results, consistent with the overall Label Generalization Task Scores discussed above, suggest that label generalization was very poor at both grade levels in the No-Basis

Condition. In contrast, in the Basis Condition, first graders readily generalized superordinate words. Even in this condition, however, few kindergartners were able to generalize superordinate words.

Summary. The results on superordinate label generalization indicate that basis information was facilitory for first graders in generalizing superordinate words, and that in its absence, very few (only 25%) subjects could generalize. Basis information was generally not facilitory for kindergartners, except in the condition of having to generalize the labels to hierarchical generalization items in the presence of inclusion information. This suggests that kindergartners need a lot of support for use of basis information, namely, inclusion information and the involvement of hierarchical-inclusion relations. Generalization is so difficult in the No-Basis Condition that first-graders do not exceed kindergartners in this condition.

The main effect that obtained for generalization object type, indicating that hierarchical generalization generally exceeded non-hierarchical in the Basis Condition, suggests that the implicit constitution of hierarchical-inclusion relations facilitates generalization based on the superordinate functions. The fact that kindergartners in particular benefitted from the hierarchical generalization object type suggests that these children need more external support for perceiving hierarchical-inclusion relations than do first-grade children.

The effect of inclusion information was more complex. It appeared to be facilitory of generalization for kindergartners in the

Basis Condition, suggesting that, like the involvement of hierarchical-inclusion relations, it is facilitory of the use of basis information. It appeared to have an opposite, inhibitory effect on generalization in the No-Basis conditions, however. This suggests that different processes of generalization may be going on in the Basis and No-Basis Conditions.

Superordinate Function Generalization

Function Generalization Scores were a measure of the extent to which children were able to generalize the superordinate functions, measuring; attaching things together; and making something better, like more pretty, more safe, or more fun. There were two types of Function Generalization Score, hierarchical and non-hierarchical, defined by whether the objects involved were hierarchical or non-hierarchical generalization objects. There were 16 generalization objects queried on each of the two Function Generalization Tasks, and children's scores on these tasks consisted of the number of these objects that they correctly generalized the superordinate functions to. Four of the objects in each set of generalization objects (called foil objects) were not members of any of the three superordinates; these were scored as being correct if the child did not generalize any of the three superordinate functions just described to them. Occasionally, a child would describe one of the foil items in terms of one of the three superordinate functions, as in saying that the pliers put things together or measure; such responses were counted as incorrect responses.

The Function Generalization Scores are presented in Table 5 by

grade, inclusion condition, basis condition, and generalization object type. It should be noted how generally good children were at generalizing the correct superordinate functions to the transfer objects, especially when considered against their ability to generalize the correct superordinate labels to those same objects. The function generalization scores are high when considered against the fact that children were not constrained by the experimental task to respond in terms of the superordinate functions. They were merely asked to tell what the objects did, and could have referred to the object functions in ways other than in terms of the superordinate functions (e.g., said that the divider "made lines" rather than "measured"). As Table 5 reveals, kindergartners, as well as first graders, were very good at this type of generalization, and they appeared to benefit more from basis information on this kind of generalization than first graders did.

The Non-Hierarchical and Hierarchical Function Generalization Scores were entered into a 2 (Grade) X 2 (Inclusion Condition) X 2 (Basis Condition) X 2 (Generalization Object Type) Repeated Measures Analysis of Variance, with Generalization Object Type, Non-Hierarchical vs. Hierarchical, treated as a trials factor. There was a main effect of grade $F(1,66) = 6.89, p < .01$ in the one-tailed test, and basis condition $F(1,66) = 4.16, p < .05$. Function generalization in first graders exceeded kindergartners' function generalization and function generalization in the Basis conditions generally exceeded function generalization in the No-Basis conditions. There was a near-significant effect of Generalization Type, $F(1,66) = 2.75, p = .051$ in

the one-tailed test, reflecting a greater difficulty in generalizing the superordinate functions to already-familiar objects (i.e., the hierarchical transfer objects) than in generalizing the superordinate functions to unknown objects (i.e., the non-hierarchical transfer objects). This effect may be due to children having already-designated functions for familiar objects.

The following interactions were significant: Grade X Basis, $F(1,66) = 51.93, p < .01$ and Generalization Type X Grade X Inclusion Condition X Basis Condition, $F(1,66) = 10.60, p < .01$. The Grade X Basis interaction reflects the greater ability of kindergarteners to benefit from basis information. When the Basis Condition difference was examined within each grade separately, it was only significant for kindergartners, $F(1,35) = 14.48, p < .001$, and was not significant for first graders.

Summary. These results reveal that kindergartners and first graders were very good at generalizing the correct superordinate functions to new objects, and were much better at this type of generalization than at superordinate label generalization. Kindergarteners were significantly better at generalizing the superordinate functions in the Basis Condition than in the No-Basis Condition; in fact, their function-generalization rate was so enhanced in this condition that it was equivalent to first graders'. Although there was a main effect of Basis Condition on function generalization across age, kindergarten children were better able than first graders to benefit from basis information on this type of generalization.

The Relationship between Superordinate Function Generalization and Label Generalization

The relationship between superordinate label and function generalization was assessed via a correlation score. The label and function generalization scores for non-hierarchical and hierarchical generalization objects were entered into separate analyses. The correlation between label and function generalization was examined: across all subjects in all conditions; for all children in the Basis Condition; and for all children in the No-Basis condition. The correlation between non-hierarchical function and non-hierarchical label generalization, $r(n=80) = .287$, $p < .01$, and the correlation between hierarchical function and label generalization, $r(n=74) = .371$, $p < .001$, were both significant in the one-tailed test. However, when the correlations for the Basis and No-Basis Conditions were considered separately, only the correlations for the Basis Condition were significant. The correlations between non-hierarchical label and function generalization in the Basis Condition, and between hierarchical label and function generalization in the Basis Condition, were $r(n=40) = .317$, $p < .005$ and $r(n=36) = .495$, $p < .001$, respectively.

These findings suggest that function-generalization serves as a basis for label generalization only when basis information is given. That is, the detection of the superordinate function that links category members and makes them similar is not enough; additional information has to be given linking this function or basis to word meaning, as occurs in the Basis condition (via Basis Statements).

The fact that function-generalization is not enough is better illustrated if we consider the proportion of function-generalized items that were also label-generalized. Table 6 depicts this proportion by grade, inclusion condition, and basis condition. As can be seen, for kindergartners in all conditions, this proportion never exceeds 32%. Thus, even when kindergartners do relate individual objects to the appropriate superordinate functions, only a very low percentage of these objects is related to the appropriate superordinate labels. The same is true of first graders in the No-Basis Conditions, in which the proportion of function-generalized objects that are also label-generalized does not exceed 21%. Only first graders in the Basis Condition label-generalize a majority of their function-generalized objects - between 55 and 64%.

These findings and the correlation data considered together indicate the following: that the ability to generalize the appropriate superordinate functions (e.g., measuring) to objects is an important basis of the ability to generalize the appropriate superordinate labels (e.g., "gauges") to those same objects. However, function-generalization is not all that is required, and in the absence of basis information, only a small percentage of appropriately function-generalized objects will have the correct superordinate labels generalized to them. Basis information, which establishes a link between particular functions and superordinate word meaning, seems to be required. In first graders, the constraint that a single shared feature or function among objects can serve as a basis for superordinate word meaning does not appear to be very strong, because

these children need to be provided with the link between the function and the superordinate word meaning, they cannot deduce the link themselves. Kindergarteners seem to be unable to use single features as the basis for superordinate word meaning even when the word-function link is provided for them (i.e., in the Basis Conditions), suggesting that their sense of the constraint is weaker than first-graders'.

The inability of function-generalization to fully account for label generalization was evident in a different way. There were many cases where differences between basis conditions or grade levels in label generalization were not accounted for by differences in function generalization. That is, basis-condition or grade differences in label generalization were often not accompanied by differences in function-generalization. For example, increased function generalization did not account for the increased hierarchical label generalization that occurred in kindergartners in the Basis Condition over the No-Basis Condition in the Inclusion Condition. Here, basis information did not increase function generalization, only label-generalization. Similarly, in first graders, where label-generalization in the Basis conditions exceeds label generalization in the No-Basis conditions, increased function-generalization is not the cause or explanation of the increased label generalization, because basis information does not enhance function generalization in first graders. Finally, increased function generalization is not an explanation of the grade difference which obtained in label-generalization in the Basis Condition; function generalization in

first graders does not exceed function generalization in kindergarteners in this condition. Thus, in all these cases, differences in function-generalization do not serve as an explanation of differences in label generalization. In fact, in no case were cell differences in label-generalization accompanied by corresponding differences in function-generalization.

Summary. The correlation data suggest that the greater the extent to which children are able to detect the shared function among superordinate category exemplars, the greater will be the extent to which they will be able to generalize the superordinate labels of those categories. However, the fact that this relationship was only significant in the Basis Condition and that only a small percentage of function-generalized objects become label-generalized in the No-Basis Condition (and by kindergartners in both basis conditions) suggests that the ability to generalize the correct superordinate functions to potential referents is not all that is required for superordinate word generalization. It appears that additional knowledge, in the form of a word meaning constraint, designating that a single shared feature or function can serve as a basis for superordinate word meaning, is required. This knowledge enables first graders to utilize basis statements, which establish a relationship between a single feature and superordinate word meaning, in generalizing superordinate words. Kindergarteners seem to have a much weaker sense of this constraint; even though they are well able to detect the shared function that exists among the exemplars of superordinate categories, they appear to lack the knowledge to be able to use this function as a superordinate

word meaning basis, even when the link between it and superordinate word meaning is explicitly established via Basis Statements.

The Role of Experimenter-Provided Superordinate Function-Generalizing Statements on Child Superordinate Function Generalization

As was described in the Method Section, half of the objects in each generalization set (termed Experimenter-Generalized Objects) were objects to which the experimenter explicitly generalized the superordinate functions (through use of Experimenter-Provided Superordinate Function-Generalizing Statements) and the other half (termed Non-Generalized Objects) were objects to which the experimenter did not generalize the superordinate functions (i.e., for which she used Non-Generalizing Statements). The role of Experimenter-Provided Superordinate Function-Generalizing Statements in helping children generalize the superordinate functions appropriately to transfer objects was assessed through comparing children's Function Generalization Scores for Experimenter-Generalized and Non-Generalized transfer objects. The scores for the non-hierarchical and hierarchical generalization objects are given in Table 7. These scores were entered into two 2 (Grade) X 2 (Inclusion Condition) X 2 (Basis Condition) X 2 (Status of Experimenter Function-Generalization) Repeated Measures Anovas, one for each type of generalization object (Hierarchical and Non-Hierarchical). Status of Experimenter Generalization, Generalized vs. Non-Generalized, was treated as the trials factor. There was no main effect of the trials factor on superordinate function generalization for either hierarchical or non-hierarchical generalization objects, and there were no

significant interactions.

Summary. Experimenter-Provided Superordinate Function-Generalizing Statements did not aid children in generalizing the superordinate functions to potential referents. These results, considered together with the results of the previous section, indicate that kindergarteners and first graders were quite good at generalizing the superordinate functions to potential referents and did not require experimenter-provided mediators in order to do so. These results suggest further that children were able to invoke their own mediators to aid in the process of generalizing superordinate functions.

Determinants of None-of-Those-Things Responses

Four items in each generalization test set (called foil objects), hierarchical and non-hierarchical, were not members of any of the three to-be-trained superordinates. The correct response for these objects was "none-of-those-things". A heavy reliance on this response category, that is, a frequency significantly greater than 4, was of interest for two reasons: (1) a heavy reliance on this response category for hierarchical transfer objects would signal reliance on an exaggerated form of the Mutual Exclusivity Constraint, designating that any one object can have only one name. (2) If this response category is heavily relied upon for both types of generalization objects, hierarchical and non-hierarchical, this would suggest that children think that words apply only to the particular basic level object classes upon which they are trained, and not to other object classes that are similar to them in some non-basic level sort of way.

This hypothesis is what was referred to as the Basic Level Object Class Hypothesis in the Introduction.

Table 8 presents the frequency of "none-of-those-things" responses for both sets of generalization test objects, hierarchical and non-hierarchical, by grade, inclusion condition, and basis condition. As can be seen, the rate of such responses is unduly high (exceeding 4) only in the case of kindergarteners in the No-Basis Condition, No-Inclusion Condition. These frequencies were entered into a 2 (Grade) X 2 (Inclusion Condition) X 2 (Basis Condition) X 2 (Generalization Object Type) Repeated Measures Anova, with Generalization Object Type (hierarchical vs. non-hierarchical) treated as the trials factor. There were main effects of inclusion condition, $F(1,72) = 6.28$, $p < .01$ in the one-tailed test, and generalization object type, $F(1,72) = 3.80$, $p < .05$ in the one-tailed test. "None-of-those-things" responses were more frequent for hierarchical generalization than non-hierarchical generalization objects, and were inhibited by inclusion information, as predicted. There was also a significant inclusion X basis condition interaction, $F(1,72) = 3.02$, $p < .05$ in the one-tailed test, and a significant grade X inclusion X basis condition interaction, $F(1,72) = 2.92$, $p < .05$ in the one-tailed test.

The Newmann-Keuls post-hoc test revealed that the inclusion condition difference was only significant for kindergarteners in the No-Basis Condition. This may be because it is only here that none-of-those-things responses are inappropriately or excessively relied upon and thus, where inclusion statements can be the most helpful.

Summary. These results suggest that kindergartners rely on the Basic Level Object Class Hypothesis, and that, in the absence of basis and inclusion information, they think that superordinate labels refer to the specific basic level object classes that they were matched to in the Learning Session. Inclusion information counters this hypothesis and inhibits none-of-those-things responses, especially for kindergartners in the No-Basis Condition. However, despite this potentially positive effect of Inclusion information, superordinate word learning is in actuality not enhanced by giving inclusion information in the No-Basis Condition, and is in fact inhibited, as we saw in the section on Superordinate Label Generalization. Basis information also counters the Basic Level Object Class Hypothesis, evident here in the significantly lower rate of none-of-those-things responses that occurred in the Basis Condition in comparison to the No-Basis Condition.

These findings suggest that although children rely on and utilize the Basic Level Object Class Hypothesis in superordinate label extension, their reliance on this hypothesis is not the basic cause of their inability to extend superordinate labels appropriately, as evidenced by the fact they they do not generalize the labels correctly even when this hypothesis is countered (as through Inclusion and Basis Information).

The finding that the frequency of none-of-those-things responses was greater for hierarchical than non-hierarchical generalization objects suggests that children in the present study relied on the Mutual Exclusivity Hypothesis. However, the potentially negative

impact of this hypothesis on superordinate label generalization is not very great. Potentially, this hypothesis could inhibit generalization by leading to a heavy reliance on none-of-those-things responses. However, it does not do so; as we saw in the section on Superordinate Label Generalization, the involvement of hierarchical-inclusion relations (i.e., the hierarchical generalization objects) actually elevated rather than depressed generalization performance. Once again, children's reliance on a "wrong" hypothesis of superordinate word meaning, the exaggerated form of the Mutual Exclusivity Hypothesis, is not a direct cause of their inability to generalize superordinate labels appropriately.

Sorting

The sorting score for each session, hierarchical and non-hierarchical, consisted of the number of objects, out of a possible 13, that were incorrectly sorted into 4 envelopes. The non-hierarchical and hierarchical sorting scores are presented in Table 9 by Grade, Inclusion Condition, and Basis Condition. Note that the error rate was typically quite high, more than 50%, except for first graders in the Basis Condition.

These scores were entered into a 2 (Grade) X 2 (Inclusion Condition) X 2 (Basis Condition) x 2 (Generalization Object Type) Repeated Measures Analysis of Variance, with Generalization Object Type (Hierarchical or Non-Hierarchical) treated as the trials factor. The main effects and interactions mirrored those that had occurred for the label generalization scores. There was a main effect of grade,

$F(1,72) = 12.82, p < .001$, reflecting the fact that first graders made fewer sorting errors than kindergarteners. There was a main effect of basis condition, $F(1,72) = 5.86, p < .05$, reflecting the fact fewer sorting errors were made in the Basis Condition than in the No-Basis Condition. There was also a main effect of Generalization Object Type, $F(1,72) = 10.48, p < .01$, indicating that hierarchical generalization objects yielded fewer sorting errors than non-hierarchical generalization objects.

There was a significant Grade X Basis interaction, $F(1,72) = 3.11, p < .05$ in the one-tailed test. The post-hoc test revealed that the basis condition difference was significant at first grade but not at kindergarten at the .01 level. Recall that a similar interaction had occurred in the label generalization scores.

In fact, all of the main effects and interactions that obtained for sorting mirrored those that occurred for label generalization. Moreover, like label generalization, sorting performance falls far below function generalization performance. This difference between children's performance in superordinate function generalization and sorting indicates that it is not that children are unable to detect the superordinate functions in the extension items, it is some additional knowledge that is lacking that prevents children from being able to classify the items. One hypothesis that suggests itself at this point and that follows from these findings is that children can only use particular functions as a classification basis when they understand their role in serving as a word meaning basis.

In order to examine the relationship between word constraint

knowledge and sorting performance directly, first graders were divided into two groups, those who had gotten half or more of the items correct on each label generalization task, hierarchical and non-hierarchical, and those who had gotten fewer than half of the items correct on these tasks. A similar breakdown was not executed for kindergarteners, since almost no kindergarteners had gotten at least half of the items correct on either label generalization task. A Mann-Whitney U-Test was executed on the first graders' scores, testing whether the two groups differed significantly on their sorting scores. The U-score ($m = 28$; $n = 12$) for the non-hierarchical generalization objects was 73.5, $p < .05$; the U-score ($m = 25$; $n = 15$) for the hierarchical generalization objects was 100.5, $p < .05$. These results indicate that the sorting scores of the better word generalizers were significantly higher than the sorting scores of the poorer word generalizers.

This statistical relationship is suggestive of (though not conclusive of) a causal relationship, namely, that understanding particular functions as word meaning bases is necessary in order to be able to use the same functions as classification bases, especially when we consider the fact that poor classification performance is not due to poor ability to generalize the superordinate functions. That is, it is not that children are failing to detect the shared function among superordinate category members that leads to their failing to classify them together. They are very good at generalizing the superordinate functions to the transfer objects, at the same time that they are very poor at classification. Therefore, the only

remaining account of poor sorting performance is that children do not use the superordinate functions as sorting-bases because they do not understand them as word-meaning bases.

Levels of Knowledge of the One-Feature Constraint on Superordinate Word Meaning

Basis Condition children's scores on the Justification Tasks (Hierarchical and Non-Hierarchical) were examined in order to look at whether there were any intermediate levels of knowledge of the One-Feature Constraint on Superordinate Word Meaning, that is, whether children understood that the superordinate functions had something to do with word meaning even if they did not productively use the functions in extending the superordinate words. No-Basis children's scores were not examined because this task was intended as a measure of ability to utilize, rather than deduce, word meanings based on single features. Children's scores on the Justification Tasks consisted of the number of queried objects, out of a total of 6 for each task, that they justified according to one of the three superordinate functions, measuring, attaching things together, and making things better, like more pretty, more safe, or more fun. A justification response was scored as correct if the child named one of the 3 functions in response to the experimenter's probe, even if the function given did not match the superordinate category of the object being queried. Children who justified 1 or 0 objects by naming one of the three functions were coded as Non-Justifiers. Children who justified 2 or more of the items by naming one of the three functions were coded as Justifiers. As it turned out, all children coded as Justifiers could justify at least 3

of the items by using one of the three features, and most justified more than half of the items in this way.

Six of the 20 kindergarteners and three of the 20 first graders in the Basis Condition were Non-Justifiers. These children appeared to have no sense or knowledge of the fact that the three functions had anything to do with word meaning, despite the fact that they had been trained on these functions as meanings of the three superordinate words during the Learning Session, and despite the fact that all children, including the Non-Justifiers, knew the functions and could recite them on demand when the experimenter requested the definitions of the three words at the beginning of each Generalization Session. Thus, even though Non-Justifiers knew the functions, they did not use them as justifications, suggesting that they had no knowledge or sense of the One-Feature Constraint on superordinate word meaning. For the purposes of explication here, Non-Justifiers' level of knowledge of the One-Feature constraint on superordinate word meaning will be termed Level 1 knowledge. Level 1 knowledge involves having no sense that a single feature or function can underlie superordinate word meaning.

Of the Justifiers, 5 kindergartners and 16 first graders were able to use the functions correctly in generalizing the three superordinate labels (i.e., could use them on the Label Generalization Task). These children had productive knowledge of the One-Feature Constraint, involving knowing that single features or functions have something to do with word meaning and actually using such functions in label extension. This level of knowledge will be termed Level 3 knowledge.

Nine kindergartners fell into a third category, constituting an intermediate level of knowledge of the constraint termed Level 2. These children knew that the superordinate functions had something to do with word meaning - they used the functions as justifications for their labels - but did not use them productively, that is, as a basis for label extension, as indicated by their poor label generalization scores.

Are information processing demands an account of Level 2 children's inability to use the superordinate functions productively in superordinate word extension? The information processing demands involved are certainly great; three steps are involved in correctly generalizing a superordinate term to a potential referent. Children have to generalize the superordinate function to the potential referent (a process that, as we have seen, has been well mastered by most children in this age range), remember all three of the definitions (what function goes with what word), and match the object's function with one of the definitions.

An alternative hypothesis has been suggested by a recent line of research termed the "learning by doing approach", (e.g., Kuhn, Phelps, & Ho, 1982). This group argues that children often evidence knowledge of and ability to use particular strategies or rules, but simply do not execute them spontaneously because they have not achieved "metacognitive control" over them. Achieving "metacognitive control" involves understanding why the strategy works, and what it affords over other, competing strategies. Achieving such metaknowledge or metacognitive control often involves giving up familiar and favored

competing strategies that simply do not afford one as much as the "right" strategy in terms of problem solution.

It is just such a process that may distinguish Level 2 from Level 3 children in the present sample. Level 2 children seem to have knowledge of the strategy of basing superordinate word meaning on one feature or function, as evidenced by their referring to the superordinate functions in their justifications. However, they do not spontaneously carry out the strategy. Increased experience with word meaning relations may be required in order to convey to these children what the strategy of basing superordinate word meaning on one feature "buys one" in terms of superordinate word extension.

The learning-by-doing theorists argue that one major obstacle to children's assuming metacognitive control over a particular hypothesis is their tendency to fall back on competing, more familiar, but less effective hypotheses. Children in the present study seemed to rely on a less effective hypothesis of superordinate word meaning, the Basic Level Object Class Hypothesis. This hypothesis was evident in the analysis of "none-of-those-things" responses. There was further evidence that children relied on this hypothesis in their responses on the Trials-to-Criterion-Basis Task, the results of which will now be reported. (Recall that only children in the Basis Condition had this task). Many of the children, 7 of the 20 kindergarteners, and 9 of the 20 first graders, evidenced a Basic Level Object Class Hypothesis on this task. These children, when asked "what is a gauge?", responded by referring to a particular training object rather than by referring to one of the superordinate functions. For example, instead

of saying "something that measures", they would say "the thing that makes lines (surface gauge)" or "the one that sees if it's straight (level)". These responses tended to occur at the outset of the Trials-to-Criterion-Basis Task, and disappeared as the task proceeded and children learned the experimenters' criteria for correct responses. However, the fact that they occurred at all, in a large percentage (40%) of the children, is further evidence that children harbor a Basic Level Object Class Hypothesis for superordinate word meaning. For the learning-by-doing theorists, the implication of this reliance is that it may impede the developmental process of children's coming to assume metacognitive control over the One-Feature Constraint (Kuhn, Phelps, & Ho, 1982).

The highest level of knowledge of the One-Feature Constraint was evidenced by children who could deduce the word meanings in the No-Basis (ostensive) condition. This level involves having a strong enough sense of the constraint to "search out" a shared function or feature among objects in response to hearing a novel label. In the present study, a good point to engage in this process was in the Learning Session, when novel labels were paired to objects by the experimenter. The 3 kindergarteners and 5 first graders who were able to generalize at least one of the superordinates in the No-Basis Condition had this level of knowledge. So also did 5 additional children who came up with stable, productive definitions for the novel words, "gauge", "dax", and "fid", that did not involve the functions underlying the experimenter's word meanings. ("Productive" meant that the child used the self-derived word meaning productively in

generalization, correctly extending the label to instances of the feature and correctly excluding non-instances). This level of knowledge constitutes a fourth level of knowledge of the One-Feature Constraint on superordinate word meaning, and will be termed Level 4 knowledge.

Summary. The analysis of the justification data indicated that within the narrow age span sampled in the present study, four levels of knowledge of the One-Feature Constraint were found. Level 1 involves having no sense that a single feature or function can have anything to do with superordinate word meaning. Level 2 involves having knowledge of the constraint but not being able to use or apply it. Level 3 involves being able to apply the knowledge productively, but not deductively. Level 4, the most advanced level, involves ability to deduce the single feature underlying superordinate word meaning in ostensive learning situations. These findings suggest that the age period sampled here is one of rapid development of knowledge of the One-Feature Constraint.

Children's Self-Generated Definitions in the No-Basis (Ostensive) Condition

As discussed in the previous section, there were children who came up with stable meanings for "gauge", "dax", and "fid" based on one feature that they used productively but that did not match the experimenter's meanings. One kindergartener and nine first graders came under this category, which represented Level 4 knowledge of the One-Feature Constraint. The definitions they came up with were as

follows: (1) gauge and dax mean "gauge things together" and "dax things together"; (2) fid means "fit"; (3) gauge means "shiny"; (4) gauge means "big", dax means "medium-sized", and fid means "small"; (5) gauge means "tool"; (6) fids are "fun things" and gauges and daxes are "tools, they help you do something"; (7) gauge and fid mean "fun, cause they're fun words" and dax means "not fun, cause it's not a fun word"; (8) fid means "small" and dax means "medium-sized and not measuring" (this was a boy who had deduced that gauges meant "measuring"; (9) fid means "round" and gauge means "shiny or silver"; (10) fid means "making holes" (non-hierarchical generalization session) and "something you wear" (hierarchical generalization session) and gauge and dax mean "decoration".

These definitions are reported here because they help locate where children's difficulty in deducing superordinate word meaning in the No-Basis (Ostensive) Condition may reside, even when, as is the case with these children, they have Level 4 knowledge of the One-Feature Constraint. One problem was that there were alternative features or contrasts available in the stimulus sets to those that underlay the experimenter's definitions, and children often hit upon these (e.g., shiny, round). This problem underscores one great difficulty involved in deducing superordinate word meaning ostensively. Any given set of objects may share many features, but only a subset of these bear on superordinate word meaning. A second problem was that children seemed to have difficulty with the contrastive nature of word meaning. For example, they sometimes said that two different words had the same meaning (e.g., the child who

gave similar definitions for gauge and dax, "gauges things together" and "daxes things together"; the child who said that both gauge and dax mean "decoration"). Or they sometimes said that one of the to-be-trained words had the same meaning as another, already-known word (e.g., the child who said that gauge means "tool"; the child who said that fid means "something you wear").

A third problem was that children sometimes thought that the word had to have some relation to the feature it denoted. We may term this the Onomatopoeic Hypothesis. Thus, fid meant "fit" (the word and feature share a sound relationship) or fid meant "fun" because "fid is a fun word". This hypothesis was evidenced in other children who did not develop stable, productive word meanings but who mentioned such onomatopoeic rules in their justifications.

Summary. Several first graders and one kindergartener came up with stable, productive word meanings that did not match the experimenter's, underscoring several potential problems for this age group in superordinate word learning in ostensive situations other than incomplete development of the One-Feature Constraint: (1) incomplete development of the Contrastive Hypothesis; (2) the availability of alternative features and contrasts in the stimulus sets to those that underlay the experimenter's definitions; and (3) the Onomatopoeic Hypothesis.

General Summary

The results indicated that children at both ages examined were well able to generalize superordinate functions to potential

referents. Moreover, children at both ages were well able to capitalize on the two linguistic mediators, linguistic specification of category criteria, and common descriptions of category instances, in generalizing the superordinate functions to potential referents. Even the younger children could benefit from linguistic specification of category criteria (basis information), and appeared to be able to invoke their own generalizing mediators (common descriptions of category instances) to aid them in generalizing the superordinate functions. More specifically, on the Function Generalization Task, they were able to describe many objects in terms of the common, superordinate functions.

Even though children were very good at generalizing the superordinate functions to potential referents, they had much greater difficulty generalizing the superordinate labels. First graders could only do so when the link between the superordinate functions and word meaning was made explicit by means of Basis Statements. They could not deduce the link between word meaning and single features in the absence of basis information. Kindergarteners were even poorer at generalizing the superordinate words; most children could not do so even when given basis information.

The discrepancy between children's ability to generalize the superordinate labels and the superordinate functions is an important finding. It implicates the role of the One-Feature Constraint. When children are able to detect the superordinate functions in potential referents, and yet still do not use them as a basis for generalization, this implies that they lack knowledge of the

relationship between single features and word meaning.

However, it should be noted that about half of the first graders in the No-Basis Condition did come up with definitions for the superordinate words that were based on single features, even though these were different from the experimenter's. This finding suggests that these children had enough of a sense of the One-Feature Constraint to seek out word meanings based on single features. Rather than being hampered by incomplete development of the One-Feature Constraint, as were the other half of the first graders, these children were hampered by other difficulties.

Knowledge of the One-Feature Constraint appeared to undergo a great deal of development during the relatively short age span observed in the present study. Four levels were found. Level 1 involved having no sense the one feature or function has anything to do with superordinate word meaning, and characterized 30% of kindergarteners and 15% of first graders. These were children who did not use the superordinate functions as responses on the Justification Task. The level most characteristic of kindergarteners was Level 2. Level 2 involved knowing that single features underlie superordinate word meaning but not being able to apply the knowledge in actual label extension. This level constituted non-productive knowledge of the One-Feature Constraint, and was evident in children who used the superordinate functions on the Justification Task but not on the Label Generalization Task. Most first graders had Level 3 knowledge, involving being able to use superordinate functions as a basis for label extension. About half of the first graders in the No-Basis

(Ostensive) Condition appeared to have Level 4 knowledge, involving being able to derive meanings based on single features ostensively. The fact that in many cases the definitions these children came up with were not the experimenter's was due to problems such as incomplete development of the Contrastive Hypothesis, and inherent difficulties involved in ostensive word learning situations, rather than incomplete development of the One-Feature Constraint.

The results of the Sorting Task suggest that Level 3 knowledge of the One-Feature Constraint may be an important precursor of the ability to use single features as a basis for non-linguistic categorization at the superordinate level. Only children who had learned the superordinate words and thus evidenced Level 3 knowledge could sort objects in accordance with the three categories.

Other word meaning constraints also appeared to develop during the age period observed. Kindergarten children appeared to need greater support than first grade children for perceiving that inductions about hierarchical-inclusive word meaning had to be made, suggesting that their knowledge of hierarchical-inclusion relations was less well developed than older children's. To a greater extent that first graders, kindergartners needed to have hierarchical-inclusion relations implicitly constituted in the transfer objects (i.e., had higher scores on the Label Generalization for Hierarchical Generalization Objects than for Non-Hierarchical Generalization Objects).

There also appeared to be development in terms of less reliance on the Basic Level Object Class Hypothesis with age. Only

kindergarteners had exaggerated levels of none-of-those-things responses on the Label Generalization Task. However, when actual label-generalization scores were examined, the potentially inhibitory effect of this hypothesis was not actualized. That is, kindergarteners' label generalization performance was not depressed in the conditions where the constraint appeared to be operating in comparison to the conditions in which it did not appear to be operating.

A similar finding obtained for the exaggerated form of the Mutual Exclusivity Hypothesis. Children at both ages appeared to utilize it, evident in their higher rate of none-of-those-things responses for Hierarchical Generalization Objects than for Non-Hierarchical Generalization Objects. However, since actual label generalization was not depressed for Hierarchical Generalization Objects in comparison to Non-Hierarchical Generalization Objects, again it was the case that the potential impact of an inhibitory constraint was not actualized.

Discussion

The discussion of results is divided into three sections: (1) a summary of the findings; (2) conclusions as to what children in the period studied know and what is developing; (3) how the present findings contrast with previous research and theory in this area.

Summary of Results

The results of this study bear out most of the predictions that were made concerning the role of language in linguistic categorization (i.e., word extension and function extension) and non-linguistic categorization (i.e., classification) at the superordinate level. The first two predictions concerned the role of linguistic specification of category criteria in facilitating children's generalization of superordinate functions to potential referents. As predicted (Hypothesis 1), basis statements facilitated children's detection of the superordinate functions in potential referents, evident in the finding that superordinate function generalization (i.e., performance on the Function-Generalization Task) was greater in the Basis than in the No-Basis Conditions. Basis statements were especially facilitory for kindergarteners, elevating their levels of superordinate function generalization to those of first graders'. Thus, language, via its highlighting function, facilitated children's detection of the superordinate functions in potential referents.

Hypothesis 2 was one prediction that was not borne out.

Experimenter-Provided Superordinate Function-Generalizing Statements

did not facilitate children's generalization of the superordinate functions to potential referents, as had been predicted. This finding indicates either one of two things: (i) that children could not capitalize on the generalizing function of language in generalizing superordinate functions to potential referents; (ii) that children could invoke their own mediators to aid in the process of superordinate function generalization and did not need externally-provided ones. The fact that children at both ages were able to describe the objects within each superordinate in terms of the common, category functions, as evidenced by their performance on the Function Generalization Task, supports proposal (ii) over proposal (i).

Hypotheses 3-8 pertained to the role of knowledge of the One-Feature Constraint on superordinate word meaning in mediating superordinate label extension, and were all confirmed. It was proposed that in order to be able to generalize the correct superordinate label to a potential referent, the child would have to: (1) generalize the correct superordinate function to the referent; (2) know the relationship between that particular function and the meaning of that particular superordinate label; (3) possess knowledge of the One-Feature Constraint, that is, general knowledge that single features or functions serve as the basis for superordinate word meaning. Basis statements (as provided in the Basis Condition) were intended as the source of component (2).

The importance of Component 1 was demonstrated by the correlation that obtained between children's ability to generalize the superordinate functions and their ability to generalize the

superordinate words. The children who generalized the functions the best were the ones who generalized the labels the best. However, despite the fact that both kindergarteners and first graders were very good at generalizing the superordinate functions, most kindergarteners, and many first graders, could not generalize the superordinate words. Thus, lack of Component 1 could not account for this failure.

The importance of Component 2 was demonstrated by the fact that basis information was necessary in order to help children (first graders) generalize the superordinate words. As predicted (Hypothesis 3), first graders could only generalize the labels in the Basis Condition. This finding demonstrates the importance of children's knowing the relationship between the specific functions and the meanings of the specific words. The two hypotheses claiming that there would be a much closer relationship between superordinate function generalization and superordinate label generalization in the Basis Condition were confirmed (i.e., Hypotheses 5 & 7), also providing support for the importance of Component 2. These findings indicate that detecting the features or functions that are shared among a group of objects (i.e., Component 1) is not all that is required in order to extend superordinate words correctly; the relationship between these functions and word meaning must be understood. The fact that first graders did not generalize the labels well in the No-Basis Condition indicates that children at this age cannot deduce the relationship between particular functions and word meaning, and must be provided with it (i.e., through Basis

Statements).

However, when first graders were provided with knowledge of the relationship, they could generalize the superordinate words. This indicated that they must be in possession of Component 3, i.e., a general constraint specifying that single features or functions can and do underlie superordinate word meaning. Only when children are in possession of this general knowledge can they make use of information pertaining to the relationship between particular functions and the meanings of particular words. For first graders, then, knowledge of the One-Feature Constraint on superordinate word meaning mediated superordinate label extension.

In contrast to first graders, kindergarteners could not generalize even in the Basis Condition (thus confirming Hypothesis 4). They were in possession of Component 2 (Basis Statements provided these) and of Component 1 (as described above). Because these components are ruled out, kindergartener's deficit in generalizing superordinate words must reside in Component 3. In other words, kindergarten children appear to lack general knowledge that single features or functions can and do serve as the basis for superordinate word meaning, in the form of a constraint on superordinate word meaning. Lacking such knowledge, even when the specific relationship between the superordinate function and word meaning was supplied through basis statements, and even though they were able to extend the superordinate functions appropriately, kindergarteners could not capitalize on this information in order to generalize the superordinate words.

Hypothesis 8 predicted that even though kindergarteners lack productive knowledge of the One-Feature Constraint, they might still have non-productive levels of knowledge of it. This hypothesis was confirmed; many kindergarteners had Level 2 knowledge of the One-Feature Constraint, involving knowing that the superordinate functions had something to do with word meaning (i.e., being able to specify the functions as justifications for the superordinate labels), even though this knowledge was not used productively in actually generalizing the labels. Level 2 was the predominant level of knowledge manifested by kindergarteners, while Level 3 (productive, but not-deductive, knowledge of the One-Feature Constraint) was the predominant level manifested by first graders.

Interestingly, two other levels of knowledge of the One-Feature Constraint emerged in this study. Level 1 knowledge involved having no sense that single features or functions have anything to do with superordinate word meaning. This level was indicated by children who could not use the functions as bases for justifying the superordinate labels on the Justification Task. There was also fourth level of knowledge, involving being able to deduce superordinate word meanings ostensibly, that is, in the No-Basis Conditions. Nine first graders manifested this level of knowledge - the five first graders who deduced the experimenter-derived meanings and the four first graders (and one kindergartener) who derived definitions based on single features that were different from the experimenter's. The latter children's difficulty resided in problems other than incomplete development of the One-Feature Constraint.

Several hypotheses concerned the role of other word meaning constraints, such as the Basic Level Object Class Hypothesis and the exaggerated form of the Mutual Exclusivity Hypothesis, on superordinate word extension. Hypotheses 9 and 10 predicted that children, especially kindergarteners, would evidence high rates of "none-of-those-things" responses on both Label Generalization Tasks (due to reliance on the Basic Level Object Class Hypothesis). These hypotheses were borne out. Kindergarteners had very high rates of such responses in the No-Basis and in the No-Inclusion Conditions, indicating that these children rely upon the Basic Object Class Hypothesis in superordinate word extension. In contrast, first graders did not evidence inappropriately high rates of such responses. However, the fact that the cancelling out of the effect of this hypothesis (as through giving either Inclusion Statements or Basis Statements) did not improve performance on the superordinate label generalization task (kindergarteners did not perform well on the Label Generalization Tasks even in the Basis and Inclusion Conditions), indicates that reliance on the Basic Level Object Class Hypothesis is not a direct cause of superordinate label generalization failure in kindergarten children. Lack of knowledge of the One-Feature Constraint, as described previously, emerged as a better candidate for the direct cause of this failure.

Hypothesis 11, predicting that children would evidence higher rates of "none-of-those-things" responses on the Hierarchical Label Generalization Task than on the Non-Hierarchical Label Generalization Task, was borne out - the generalization object type difference was

significant at both ages. This finding indicates that kindergarteners and first graders harbor an exaggerated form of the Mutual Exclusivity Hypothesis. However, again, this supposedly inhibitory constraint on superordinate word meaning is not a direct cause of superordinate label extension failure in young children; as was evident in the results on the Label Generalization Task, superordinate label generalization was actually enhanced, rather than inhibited, on the Hierarchical Generalization Task.

Several hypotheses concerned the role of the Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning. It was proposed that "broad" word meaning, and therefore word meaning based on single features, would be enhanced by the involvement of hierarchical-inclusion relations. More specifically, it was predicted that giving hierarchical-inclusion information either explicitly, (through use of Inclusion Statements) or implicitly (through the use of Hierarchical Generalization Objects) would facilitate children's use of word meaning based on single features and would thus improve superordinate label extension in the Basis Condition. The hypothesis concerning the effect of hierarchical transfer objects (Hypothesis 16) was confirmed. Kindergarteners and first graders, especially kindergarteners, generalized the superordinate words better when the objects involved were Hierarchical Generalization Objects than when they were Non-Hierarchical Generalization Objects, and this effect was confined to the Basis Condition. These findings indicate that the effect of giving hierarchical-inclusion information is very specific; it helps children utilize word meaning based on single features. It is in the

Basis Condition, after all, that extension based on single features is more operative at this age level. The findings support the claim that children entertain a broad meaning constraint on hierarchical-inclusive word meaning. Moreover, they suggest that kindergarteners, in comparison to first grade children, do not encode hierarchical-inclusion relations very well, since they require more external support in order to perceive such relations.

Concerning the facilitory effect of Hierarchical Generalization Objects on kindergarteners' superordinate label extension in the Basis Condition, it might be argued that these objects, rather than facilitating superordinate label generalization through their implicit constitution of hierarchical-inclusion relations, do so because they are familiar objects, in contrast to the Non-hierarchical Generalization Objects, which are unfamiliar. However, the findings from the Function Generalization Task ruled out this alternative explanation. They showed that children actually had greater difficulty generalizing the superordinate functions to the familiar (Hierarchical) generalization objects than to the unfamiliar (Non-Hierarchical) generalization objects, indicating that familiarity could not serve as an account of the facilitory effect of the Hierarchical Generalization Objects.

Hypotheses 13-14 were not confirmed; when hierarchical-inclusion relations were explicitly constituted (through use of inclusion statements), rather than implicitly constituted (through use of hierarchical-transfer objects), this was not facilitory of superordinate label extension. This may be because the Inclusion

Condition, as constituted in the present study, was confusing to children. Recall that the Inclusion Condition differed from the No-Inclusion Condition, not only in terms of explicit reference to hierarchical-inclusion relations, but also in terms of the number of labels that were applied to each training object - in the Inclusion Condition, two, rather than one label was given per object. This may have confused children and prevented them from benefitting from hierarchical-inclusion information as provided in the inclusion statements.

An interesting interaction occurred between Basis Condition and Inclusion Condition; inclusion statements were inhibitory of superordinate label generalization in the No-Basis, but not in the Basis, condition. This interaction suggests that different processes of superordinate word generalization may be going on in the Basis and No-Basis Conditions. It cannot be said that no process of label generalization was operative for kindergarteners in the No-Basis Condition; something was operating that was depressed by the provision of Inclusion Statements. Since generalization in the Basis Condition was based on the superordinate functions, some alternative type, one that is not as efficient as the superordinate function-based generalization, must have been occurring in the No-Basis Condition. One possibility for what this type of generalization might be is generalization based on single features, but on features that are incorrect or that do not correspond to the meanings of the three words. We already have some evidence on this type of generalization (i.e., the children in the No-Basis Condition who arrived at stable,

productive, but "wrong" meanings for the superordinate words). These data indicate that this type of generalization was very infrequent in kindergarteners (characterizing 1/20 children) but somewhat more frequent in first graders (evidenced by 9/20 children).

Another candidate for what a relatively inefficient strategy of label generalization might be is a complexive strategy, that is, a strategy by which label extension is based on varying criteria. Use of such a strategy would account for why kindergarteners' extension in the Inclusion Condition was so poor; basing extension on a single, stable feature is a much more precise method of generalization than one based on a complexive strategy (i.e., varying criteria). Because a complexive-based type of generalization is not very accurate, it may be more susceptible to the confusing effects of inclusion statements.

There was evidence that a complexive-type of strategy was also employed during the Learning Session. Performance on this task was not affected by the same variables that affected performance on the Label Generalization Task in the Basis Condition, suggesting that performance on the Learning Task was based on a different type of strategy than that which was used on the Label Generalization Task in the Basis Condition. Since learning was affected by the same variable as that which affected generalization in the No-Basis Condition (i.e., inclusion statements depressed learning scores), a similar strategy may have been relied on during learning and during generalization in the No-Basis Condition - that is, a complexive type of strategy.

The fact that different processes appear to be operative in learning and generalization of superordinate category terms raises an

important methodological point for research on categorization - results that are observed for category learning should not be generalized to processes of category extension. Moreover, these results indicate that many different kinds of processes may operate in learning and extension, and that no single model can account for all types of category learning and extension processes that occur under all conditions and at all ages.

Hypothesis 15, like Hypotheses 14 and 16, was a prediction concerning the interaction of the Broad Meaning Constraint on Hierarchical-Inclusive Word Meaning with another constraint, in this case, the Basic Level Object Class Hypothesis. It was reasoned that situations in which hierarchical-inclusion relations were more explicitly constituted for children would help counter the Basic Object Level Class Hypothesis and would thus reduce the rate of "none-of-those-things" responses. Consistent with this prediction, explicit reference to hierarchical-inclusion relations (i.e., through the use of inclusion statements in the Inclusion Condition), decreased the rate of "none-of-those-things" responses. However, since, as described above, the Basic Level Object Class Hypothesis does not appear to have a direct impact on superordinate label extension, then the cancelling out of the hypothesis is not an important facilitator of such extension.

The last prediction (Hypothesis 17) concerned the role of knowledge of the One-Feature Constraint on non-linguistic superordinate category extension, that is, on classification. As predicted, children who performed better on the Label Generalization

Task (thus indicating that they had a better grasp of the One-Feature Constraint on superordinate word meaning) were also the children who categorized better non-linguistically. This finding suggests that children's knowledge about superordinate word meaning constraints mediates their non-linguistic as well as their linguistic categorization at the superordinate level.

In summary, these findings indicate that all three of the mediators proposed in the section on language-cognition interactions facilitated superordinate category extension at both the linguistic and non-linguistic levels: (1) linguistic specification of category criteria that highlights superordinate functions and facilitates their generalization; (2) common descriptions of category instances that facilitate the generalization of the superordinate functions to the instances; and (3) knowledge of the One-Feature Constraint, that specifies a relationship between superordinate functions and word meaning. Children at both ages, kindergarten and first grade, could capitalize on mediators (1) and (2). However, only first graders could capitalize on mediator (3).

What Develops During the Early School-Age Period?

As just described, kindergarteners' deficit in generalizing superordinate categories and labels appeared to reside in lack of development of constraints on superordinate word meaning. The other linguistic mediators, (1) and (2), were well developed in these children, and they were quite well able to generalize the superordinate functions to potential referents.

Knowledge of the One-Feature Constraint on superordinate word meaning, in particular, appeared to undergo a great deal of development during this period. In contrast to first graders, only a minimal number of kindergarteners possessed the level of knowledge of this constraint that was required for superordinate label extension (i.e., Level 3 knowledge). Only 8 out of 40 kindergarteners could generalize even one of the superordinate words, despite the fact that these children were well able to generalize the superordinate functions designated by the words. Even in the Basis Condition, in which the superordinate functions were presented as the bases of the superordinate word meanings, (and which was so facilitative of superordinate label extension for first graders), only 5 of the 20 kindergarteners could generalize even one superordinate word. The other 15 kindergarteners in the Basis Condition possessed either a Level 1 (6 children) or a Level 2 (9 children) level of knowledge. In contrast, 16 of the 20 first graders had Level 3 knowledge, that is, could generalize the superordinate words in the Basis Condition.

Knowledge of hierarchical-inclusion relations also appeared to be undergoing some development during this period. This was evidenced in the fact that kindergarteners needed more support (in the form of Hierarchical Generalization Objects) in order to perceive such relations (and to, as a result, use word meaning based on single features), than did first grade children. Kindergarteners, then, do not appear to encode hierarchical-inclusion relations as well as first grade children.

Another development in word constraint knowledge that appeared to

be occurring during the age span studied here was a decreased reliance on the Basic Level Object Class Hypothesis. However, since, as noted above, the cancelling out of this hypothesis does not lead to improved superordinate label extension, decreased reliance on this Hypothesis does not account for how the ability to generalize superordinate categories develops during this period.

Thus, development of the One-Feature Constraint on superordinate word meaning emerged as the best candidate for what develops during this period to account for the onset of superordinate categorization ability. Although knowledge of hierarchical-inclusion relations also developed during this period, since this knowledge was only important inasmuch as it enhanced generalization based on single features, its development may be viewed as an aspect of the development of the One-Feature Constraint.

The finding that word meaning constraint knowledge, rather than ability to use mediators 1 and 2, is what is developing during the "transitional period" to explain the onset of superordinate categorization ability has important implications for how the development might occur. As discussed in the Introduction, ability to use mediators 1 and 2 depends on the ability to capitalize on particular functions of language, the highlighting and generalizing functions, respectively. There is no particular unit of information or knowledge that children can acquire that will help them to capitalize on these functions. There is no rule for how to execute these functions that children can learn. In contrast, in the case of learning word meaning constraints, there are particular rules that

children can be exposed to and thus internalize (e.g., the rule that superordinate word meaning refers to single features). Learning such rules is a more direct process to account for than explaining how categorization comes to be a "mediated process" (Luria, 1961; Vygotsky, 1962; 1978), or for other general shifts in how information is processed or represented that have been proposed (e.g., the shift between "iconic" and "conceptual" representation [Bruner et al., 1966]; or between "schematic" and "taxonomic" representation [Mandler, 1979]).

Nonetheless, acquisition of knowledge of the One-Feature Constraint on superordinate word meaning is not a simple, all-or-none process involving exposure to word meaning rules and their subsequent assimilation. Otherwise, it would have occurred microgenetically in the Learning Session in this study, during which children in the Basis Condition were repeatedly exposed to word meaning rules. Moreover, the fact that there were four levels of knowledge of the One-Feature Constraint is further proof that all-or-none learning of word meaning rules is not the process by which word meaning constraints are acquired.

One account of how rules or strategies are acquired by children that is compatible with many aspects of the development of knowledge of the One-Feature Constraint that were observed here is a recent approach termed the "learning-by-doing" approach. The proponents of this approach are Bransford, Kuhn, and others (e.g., Anzai & Simon, 1979; Bransford, Stein, Vye, Franks, Auble, Mezynski, & Perfecto, 1982; Karmiloff-Smith & Inhelder, 1977; Kuhn, Phelps, & Ho, 1982).

This group argues that what is involved in acquiring new rules or strategies is not merely coming to represent the rules, but also involves coming to assume "metacognitive control" over the rules. This transition process is a lengthy one, involving several steps (Kuhn, Phelps, & Ho, 1982). (Within this approach, strategies or rules are called "theories".) First, the "theory" has to be represented; this shift characterizes the shift between Level 1 and Level 2 knowledge of the One-Feature Constraint that was observed here. Second, the rule has to be consolidated, that is, confirmed across a variety of positive theory-outcomes. Mapping these constructs onto the transition process involved in acquiring knowledge of the One-Feature Constraint, children would have to encounter many positive theory outcomes, that is, cases of positive exemplars that possess defining functions or features of superordinate terms and negative exemplars that do not possess defining functions or features of superordinate terms. A third step involves seeing what the theory "buys one" in relation to old and favored strategies. The new theory would have to be pitted against the old theory and lead to more positive theory-outcomes than the old theory. Thus, children would have to encounter many exemplars for which an already-favored theory of superordinate word meaning (such as the Basic Level Object Class Hypothesis, which was shown here to be relied upon by kindergarteners) would lead to a negative theory outcome and for which the One-Feature Constraint (the new, to-be-acquired theory) would lead to a positive theory outcome.

Characterizing the process of knowledge acquisition as one of

assuming "metacognitive control" over the knowledge is compatible with many aspects of the development of knowledge of the One-Feature Constraint that were observed in the present study. First, as discussed, this transition model predicts that knowledge acquisition will be a lengthy process. Consistent with this prediction, development of knowledge of the One-Feature Constraint was observed here to be a lengthy process, one that could not occur microgenetically, and one that spanned an age range much broader than that which the study encompassed (e.g., more than half of the first graders had not achieved Level 4 knowledge). Second, although the shift between Level 1 and Level 2 knowledge can be characterized as a shift from not representing the constraint to representing it, other shifts involved in its development (e.g., the shift between Levels 2 and 3; the shift between Levels 3 and 4) can better be characterized as assuming increasing ability to manipulate the knowledge and assume "metacognitive control" over it.

In summary, what appeared to be developing during the period studied here to account for the onset of superordinate categorization ability was knowledge of certain constraints on superordinate word meaning, especially the One-Feature Constraint. Even though language was shown to mediate superordinate category extension in other ways than via knowledge of constraints on superordinate word meaning (i.e., via linguistic mediators 1 and 2), word meaning constraint knowledge appeared to be undergoing the greatest transition during the period under investigation here. Due to the nature of the development of this knowledge during this period, as observed here, it is proposed

that the Kuhn, Phelps, & Ho (1982) model of transitional mechanisms is a viable one within which to view this development. Although the results of the present study do not prove the relative merits of the learning-by-doing model of knowledge acquisition over other models (e.g., an information processing account of development), they are compatible with this approach.

Comparison with Previous Theory and Research

The present findings contrast with previous research and theory concerning superordinate category development in several ways. The present research indicates that what develops to account for the onset of superordinate categorization ability is the acquisition of knowledge in the form of constraints on (superordinate) word meaning. In this way, this research contrasts with many theories positing shifts in general cognitive processing or in general representational modes (e.g., the iconic-to-conceptual shift; the schematic-to-taxonomic shift; the wholistic-to-analytic shift). Similarly, it contrasts with Soviet mediation theory, which posits shifts in how information is processed (e.g., whether or not children utilize language's generalizing function in categorizing objects) rather than in what information is used (e.g., a word meaning rule designating that superordinate word meaning refers to single features). Even though language was found to "mediate" superordinate categorization in ways other than via word constraint knowledge in the present study, the changes that occurred during the period under investigation are better characterized in terms of advances in word meaning constraint

knowledge than in terms of advances in children's ability to utilize the generalizing and highlighting functions of language.

Empirically, these results diverged with past findings in several ways. One major finding was that young children's inability to extend superordinate categories does not reside in their not being able to detect the features that underlie superordinate word meaning, as has been found in previous research (e.g., Horton & Markman, 1980). In the present study, kindergarten children were very well able to detect the superordinate functions in potential referents, as evident in the function generalization data. The discrepancy between this finding and past research may reside in the fact that ecologically-valid, function-based superordinate categories were used here. Previous research has employed artificially-constructed, perceptually based superordinates. The superordinate functions of the categories used here were closely related to the goals of children's activities (e.g., measuring was important to the goal of building a wagon), and this may have enhanced children's ability to detect the functions in individual objects. The present finding refutes the claim that there is something intrinsically "abstract" and difficult to detect about the nature of the features that underlie superordinate categories (Horton & Markman, 1980; Mervis & Crisafi, 1982).

The present findings diverged from past claims and research on word meaning constraints in three major ways. First, a new constraint on superordinate word meaning, the One-Feature Constraint, was proposed. This is a variant of the Similarity Constraint, which is typically assumed to underlie superordinate word meaning (e.g.,

Markman, 1984). It is proposed here that the One-Feature Constraint more adequately characterizes what the child would have to know in order to extend superordinate words correctly than the Similarity Constraint. Although the two constraints were not directly pitted against one another in the present research, a converging pattern of results indicated that the One-Feature Constraint is an important mediator of superordinate category extension.

A second difference between the present and past research was that young children evidenced less knowledge of word meaning constraints related to superordinate word meaning than has been found in previous studies (e.g., Markman & Hutchinson, 1984; Gelman & Waxman, 1986). The present results indicate that knowledge of the One-Feature Constraint is not operative in most kindergarteners, and rapidly develops during the early school-age period such that it is operative (i.e., reaches Level 3 status) in most first graders. The previous research has shown word constraint knowledge relative to the superordinate level to be operative during the preschool period.

One reason for this difference may reside in the fact that the tasks used in this study involved extension of superordinate categories to new referents, rather than to already-known referents of the categories. The tasks used in previous research involve the extension of categories to objects for which children already know the superordinate names. Since the claims about the role of superordinate word meaning constraints are typically made for learning and extension of new superordinates, rather than about the extension of words to known referents, the tasks that were used here are actually more

appropriate for testing the claims made about the impact of the constraints on superordinate word learning than those that have been used in past research.

The difference between results may be viewed in terms of problems of performance rather than of competence. Children may possess knowledge of the constraints, but may only be able to use the knowledge when other task demands are minimal. For example, the finding that children appear to use knowledge of superordinate word meaning constraints on match-to-sample tasks with known referents may be viewed in terms of seeing the competing demands made on children on these tasks as being kept to a minimum. Within this framework, constraint theorists' claims need only be modified to state that children appear to have knowledge of superordinate word meaning constraints early on, and that they are operative on certain tasks, but do not appear to be operative in word learning and extension situations.

Certainly, it is an important finding that children perceive different constraints on verbal-semantic (i.e., word-meaning related) and real-world organization early on, as the studies of Markman and Hutchinson (1984) and Waxman and Gelman (1986) demonstrate. It is very likely that the more sophisticated levels of knowledge of the constraints needed for word learning and extension build on this earlier-available sensitivity to unique organizational principles of language. However, the transition between levels and types of word constraint knowledge is an important issue that needs to be addressed.

Whenever developmental differences are noted in research on word

meaning constraints, these are usually attributed to information processing constraints, i.e., constraints on general cognitive processing and younger children's deficit in having mastered general memory and problem-solving skills that would free up working capacity in the problem space. The results of the present experiment, in being compatible with the Kuhn, Phelps, and Ho (1982) model of knowledge development, suggest another possibility: that it is the development of specific knowledge, rather than the development of general problem solving skills or mnemonic strategies, that underlies the changing ability of children to apply the constraints. Children merely have to undergo the types of learning experiences implicated by Kuhn, Phelps, and Ho's model (e.g., situations that pit children's favored strategies against the to be-applied strategy) in order to assume increasing metacognitive control over the word meaning constraints.

The results of the present experiment are compatible with Kuhn, Phelps, and Ho's model but do not rule out the information processing account. The proposal that knowledge acquisition consists of assuming increasing metacognitive control over knowledge of particular rules is a more parsimonious account of the present findings than the proposal that some unspecified general problem solving skill or mnemonic strategy is being acquired, as an information processing account would maintain. However, the relative merits of the two approaches can be tested directly. Children in the "transitional period" can be given the types of training experiences proposed by the Kuhn, Phelps, and Ho's model over a short (e.g., three-month) period. These children's progress in being able to apply the One-Feature

Constraint can be compared to a control group that receives equal exposure to the principle in terms of number of times referred to but that does not receive the types of training experiences alluded to by the model. Moreover, children's progress in terms of possible "general" cognitive skills can be measured and controlled for through correlational or other measures.

A third major difference between the present research and past claims that have been made was that, in contrast to the claims of word meaning constraint theorists, the present findings indicate that it is very difficult for young children, even first graders (who possess a great deal of knowledge of the One-Feature Constraint), to deduce word meaning in ostensive word learning situations (i.e., in the No-Basis Condition). These children simply do not possess the level of One-Feature Constraint knowledge that is required for such deduction (i.e., Level 4 knowledge). Or even if they do, other problems, such as incomplete development of the Contrastive Hypothesis, and the fact that features other than those that underlie the word meanings may be shared among the child's earliest-encountered referents of the words, may impede superordinate label extension. Again, one reason that word constraint theorists have overlooked these problems and deficits is that they have not examined how the constraints actually operate in contexts approximating naturalistically-occurring processes of superordinate category learning and extension.

As noted previously, most of the claims that are made for how word meaning constraints operate are made about ostensive learning situations. However, the degree to which such situations approximate

naturally-occurring ones is called into question by recent research (e.g., Lucariello & Nelson, 1986) indicating that word learning more often proceeds via explicit mention of the functions underlying word meaning (as in the Basis condition in this study) than via ostensive definition (as in the No-Basis Condition). Moreover, this type of explicit instruction may better characterize the word learning situation as it occurs in the classroom, possibly accounting for the rapid development of knowledge of the One-Feature Constraint during the early school-age period of development that was observed here.

In summary, the present findings diverge from many previous theories superordinate category development in indicating that it is knowledge of particular word meaning rules, in the form of constraints on superordinate word meaning, that is developing during the period just prior to onset of superordinate categorization ability, rather than changes in general cognitive processing or representational modes. The present findings also diverge from previous research and theory on word meaning constraints, and this may be due to the fact that the present study examined the operation of the constraints in an ecologically-valid context of superordinate word learning and extension that may have required more advanced levels of knowledge of the constraints than those required on tasks used in previous research. Finally, the way in which knowledge of the One-Feature Constraint appeared to develop during the age span examined in this study, in being compatible with the Kuhn, Phelps, and Ho (1982) model of knowledge development, raises the possibility that increasing ability to apply the constraint is due to the types of learning

experiences alluded to by the model (involving encountering a judicious mix of negative and positive theory outcomes and pitting the specific rule against alternative rules) rather than to the acquisition of general problem-solving or cognitive skills.

Implications

The most important finding to emerge from this research was that knowledge of the One-Feature Constraint appeared to afford children a powerful new tool of conceptual thinking. It enabled children to utilize broad, functional features that didn't appear to carry much psychological coherence for these children (e.g, measuring; fastening) as a basis for category formation. Without the word constraint knowledge, they did not seem to be able to utilize such features as an equivalence or grouping basis, even though they detected the features in individual potential referents. Thus, knowledge of this word meaning constraint may free children from the entailments of their phenomenological experience, allowing them to use features as a basis for forming groupings that do not carry much conceptual coherence for these children. Another way of saying this is that word constraint knowledge may effect an "abstract orientation", allowing children to utilize arbitrarily designated criteria as the basis for forming all kinds of categories they would not have been able to form previously.

The finding that superordinate category formation is facilitated by children's use of a One-Feature Constraint on superordinate word meaning is, at first glance, inconsistent with a great deal of recent research (e.g., Rosch et al., 1976) showing that category formation does not proceed in accordance with the classical view, which claims that categories are organized in terms of necessary and sufficient features. However, it is not being claimed here the One-Feature Constraint is the only means by which children acquire categories at

all hierarchical levels, or even that it is the only way by which they form superordinates. In fact, the literature reviewed in the Introduction indicates that long before the age of onset of productive use of the One-Feature Constraint, as observed here, children have a lot of knowledge of superordinate categories, which suggests that they can rely on other processes for forming such categories (e.g., a prototype-based strategy). The only claim being made here is that the One-Feature Constraint may enable broader and more facile extension of superordinates to novel referents, including referents that are not conceptually coherent, for whatever reason, with the earliest-encountered or prototypical members of the superordinate. Thus, the constraint, once mastered to its productive level, may enable extension of superordinates to many more of their potential subsets than would have been included otherwise, and may render superordinate categories with greater ability to serve as a basis for the deployment of organizational strategies on cognitive tasks. The constraint may therefore account for some of the developmental phenomena discussed in the introduction (e.g., the less "fragmented" superordinates we see in older children, and their ability to make use of superordinate categories on a greater number of cognitive tasks).

In conclusion, language, in the form of knowledge of the One-Feature Constraint on superordinate word meaning, may serve to "bootstrap" the child into being able to form the type of categories envisioned in the classical view. However, such categories do not not characterize all categories available for use on all cognitive tasks, at all developmental levels, nor at all hierarchical levels within

taxonomies.

TABLE 1

Mean Number of Learning Exemplars to Which Superordinate Labels Were Learned by Grade, Inclusion Condition, and Basis Condition

Inclusion Condition =		No	No	Yes	Yes	
Basis Condition =		No	Yes	No	Yes	Marginal
<u>Grade</u>						
Kindergarten	M	4.00	2.70	1.80	2.90	2.85
	(SD)	(3.62)	(2.91)	(1.55)	(2.69)	
First	M	6.60	6.80	3.70	5.80	5.73
	(SD)	(3.30)	(3.36)	(3.19)	(4.21)	
Marginal		5.30	4.75	2.75	4.35	4.29

Note: Maximum Possible Score = 9.00

TABLE 2

Mean Number of Superordinate Words Learned to Two or More Exemplars by
Grade, Inclusion Condition, and Basis Condition

Inclusion Condition =		No	No	Yes	Yes	
Basis Condition =		No	Yes	No	Yes	Marginal
<u>Grade</u>						
Kindergarten		1.40	0.70	0.50	0.70	0.83
First		2.20	2.30	1.20	2.20	1.98
Marginal		1.80	1.50	0.85	1.45	1.41

Note: Maximum Possible Score = 9.00

TABLE 3

Mean Non-Hierarchical and Hierarchical Label Generalization Scores by
Grade, Inclusion Condition, and Basis Condition

Inclusion Condition =		No	No	Yes	Yes	
Basis Condition =		No	Yes	No	Yes	Marginal
<u>Grade</u>						
Kindergarten						
Non-Hierarchical	M	3.30	1.90	1.20	3.10	2.38
	(SD)	(2.11)	(1.85)	(1.81)	(4.33)	
Hierarchical	M	2.50	3.40	1.40	4.20	2.88
	(SD)	(2.12)	(3.66)	(1.07)	(4.47)	
First Grade						
Non-Hierarchical	M	3.30	8.10	2.50	7.40	5.33
	(SD)	(3.68)	(4.46)	(2.37)	(4.93)	
Hierarchical	M	4.10	8.20	1.40	9.10	5.70
	(SD)	(3.31)	(4.24)	(1.43)	(4.46)	
Marginal		3.30	5.40	1.63	5.95	4.07

Note: Maximum Possible Score = 16.00

TABLE 4

Mean Number of Superordinate Labels Generalized by Grade, Inclusion Condition, and Basis Condition

Inclusion Condition =		No	No	Yes	Yes	
Basis Condition =		No	Yes	No	Yes	Marginal
<u>Grade</u>						
Kindergarten		0.30	0.10	0.40	0.60	0.35
First		0.40	2.00	0.30	2.00	1.18
Marginal		0.35	1.05	0.35	1.30	0.77

Note: Maximum Possible Score = 3.00

TABLE 5

Mean Non-Hierarchical and Hierarchical Function Generalization Scores
by Grade, Inclusion Condition, and Basis Condition

Inclusion Condition =		No	No	Yes	Yes	
Basis Condition =		No	Yes	No	Yes	Marginal
<u>Grade</u>						
Kindergarten						
Non-Hierarchical	M	8.70	9.67	7.00	10.30	8.92
	(SD)	(2.63)	(1.58)	(2.16)	(2.36)	
Hierarchical	M	7.50	9.78	7.70	9.20	8.55
	(SD)	(1.72)	(1.20)	(2.06)	(2.04)	
First Grade						
Non-Hierarchical	M	9.44	10.63	11.56	8.67	10.07
	(SD)	(1.51)	(2.07)	(2.24)	(3.87)	
Hierarchical	M	9.22	9.25	9.67	9.89	9.51
	(SD)	(1.39)	(1.67)	(1.80)	(2.03)	
Marginal		8.72	9.83	9.26	9.52	9.26

Note: Maximum Possible Score = 16.00

TABLE 6

Mean Percentage of Non-Hierarchical and Hierarchical Function-
Generalized Transfer Objects that were also Label-Generalized by
Grade, Inclusion Condition, and Basis Condition

Inclusion Condition =		No	No	Yes	Yes	
Basis Condition =		No	Yes	No	Yes	Marginal
<u>Grade</u>						
Kindergarten						
Non-Hierarchical	M	31.9	11.1	10.0	25.1	19.5
	(SD)	(22.5)	(10.1)	(22.4)	(33.8)	
Hierarchical	M	24.9	26.8	06.9	29.9	21.1
	(SD)	(25.3)	(25.3)	(07.9)	(39.6)	
First Grade						
Non-Hierarchical	M	15.7	54.7	15.8	56.9	35.8
	(SD)	(08.8)	(33.2)	(19.6)	(38.6)	
Hierarchical	M	20.6	58.3	12.0	63.5	38.6
	(SD)	(14.4)	(32.3)	(14.0)	(36.8)	
Marginal		23.3	37.7	11.2	43.9	28.3

TABLE 7

Mean Label-Generalization Scores for Experimenter-Generalized and Non-Generalized Transfer Objects by Grade, Inclusion Condition, Basis Condition, and Generalization Object Type

Inclusion Condition =	No	No	Yes	Yes		
Basis Condition =	No	Yes	No	Yes	Marginal	
<u>Grade</u>						
<u>Kindergarten</u>						
<u>Non-Hierarchical</u>						
Experimenter-Generalized	M (SD)	2.70 (1.83)	2.90 (1.37)	2.40 (1.71)	3.40 (1.17)	2.85
Non-Generalized	M (SD)	2.60 (1.50)	3.50 (0.85)	1.50 (1.08)	3.50 (1.65)	2.78
<u>Hierarchical</u>						
Experimenter-Generalized	M (SD)	2.20 (1.66)	2.89 (1.64)	2.10 (1.14)	2.70 (1.52)	2.47
Non-Generalized	M (SD)	1.80 (1.03)	2.89 (0.60)	2.10 (0.99)	2.60 (0.97)	2.35
<u>First Grade</u>						
<u>Non-Hierarchical</u>						
Experimenter-Generalized	M (SD)	3.60 (1.58)	3.20 (1.40)	4.20 (1.03)	3.80 (1.55)	3.70
Non-Generalized	M (SD)	3.10 (1.10)	4.00 (1.05)	4.10 (1.52)	3.10 (1.85)	3.58
<u>Hierarchical</u>						
Experimenter-Generalized	M (SD)	2.67 (1.09)	3.00 (1.96)	2.89 (1.59)	3.56 (2.03)	4.04
Non-Generalized	M (SD)	2.56 (0.88)	2.50 (1.20)	3.11 (0.93)	2.78 (1.09)	2.74
Marginal		2.64	3.11	2.80	3.18	2.93

Note: Maximum Possible Score = 6.00

TABLE 8

Mean Frequency of "None-of-Those-Things" Responses for Non-Hierarchical and Hierarchical Transfer Objects by Grade, Inclusion Condition, and Basis Condition

Inclusion Condition =		No	No	Yes	Yes	
Basis Condition =		No	Yes	No	Yes	Marginal
<u>Grade</u>						
<u>Kindergarten</u>						
Non-Hierarchical	M	6.70	2.60	0.50	2.50	3.08
	(SD)	(6.43)	(3.86)	(0.84)	(3.57)	
Hierarchical	M	7.30	4.10	0.60	3.10	3.78
	(SD)	(6.80)	(4.46)	(1.35)	(5.24)	
<u>First Grade</u>						
Non-Hierarchical	M	2.70	3.80	2.00	2.80	2.83
	(SD)	(2.79)	(2.57)	(3.13)	(2.20)	
Hierarchical	M	3.30	4.20	2.40	3.70	3.40
	(SD)	(5.52)	(2.82)	(4.58)	(3.09)	
Marginal		5.00	3.68	1.38	3.03	3.27

Note: Maximum Possible Score = 16.00

TABLE 9

Mean Non-Hierarchical and Hierarchical Sorting Scores by Grade,
Inclusion Condition, and Basis Condition

Inclusion Condition =		No	No	Yes	Yes	
Basis Condition =		No	Yes	No	Yes	<u>Marginal</u>
<u>Grade</u>						
<u>Kindergarten</u>						
Non-Hierarchical	M	9.20	9.40	9.70	8.90	9.30
	(SD)	(1.62)	(1.26)	(1.16)	(2.42)	
Hierarchical	M	8.10	8.10	8.70	8.00	8.23
	(SD)	(2.77)	(2.42)	(1.95)	(2.62)	
<u>First Grade</u>						
Non-Hierarchical	M	8.80	7.00	7.60	5.90	7.33
	(SD)	(2.90)	(2.87)	(3.17)	(3.18)	
Hierarchical	M	7.70	6.10	8.00	4.80	6.65
	(SD)	(2.50)	(2.42)	(3.13)	(2.78)	
<u>Marginal</u>		8.45	7.65	8.50	6.90	7.88

Note: Maximum Possible Score = 13.00

Appendix A:

Prelude Statements Used During Learning Session

Prelude Statement - No-Inclusion, No-Basis Condition

Today we're going to learn about three new things, gauges, daxes, and fids. Can you say those words? Gauges.....Daxes.....Fids.....

We're going to use all of these things on the table to help us make a wagon. Some of the things will be gauges, some will be daxes, some will be fids, and some won't be any of those things. Try to remember what each thing is called because later I'll ask you to remember what each thing is called.

Prelude Statement - Inclusion, No-Basis Condition

Today we're going to learn about three new things, gauges, daxes, and fids. Can you say those words? Gauges.....Daxes.....Fids.....

We're going to use all of these things on the table to help us make a wagon. Some of the things will be kinds of gauges, some will be kinds of daxes, some will be kinds of fids, and some won't be kinds of any of those things. Try to remember what each thing is called because later I'll ask you to remember what each thing is called.

Prelude Statement - No-Inclusion, Basis Condition

Today we're going to learn about three new things, gauges, daxes, and fids. Gauges are things that measure. Can you say that? Daxes are things that attach things together and hold things together. Can you say that? Fids are for-extra things you add to something to help make it a little better. Like to make it more pretty, more safe, or more fun. Can you say that?

We're going to use all of these things on the table to help us make a wagon. Some of the things will be gauges, some will be daxes, some will fids, and some won't be any of those things. Try to remember what each thing is called because later I'll ask you to remember what each thing is called.

Prelude Statement - Inclusion, Basis Condition

Today we're going to learn about three new things, gauges, daxes, and fids. Gauges are things that measure. Can you say that? Daxes are things that attach things together and hold things together. Can you say that? Fids are for-extra things you add to something to help make it a little better. Like to make it more pretty, more safe, or more fun. Can you say that?

We're going to use all of these things on the table to help us make a wagon. Some of the things will be kinds of gauges, some will be kinds of daxes, some will be kinds of fids, and some won't be kinds of any of those things. Try to remember what each thing is called because later I'll ask you to remember what each thing is called.

Appendix B: Stimuli

<u>Superordinate Category</u>	Learning	<u>Session</u>	
		Hierarchical Generalization	Non-Hierarchical Generalization
Gauges (Measuring Things)	surface gauge level contour pattern gauge	scale thermometer tape measure clock	micrometer t-bevel chalkline tool divider
Daxes (Fasteners)	dowel corrugated fastener latch	scotch tape paper clip shoe lace button	swivel snap clasp rivet nametag tie
Fids (Accessories)	number glide caster cup	headphones necklace bike horn sunglasses	corner rhinestone horsehair hank Indian claw
Foils	brace punch haft	marble comb nail clip can opener	setting tool sanding block anvil punch pliers

References

- Anglin, J. (1977). Word, object, and conceptual development. New York: Norton.
- Anglin, J. (1983). Extensional aspects of the preschool child's word concepts. In T. Seiler & W. Wannenmacher (Eds.), Concept development and the development of word meaning (pp. 247-266). Berlin: Springer-Verlag.
- Anzai, Y. & Simon, H. A. (1979). The theory of learning by doing. Psychological Review, 86, 124-140.
- Barrett, M. D. (1978). Lexical development and overextension in child language. Journal of Child Language, 5, 205-219.
- Bjorkland, D.F. (1980). Children's identification of category relations in lists presented for recall. Journal of Genetic Psychology, 136, 45-53.
- Bjorkland, D.F. & Jacobs, J.W. III (in press). Associative and categorical processes in children's memory: The role of automaticity in the development of organization in free recall. Journal of Experimental Psychology.
- Blewitt, P. (1983, April). What determines order of acquisition of object categories? Paper presented at the meeting of the Society for Research in Child Development, Detroit, Michigan.
- Bloom, L. (1973). One word at a time: The use of single word utterances before syntax. The Hague: Mouton.
- Bousfield, W.A., Esterson, J., & Whitmarsh, G.A. (1958). A study of developmental changes in conceptual and perceptual associative clustering. Journal of Psychology, 92, 95-102.
- Bowerman, M. (1977). The acquisition of word meaning: An investigation of some current conflicts. In P.N. Johnson-Laird & P. C. Wason (Eds.), Thinking (pp. 239-253). Cambridge: Cambridge University Press.
- Bransford, J.D., Stein, B.S., Vye, N.J., Franks, J. J., Auble, M., Mezynski, K.J., & Pefecto, g.A. (1982). Differences in approaches to learning: An overview. Journal of Experimental Psychology: General, 111: 390-398.
- Bruner, J., Olver, R., & Greenfield, P. M. (1966). Studies in cognitive growth. New York: Wiley.

- Callanan, M. (1985). How parents label objects for young children: The role of input in the acquisition of category hierarchies. Child Development, 56, 508-523.
- Callanan, M. & Markman, E. M. (1982). Principles of organization in young children's natural language hierarchies. Child Development, 53, 1093-1101.
- Clark, E. V. (1973). What's in a word? On the child's acquisition of semantics in his first language. In T. E. Moore (Ed.), Cognitive development and the acquisition of language (pp. 65-110). New York: Academic Press.
- Clark, E. V. (1983). Meanings and concepts. In J.H. Flavell & E. M. Markman (Eds.), Cognitive development (pp. 787-840). Vol. 3 of P. Mussen (Ed.), Handbook of child psychology, 4th ed. New York: Wiley.
- Cole, M., Frankel, F., & Sharp, D. (1971). Development of free recall learning in children. Developmental Psychology, 4, 109-123.
- Cole, M. Gay, J., Glick, J.A. & Sharp, D.W. (1971). The cultural context of learning and thinking. New York: Basic Books.
- Entwisle, D. R. (1966). The word associations of young children. Baltimore, Md.: Johns Hopkins University Press.
- Frankel, M.T. and Rollins, H. A. (1985). Associative and categorical hypotheses of organization in the free recall of adults and children. Journal of Experimental Child Psychology, 27, 150-161.
- Furth, H.G., & Milgram, N.A. (1973). Labelling and grouping effects in the recall of pictures by children. Child Development, 44, 511-518.
- Gelman, R. & Baillargeon, R. (1983). A review of some Piagetian concepts. In J.H. Flavell and E.M. Markman, (Eds.,) Carmichael's Manual of Child Psychology, Vol. 3, New York: Wiley, 1983.
- Gruendel, J. (1977). Referential extension in early language development. Child Development, 48, 1567-1576.
- Hagen, J.W., Jongeward, R.H., Jr., & Kail, R.V., Jr. (1973). Cognitive perspective on the development of memory. In H. Reese (Ed.). Advances in child development and behavior (Vol. 10, pp. 57-101). New York: Academic Press.
- Halperin, M.S. (1974). Developmental changes in the recall and recognition of categorical word lists. Child Development, 45, 144-151.

- Haynes, C.R., & Kulhavy, R.M. (1976). Conservation level and category clustering, Child Development, 12, 179-184.
- Horton, M.S. (April, 1983). The development of hierarchical and contrastive organization in natural category domains. Paper presented at the meeting of the Society for Research in Child Development, Detroit, Michigan.
- Horton, M.S. & Markman, E.M. (1980). Developmental differences in the acquisition of basic and supordinate categories. Child Development, 51, 708-719.
- Huttenlocher, J. & Lui, F. (1979) The semantic organization of some simple nouns and verbs. Journal of Verbal Learning and Verbal Behavior, 18, 141-162.
- Inhelder, B. & Piaget, J. (1964). The early growth of logic in the child. New York: Harper & Row.
- Karmiloff-Smith, A., & Inhelder, B. (1977). 'If you want to get ahead, get a theory.' In P. N. Johnson-Laird & P. C. Wason (Eds.), Thinking: Readings in cognitive science (pp. 293-306). Cambridge, England: Cambridge University Press.
- Keil, F. (1981). Constraints on knowledge and cognitive development. Psychological Review, 88, 197-227.
- Kobasigawa, A. & Middleton, D.B. (1972). Free recall of categorized items by children at three grade levels. Child Development, 43, 1067-1072.
- Kobasigawa, A. & Orr, R. R. (1973). Free recall and retrieval speed of categorized items by kindergarten children. Journal of Experimental Child Psychology, 15, 187-192.
- Kuhn, D., Phelps, E., & Ho, V. (1982). The development of problem-solving strategies. Unpublished manuscript, Harvard University.
- Kyratzis, A., Lucariello, J., Nelson, K. (1988). Complementary, slot-filler, and taxonomic relations as memory organizers for young children. Unpublished manuscript, City University of New York.
- Lange, G. (1973). The development of conceptual and rote recall skills among school age children. Journal of Experimental Child Psychology, 15, 394-407.
- Lange, G. (1978). Organization-related processes in children's recall. In P. Ornstein, (Ed.), Memory development in children Hillsdale, N. J.: Lawrence Erlbaum.

- Lucariello, J. (1987). Concept formation and its relation to word learning and use in the second year. Journal of Child Language, 14, 309-332.
- Lucariello, J. & Nelson, K. (1985). Slot-filler categories as memory organizers for young children. Developmental Psychology, 21, 272-282.
- Lucariello, J. & Nelson, K. (1986). Context effects on lexical specificity in maternal and child discourse. Journal of Child Language, 13, 507-522.
- Luria, A. (1961). The role of speech in the regulation of normal and abnormal behavior. New York: Liveright Publishing Corp.
- Lyons, J. (1977). Semantics (Vol.1). Cambridge: Cambridge University Press.
- Macnamara, J. (1982). Names for things. Cambridge, Mass.: M.I.T. Press.
- Mandler, J.M. (1979). Categorical and schematic organization in memory. In C.R. Puff (Ed.), Memory organization and structure (pp. 259-299). New York: Academic Press.
- Mandler, J.M. (1983). Representation. In J.H. Flavell & E.M. Markman (Eds.), Cognitive development. Vol. 3 of P. Mussen (Ed.), Manual of child psychology (4th ed., Vol. 3, pp. 420-494). New York: Wiley.
- Markman, E. M. (1984). Constraints children place on possible word meanings. Unpublished manuscript, Stanford University.
- Markman, E.M., Cox, B. & Machida, S. (1981). The standard object-sorting task as a measure of conceptual organization. Developmental Psychology, 17, 115-117.
- Markman, E.M., Horton, M. S., & McLanahan, A.G. (1980). Classes and collections: Principles of organization in learning of hierarchical relations. Cognition, 8, 227-241.
- Markman, E.M. & Hutchinson, J. E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic vs. thematic relations. Cognitive Psychology, 16, 1-27.
- Markman, E.M. & Seibert, J. (1976). Classes and collections: Internal organization and resulting holistic properties. Cognitive Psychology, 8, 561-577.

- Mervis, C. B. & Crisafi, M. (1982). Order of acquisition of subordinate-, basic-, and superordinate-level categories. Child Development, 53, 267-273.
- Miller, G. A. & Johnson-Laird, P.N. (1976). Language and perception. Cambridge, Mass.: Harvard University Press.
- Moely, B.E., Olson, F.A., Halwes, T.G., & Flavell, J.H. (1969). Production deficiency in young children's clustered recall. Developmental Psychology, 1, 26-34.
- Moely, B.E. & Shapiro, S.I. (1971). Free recall and clustering at four age levels: Effects of learning to learn and presentation method. Developmental Psychology, 4, 490.
- Moran, L. J. (1973). Comparative growth of Japanese and North American cognitive dictionaries. Child Development, 44, 862-865.
- Myers, N.A. & Perlmutter, M. (1978). Memory in the years from two to five. In P.A. Ornstein (Ed.), Memory development in children (pp. 191-218). Hillsdale, NJ: Erlbaum.
- Nelson, K. (1969). The organization of free recall by young children. Journal of Experimental Child Psychology, 8, 284-295.
- Nelson, K. (1973). Some evidence for the cognitive primacy of categorization and its functional basis. Merill-Palmer Quarterly of Behavior and Development, 19, 21-39.
- Nelson, K. (1973). Structure and strategy in learning to talk. Society for Research in Child Development Monographs, 38, (1-2 Serial No. 149).
- Nelson, K. (1974). Concept, word, and sentence: Interrelations in acquisition and development. Psychological Review, 81, 267-285.
- Nelson, K. (1974). Variations in children's concepts by age and category. Child Development, 45, 577-584.
- Nelson, K. (1977). The syntagmatic-paradigmatic shift revisited: A review of research and theory. Psychological Bulletin, 84, 93-116.
- Nelson, K. (1978). Semantic memory. In K.E. Nelson, (Ed.), Children's language: Volume 1. (pp. 39-81). New York: Gardner Press.
- Nelson, K. (1979). Explorations in the development of a functional semantic system. In W. Collings (Ed.), Children's language and communication, Child Psychology (Vol. 12) (pp. 47-81). Hillsdale, N.J.: Erlbaum.

- Nelson, K. (1982). The syntagmatics and paradigmatics of conceptual representation. In S. Kuczaj (Ed.), Language Development: Language, thought and culture (pp. 335-364). Hillsdale, N.J: Erlbaum.
- Nelson, K. (1985). Toward making sense: Development of meaning in early childhood. New York: Academic Press.
- Nelson, K. & Gruendel, J. (1981). Generalized event representations: Basic building blocks of cognitive development. In M. Lamb & A. Brown (Eds.), Advances in developmental psychology (Vol. 1, pp. 131-158). Hillsdale, N.J.: Erlbaum.
- Nelson, K., Kessen, W., & Platt, J. (1978). Cognitive processing in later infancy. Unpublished manuscript, Yale University.
- Olver, R.R. & Hornsby, J.R. (1966). On equivalence. In J.S. Bruner, R. R. Olver, & P.M. Greenfield (Eds.), Studies in cognitive growth (pp. 68-85). New York: Wiley:
- Ornstein, P.A. & Corsale, K. (1979). Organization factors in children's memory. In C.R. Puff (Ed.), Memory organization and structure (pp. 219-257). New York: Academic Press.
- Osler, S.F. & Kofsky, E. (1965). Stimulus uncertainty as a variable in the development of conceptual ability. Journal of Experimental Child Psychology, 2, 264-279.
- Penk, W. E. (1971). Developmental changes in idiodynamic sets of children's word associations. Developmental Psychology, 5, 55-63.
- Perlmutter, M. & Myers, N.A. (1979). Development of recall in 2-to 4-year old children. Developmental Psychology, 15, 73-83.
- Perlmutter, M., Sophian, C., Mitchell, D.B. & Cavanaugh, J.C. (1981). Semantic and contextual cuing of preschool children's recall. Child Development, 52, 873-881.
- Petrey, S. (1977). Word association norms and the development of lexical memory. Cognition, 5, 57-71.
- Prawatt, R. S. & Cancelli, A. A. (1977). Semantic retrieval in young children as a function of type of memory. Developmental Psychology, 13, 354-358.
- Rescorla, L. (1980). Category development in early language. Journal of Child Language, 8, 225-238.
- Riccuiti, H. (1965). Object grouping and selective ordering in infants 12-24 months old. Merrill Palmer Quarterly, 11, 129-48.

- Rosch, E. (1979). 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.D., Johnson, D.M., & Boyes-Braem, P. (1976). Basic objects in natural categories. Cognitive Psychology, 8, 382-489.
- Ross, G. (1980). Concept categorization in 1- to 2-year-olds. Developmental Psychology, 16, 391-396.
- Ross, G., Nelson, K. Wetstone, H., Tanouye, E. (1985). Acquisition of novel object concepts by young language learners. Journal of Child Language.
- Rossi, E.L. & Rossi, S.I. (1965). Concept utilization, serial order and recall in nursery school children. Child Development, 36, 771-9.
- Rumelhart, D. E. & Ortony, A. (1977). The representation of knowledge in memory. In R. C. Anderson, R. J. Shapiro, & W. E. Montague (Eds.), Schooling and the acquisition of knowledge (pp. 99-135). Hillsdale, N. J.: Lawrence Erlbaum.
- Saltz, E., Soller, E. & Sigel, I.E. (1972). The development of natural language concepts. Child Development, 1972, 43, 1191-1202.
- Scribner, S. (1977). Modes of thinking and ways of speaking: Culture and logic reconsidered. In P. N. Johnson-Laird & P.C. Wason (Eds.), Thinking: Readings in cognitive science (pp. 483-500). Cambridge, England: Cambridge University Press.
- Shipley, E., Kuhn, I. & Colby Madden, E. (1983). Mothers' use of superordinate category terms. Journal of Child Language, 10, 571-588.
- Smith, E.E., & Medin, D.L. (1981). Categories and concepts. Cambridge, Mass.: Harvard University Press.
- Smiley, S.S. & Brown, A.L. (1979). Conceptual preferences thematic or taxonomic relations: A non-monotonic trend from pre-school to old age. Journal of Experimental Child Psychology 28, 249-257.
- Steinberg, E.R. & Anderson, R.C. Hierarchical semantic organization in 6-year olds. Journal of Experimental Child Psychology, 1975, 19, 544-553.

- Sugarman, S. (1981). The cognitive basis of classification in very young children: An analysis of object ordering trends. Child development, 52, 1172-1178.
- Tversky, B. (1986). Development of taxonomic organization named and pictured categories. Developmental Psychology, 21, 1111-1119.
- Vaughan, M.E. (1968). Clustering, age and incidental learning. Journal of experimental child psychology, 6, 323-334.
- Vygotsky, L.S. (1962). Thought and language. Cambridge, MA: The M.I.T. Press.
- Vygotsky, L. S. (1978). Mind in society. Cambridge, MA: The M.I.T. Press.
- Wales, R., Colman, M., & Pattison, P. (1983). How a thing is called: A study of mothers' and children's naming. Journal of Experimental Child Psychology, 36, 1-17.
- Walker, C.M., & Bourne, L.E., Jr. Concept identification as a function of amounts of relevant and irrelevant information. American Journal of Psychology, 1961, 74, 410-417.
- Waxman, S. H. & Gelman, R. (1986). Preschoolers' use of superordinate relations in classification and language. Cognitive development, 1, 139-156.
- White, T. (1982). Naming practices, typicality, and underextension in child language. Journal of Experimental Child Psychology, 33, 324-346.
- Wittgenstein, I. (1953). Philosophical investigations. New York: Macmillan, 1953.