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ABSTRACT

Forty-eight nursery school and kindergarten children participated in a study of concept learning. The study focused on children's use of intensional and extensional information in the acquisition of basic and superordinate categories. The intension of a concept is its definition or set of defining attributes; its extension is the set of all exemplars. The children completed a concept training task using natural categories assigned into basic and superordinate levels. Each child was trained on two categories at the same level, one through extensional information alone and one through combined extensional and intensional information. After training on both categories, each child participated in two successive tests for each category: a discrimination test that measured learning in terms of the child's ability to identify old training exemplars as positive, to generalize to new exemplars, and to discriminate between exemplars and distractors; and a sorting exercise that required the children to sort a series of pictures used in the training task into groups of positive exemplars and nonexemplars. The results indicated that the children acquired basic level categories more easily than superordinate categories, that intensional information benefited the acquisition of categories only at the superordinate level, and that children's ability to take advantage of the intensional information for their acquisition of superordinate categories developed with age. (FL)

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Children's Use of Extensional and Intensional Information in the Acquisition of Basic and Superordinate Categories

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Today I would like to report on research that I have conducted in conjunction with Ellen Markman on the young child's acquisition of natural categories. Since our predictions were based on work by Eleanor Rosch and her colleagues (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976), I will briefly review their work.

Rosch distinguishes between basic and superordinate categories. At the basic level of categorization, cuts are made that produce categories that carry the most information and are most distinguishable from each other. Members of basic level categories, such as chair, are very similar to each other perceptually and/or functionally and are also very different from members in contrasting basic categories, for example, table. In contrast, superordinate categories, such as furniture, are more inclusive -- with less perceptual or functional similarity among members, such as among lamps, chairs and tables. Rosch finds evidence that basic level terms are acquired in the child's vocabulary prior to superordinate level terms. Rosch also finds that children's taxonomic categorization is better at the basic level. We were interested in what mechanisms for acquiring basic and superordinate categories would result in such differential acquisition. We investigated the interactions of three factors in this acquisition process: the nature of the category, the type of information available and the age of the child.

Given these differences between basic and superordinate categories, we

hypothesized that different types of information would be most useful for their acquisition. In traditional research on concept learning, an underlying distinction is made between the intension and extension of a concept. The intension of a concept is its definition or set of defining attributes, and its extension is the set of all exemplars. We hypothesized that extensional information, in the form of exemplars, would be sufficient for the acquisition of basic level categories given the perceptual similarity among category members. Extensional information is hypothesized to be inadequate for complete acquisition of superordinate categories. In particular, linguistic information specifying salient defining features of the exemplars may help the child to understand the basis for category membership. If the child's abilities to use linguistic information improve with age, we might find developmental differences in the use of this intensional information in acquisition. Younger children may depend far more on extensional information than intensional, regardless of the type of concept. They might not be able to utilize the linguistic information as well as older children despite its potential value for learning. Specifically, we predicted that older children would benefit more from the intensional information than younger children. We argued that this advantage would be critical only for superodinate categories, and not for basic categories with their high degree of similarity among members.

In sum, we predicted that intensional and extensional information would be differentially useful in the acquisition of natural categories depending on the nature of the category and the age of the child.

We examined these hypotheses in a concept training task,, using natural biological categories. Through pilot studies involving children's taxonomic

sorting and adult's ratings of features, we assigned the specific categories into basic and superordinate levels and also measured the children's a priori knowledge of the categories. This pilot work also guided our selection of salient criterial features to use in our similarity scaling of exemplars and distractors. The basic categories were salamanders and squid and the superordinate categories were hooved mammals, or ungulates, and a reptiles-amphibians category. Each category included a set of distractors ranging in similarity to category exemplars. For example, the ungulate category included exemplars such as pig, giraffe and cow, and distractors such as whale, fox and lion. The salamander category included several different salamanders and distractors such as ant, turtle, and snake.

The intensional information about the categories was presented in a series of linguistic descriptions designed to draw the child's attention to criterial features of the exemplars. All linguistic descriptions were individually pretested to ensure their comprehensibility to children. For example, for the salamander category these descriptions specified the criterial features of 4 legs, long body and tail. Control sentences in the extensional training condition, designed to equate for the attention-getting aspects of the descriptions, instructed the child to study all animals carefully.

Table 1 presents the design of the training study. Twenty four nursery

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Insert Table 1 about here

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school children, mean age 4,5 and 24 kindergarten children, mean age 6,0 participated. Each child was trained on 2 categories at the same level, one through extensional information alone and one through extensional and intensional information combined. In training each child was presented with a series of 4

pictorial exemplars. These pictures were accompanied with spoken intensional or control descriptions. After training on both categories the child participated in two successive tests for each category. The discrimination test measured learning in terms of the child's ability to identify old training exemplars as positive, to generalize to new exemplars and to discriminate between exemplars and distractors. In this task children looked at a series of pictures individually and identified them as positive exemplars or non-exemplars of the category in question. After completion of discrimination tests for both categories, children participated in a sorting task. For each category, the child was asked to sort the same series of pictures and to make two piles -- one for positive exemplars and one for nonexemplars.

All data analyses were done on the combined scores of each child's performances on these two tasks -- discrimination and sorting. Separate analyses were done on the identification of exemplars -- both old and new combined -- and on the misidentification of distractors. All results I'll present are significant at least at the .05 level.

As expected, based on Rosch's work, more positive exemplars were identified correctly at the basic level than at the superordinate level ($F(1, 44) = 17.70$, $p < .01$). We also found that providing children with linguistically specified information facilitated performance: more positive exemplars were identified correctly in the intensional condition ($F(1, 44) = 5.13$, $p < .05$).

Of special interest in support of our hypothesis is that the level by condition interaction was significant ($F(1, 44) = 5.81$, $p < .05$). Figure 1 presents this interaction. As you can see, the significant main effect of

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Insert Figure 1 about here.

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condition is due primarily to effects at the superordinate level. At the

basic level we see no differences between conditions. Note that at this level children don't appear to be utilizing the intensional information to any advantage even though their performance is not at ceiling. At the superordinate level we see the clear superiority of the intensional condition (t pair (23) = 3.00, $p < .01$, 2-tailed).

Also in support of our hypothesis is the significant grade by condition interaction presented in Figure 2 ($F(1, 44) = 7.31$, $p < .01$). Note that the

Insert Figure 2 about here.

superiority of the intensional condition is not constant across ages. In the intensional condition kindergarten children's performance is clearly superior to nursery schoolers' performance ($t(46) = 2.92$, $p < .01$, 2-tailed). Paired comparisons also show that at the kindergarten level, performance is superior in the intensional condition as compared to the extensional condition (t pair (23) = 3.77, $p < .001$, 2-tailed). In contrast, at the nursery school level -- that is, at the 4-year-old level, performance is comparable in both conditions.

In sum, in their identification of category exemplars, only older children are benefiting from the intensional information, and only for the acquisition of superordinate categories. These findings are summarized in Figure 3 which

Insert Figure 3 about here.

shows the grade by condition by level interaction.

As for the children's treatment of distractors, we find a significant main effect of level, with more distractors misidentified at the superordinate level ($F(1, 44) = 23.64$, $p < .01$). No other main effects or interactions were significant. It is important to note that with superordinate categories

the child is not misidentifying more distractors in the intensional condition than in the extensional condition. This indicates that the superior performance in the intensional condition in identifying exemplars is not merely due to the tendency to be nondiscriminating by including all exemplars and distractors. Rather, it indicates the ability to spot more positive exemplars.

In summary, these results provide confirmation of our original hypotheses about the possibility of different acquisition processes for different types of categories and for different aged children. To review, these data indicate that basic level categories are acquired more easily than superordinate categories. Secondly, we find that intensional information benefits the acquisition of categories only at the superordinate level. Thirdly, the data suggest that the children's ability to take full advantage of the intensional information for their acquisition of superordinate categories develops with age, with kindergarten children more advanced in this skill than 4-year-old nursery school children.

Subjects in the extensional conditions may very well be learning the categories as the traditional concept acquisition research has typically assumed-- through scanning exemplars and abstracting the relevant and/or defining features. At the basic level this strategy may suffice. However, at the superordinate level such feature abstraction from a set of perceptually dissimilar items becomes more problematic. Hence, an acquisition mechanism utilizing the additional intensional information about criterial features facilitates the process. These findings point to the importance of the nature of category, type of information and developmental level as critical variables that we need to consider in our attempts to understand the acquisition of natural categories.

References

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

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TABLE 1: Design of training study

AGE	CATEGORY LEVEL	Subject	TYPE OF INFORMATION (TRAINING CONDITION): Extensional	TYPE OF INFORMATION (TRAINING CONDITION): Extensional plus intensional
Nursery School	Basic	1		
		2		
		.		
		.		
		12		
	Superordinate	1		
		2		
		.		
		.		
		12		
Kindergarten	Basic	1		
		2		
		.		
		.		
		12		
	Superordinate	1		
		2		
		.		
		.		
		12		

Subjects: 24 nursery school children (mean age 4,5) and 24 kindergarten children (mean age 6,0) participated.

Conditions: At each age level, 12 subjects received training on 2 basic level categories, and 12 children received training on 2 superordinate level categories. Type of information was compared within subjects on the 2 categories per level.

Categories: Basic level: Salamanders/ Squid
Superordinate level: Ungulates/ Reptiles-Amphibians

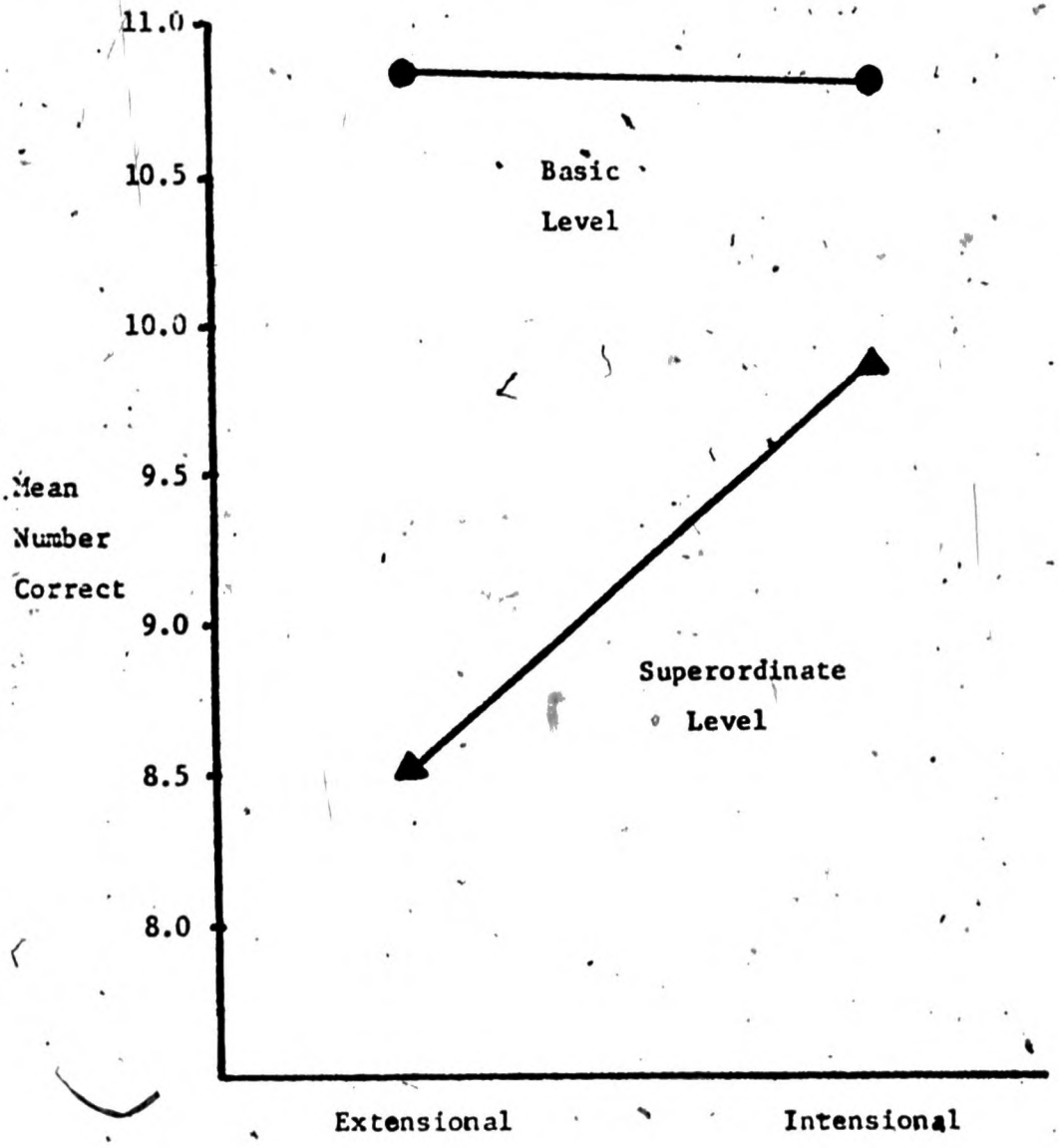

Figure 1. Condition X Level Interaction. Mean number of "Old" plus "New" exemplars (out of 12) identified as positive. Combined score for discrimination and sorting tasks.

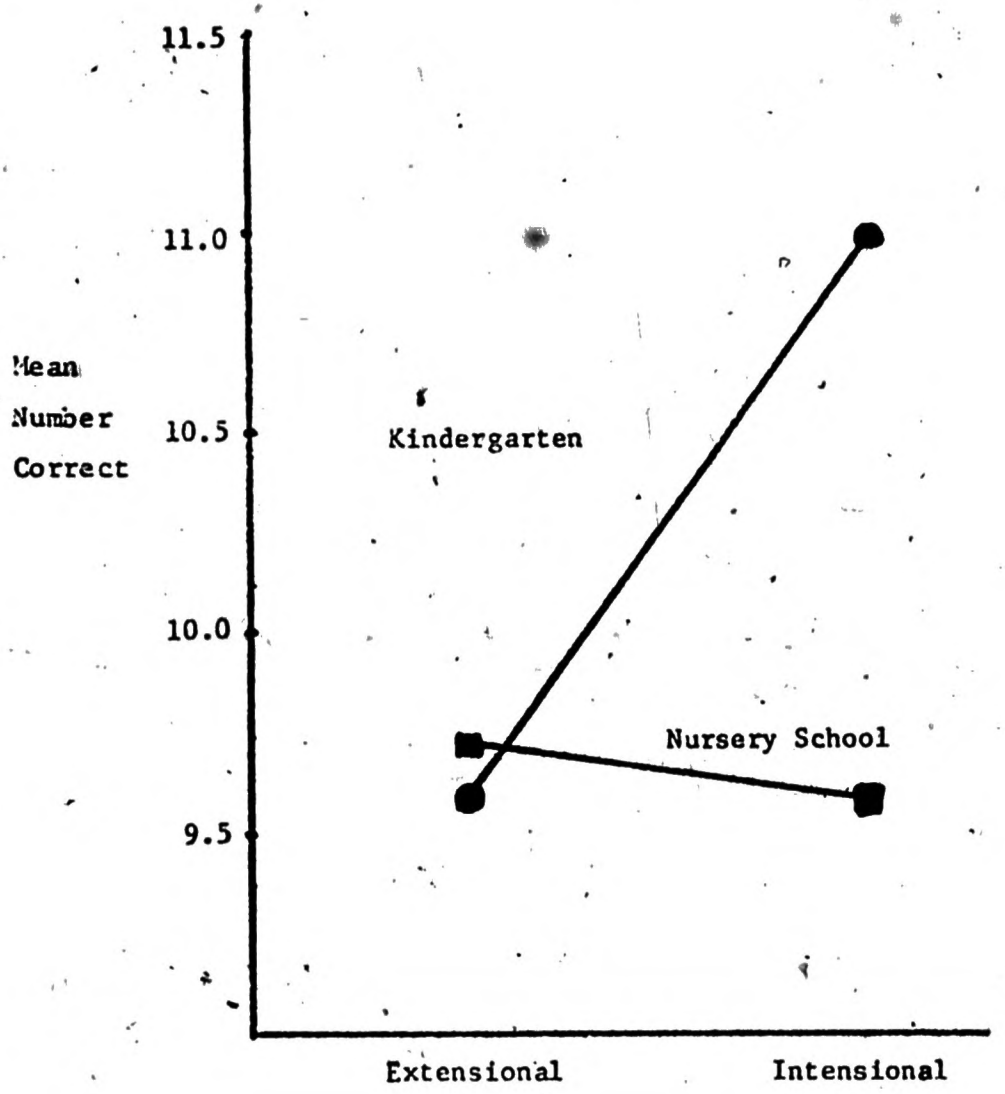

Figure 2. Grade X Condition Interaction. Mean number of "Old" plus "New" exemplars (out of 12) identified as positive. Combined score for discrimination and sorting tasks.

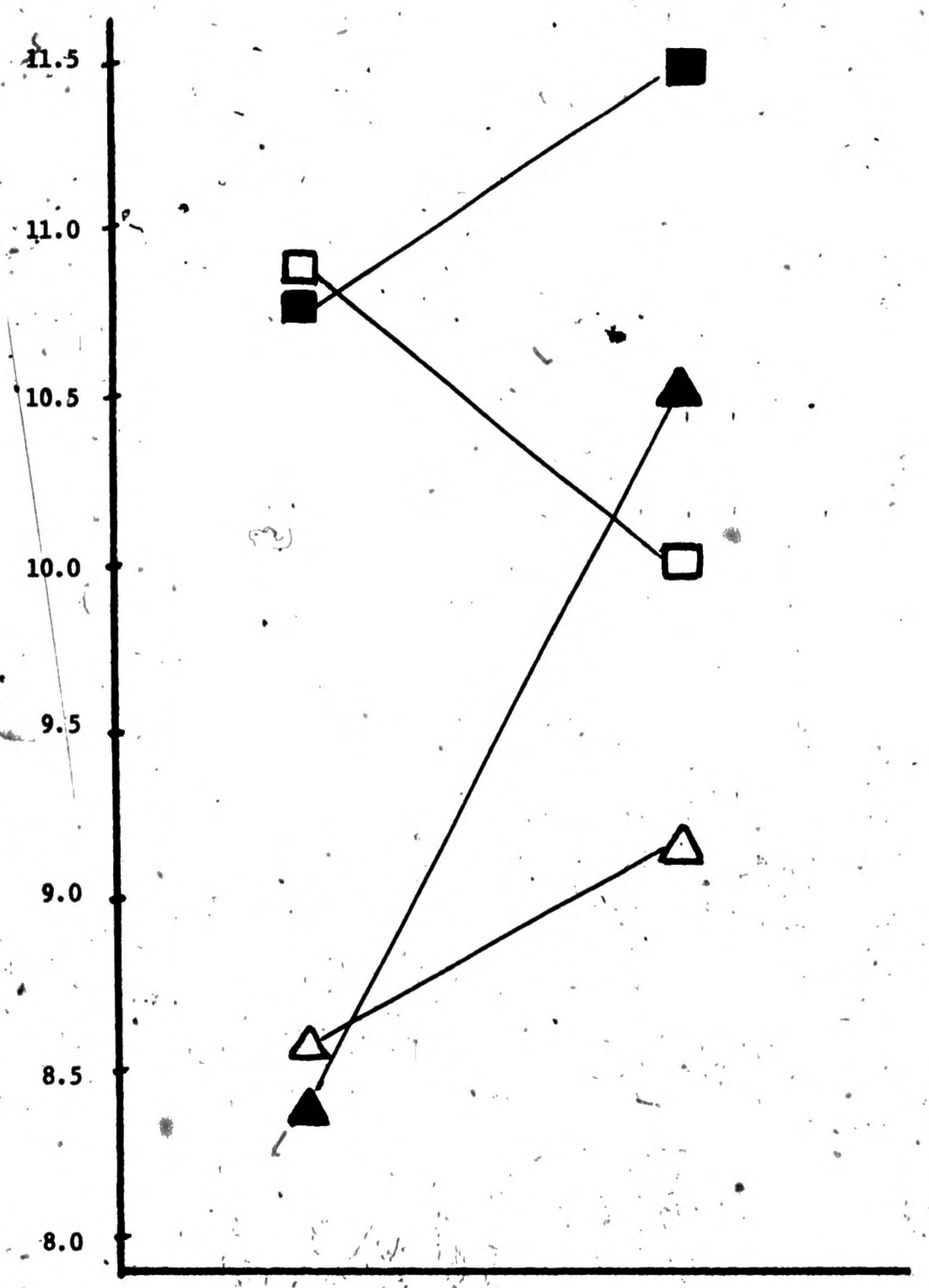

Figure 3. Grade X Condition X Level Interaction. Mean number of "Old" plus "New" exemplars (out of 12) identified as positive. Combined score for discrimination plus sorting tasks.