

Causes of taxonomic sorting by adults: A test of the thematic-to-taxonomic shift

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The tendency among adults to sort items into taxonomic and thematic categories was examined in two experiments. Past demonstrations of adults' preference for taxonomic categories have usually not used stimuli with a salient thematic organization. The stimuli in Experiment 1 could be divided into three equal-size categories either thematically or taxonomically. Under two sets of instructions, the majority of the college-student subjects sorted thematically. In Experiment 2, a subset of the stimuli was changed so that those within it were strongly taxonomically organized. Subjects then preferred to sort the remaining items taxonomically as well. The two experiments explain why many past sorting studies have yielded a taxonomic preference in adults and provide further evidence against a global change from thematic to taxonomic preference with development.

A major finding in the field of conceptual development has been that there is a shift from thematic or complexive concepts to taxonomic concepts. When adults or older children are given a set of items and are asked to choose ones that are "alike" or that "go together," they generally choose items that are in the same category, such as furniture or mammals, or at least that are similar in some respect. In contrast, when young children are given the same task, they often arrange the items according to *thematic relations*, in which things are grouped together because they occur in the same setting or event, or because one of them fulfills a function of the other one. For example, the grouping of a man and the house in which he lives is a thematic relation; the man and house are not similar and do not share properties as a man and girl or house and skyscraper do.

This shift from complexive or thematic concepts to taxonomic concepts was first proposed by Vygotsky (1962) and by Inhelder and Piaget (1964), and it has been found, to varying degrees, in later research on children's concepts (e.g., Annett, 1959; Kagan, Moss, & Siegel, 1963; Olver & Hornsby, 1966; Smiley & Brown, 1979; see Markman, 1989). For the purposes of analysis, the shift may be divided into two claims: (1) Young children prefer to categorize items thematically rather than taxonomically; and (2) adults prefer to categorize items taxonomically. But considerable evidence had raised doubts about the first component of the shift. A number of studies have not revealed any great interest in thematic categories in young children (e.g., Denney, 1975; Denney &

Moulton, 1976; Waxman & Namy, 1997). Some early reports of considerable thematic or complexive responding were based on criteria that now seem very unclear (e.g., Olver & Hornsby, 1966). Finally, the study of word learning has yielded much evidence of children's ability to acquire taxonomic categories, especially at the basic level, even in the acquisition of their first words (Huttenlocher & Smiley, 1987; Markman, 1989; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). In short, although it seems clear that children do not always perform very well in these tasks, the suggestion that they cannot understand taxonomic categories is not correct.

The second part of the thematic-to-taxonomic shift hypothesis has not received as much attention, however. In fact, the argument that children can use taxonomic categories implies even more strongly that adults will do so, since this form of categorization is thought to be more powerful and advanced (Markman & Callanan, 1983). Furthermore, adults have often shown taxonomic sorting in tasks in which children have not (Denney, 1975; Olver & Hornsby, 1966; Smiley & Brown, 1979). Yet this aspect of the shift has recently come under scrutiny as well.

In a series of 10 experiments, Lin and Murphy (2001) have found that adult college students often group items thematically when given a forced choice between a thematically and a taxonomically related (at the superordinate level) item. For example, when given an item such as *bees* and when asked whether *flies* or *honey* would go with it best to make a category (the *triad task*), subjects often choose *honey*, the thematic selection. Across experiments varying in the exact stimuli used, instructions, and presentation format, thematic categorization comprised 49%–70% of the responses. Other experiments showed that thematic categories could provide a basis for induction of a novel property and could prime taxonomic categorization. Thus, Lin and Murphy argued that thematic categories serve some of the functions of real cate-

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Table 1
Stimulus Items

Taxonomic Categories	Thematic Categories		
	Air Travel	Water Travel	Auto Travel
Vehicle	airplane	boat	limousine
Profession	pilot	fisherman	chauffeur
Location	airport	dock	garage

Note—Animals (raccoon, skunk, woodchuck) replaced the locations in Experiment 2; they were not in any thematic category.

gories. In other studies thematic responding has been found in adults, but among nonliterate people who did not have formal schooling (Luria, 1976; Scribner, 1974; Sharp, Cole, & Lave, 1979), or in elderly populations (Annett, 1959; Smiley & Brown, 1979).

The question arises as to why past studies have not found thematic responding by adults. One reason is that many studies of free sorting that formed the original data base for proposing this shift did not include strongly thematically related items. The stimuli were constructed so that they differed in certain dimensions (e.g., shape and color in geometric stimuli) or fell into taxonomic categories. Young children who could not identify these categories would sometimes form thematic groupings of subsets of items. Older subjects, however, could easily identify the taxonomic categories in the stimuli (e.g., animate and inanimate objects; rectangles and ellipses), which did not have any strong thematic organization. For example, Annett (1959) used four pictures each of animals, plants, vehicles, and furniture. These stimuli could be broken into four taxonomic categories of the same size, but they were not chosen so that they would exemplify thematic relations. Although some of them could be related in that way (e.g., a butterfly and a flower), most of them had no strong thematic relation to any of the other items used. Examination of the stimuli from a number of studies shows that this has been a very typical aspect of the stimulus design (see Lin & Murphy, 2001).

In short, stimuli of this sort do not provide a fair comparison of thematic and taxonomic organizations. The stimuli fit taxonomically defined categories, but not necessarily thematic categories. Any thematic relations that have occurred have generally not been systematic or consistent across items.

The present study investigates adult performance in the traditional free sorting or category construction paradigm that has provided much of the empirical basis for the thematic-to-taxonomic shift. In particular, the goal of the present experiments was to obtain an understanding of the reasons why the free sorting task has usually led to taxonomic sorting in the past, unlike Lin and Murphy's results from their forced-choice triad task (like choosing honey vs. a fly to go with bee). If part of the reason why adults and older children did not sort items thematically in past research was the absence of salient thematic relations in the stimuli, then it should be possible to construct a fairer test by selecting stimuli with both thematic and taxonomic organizations. To this end, I

constructed a set of nine labeled pictures that could be organized into an equal number of taxonomic or thematic categories of the same size. As shown in Table 1, this was arranged by filling a matrix of three taxonomic categories crossed with three thematic categories. In taxonomic terms, the stimuli consisted of three vehicles, three people having a profession, and three storage locations. In thematic terms, the items consisted of three items related to air travel, three related to fishing/water travel, and three related to automobile travel. Thus, subjects could choose to sort the items into three taxonomic categories of three items each or three thematic categories of three items each. Unlike in previous free-sorting studies, the number and size of the categories in the two kinds of organization were equated. Furthermore, using either a taxonomic or a thematic form of classification exhausted all the items, so that neither method was more complete than the other.

If adult college students have predominantly taxonomic concepts, they should strongly prefer to categorize items in terms of taxonomic categories, like vehicles. In contrast, if thematic relations are salient and important even to educated adults, then they may find the cohesion of triads such as pilot-airplane-airport stronger than the cohesion of superordinate taxonomic categories. Of course, the category construction task requires subjects to make a choice between these two forms of organization, even if they identify both of them and find both to be of interest (as seems likely; Smiley & Brown, 1979). However, that is equally true of previous sorting studies, and it is those studies that led to the conclusion of a thematic-to-taxonomic shift. I address the issue of multiple possible organizations in the General Discussion.

There has been a concern among some authors (e.g., Denney, 1975) that instructions could strongly influence categorization. For example, if children are asked to "find the things that go together," they may believe that thematic categories are being solicited. This concern does not explain why adults in the same experiments are more likely to sort taxonomically, and it would not be a problem if adults "think taxonomically" in real life. Nonetheless, to address this concern, I compared *neutral* instructions with some that defined the task more explicitly. In the *enhanced instructions condition*, subjects were given a definition of *category* that was explicitly taxonomic. This condition, then, was biased toward taxonomic categories rather than allowing subjects to choose their preferred organization. A substantial number of thematic responses in this condition would be strong evidence for the salience of thematic relations and against the thematic-to-taxonomic shift as a general developmental trend.

EXPERIMENT 1

Method

Subjects. Thirty University of Illinois undergraduates served as part of a course requirement.

Materials. The nine stimuli filled a 3×3 design in which three taxonomic categories were crossed with three thematic categories. The pictures were photographs, taken from Internet web pages and printed on a color printer. The name of each picture appeared below the picture, and the two were laminated on an 8.5×11 in. piece of paper. The names ensured that the subjects correctly identified the item and that there could be no ambiguity about what was intended to be depicted. Insofar as was possible, the pictures were selected so that members of other categories were not present. However, this was not always possible, because it is difficult to find a recognizable picture of an airport, for example, that does not have airplanes in it somewhere. Some pictures were cropped in order to minimize the presence of related objects.

Procedure. The pictures were presented in a single order that was constructed randomly, with restrictions. The main concern was that seeing adjacent items that shared a taxonomic or thematic relation might give subjects the idea that the items should be organized in that way. Therefore, the items were arranged so that no adjacent items shared either a taxonomic or a thematic relation. Because very few orders meet this condition, it was not possible to randomize the order for each subject.

Subjects in the neutral condition were told:

This is an experiment on people's categorizations of different types of things. In front of you are 9 pictures in a random order. Look over all the pictures and their titles. Then we would like you to arrange the pictures into the groups that seem best or most natural to you. You may make as many groups as you like, so long as there are at least two and so that there are no pictures that are not in a group. Move the pictures around so that they are grouped in the way that seems best to you, and then notify the experimenter that you are done.

A phrase like "the best and most natural group" is the standard instruction in category construction tasks with adults (Kaplan & Murphy, 1999; Lassaline & Murphy, 1996; Medin, Wattenmaker, & Hampson, 1987).

The enhanced condition received identical instructions except for an additional sentence designed to emphasize the taxonomic nature of the categories: "A *category* is a set of things that share some commonalities, such as genetic makeup, functions, physical or perceptual characteristics, or behaviors." Subsequent sentences in the instructions referred to *categories* rather than *groups*.

After sorting the items, subjects wrote down the groups that they had formed and a brief explanation of why those pictures had been grouped together.

Results and Discussion

The groupings were classified on an a priori basis as to whether they fit the experimenter-defined taxonomic or thematic groupings. Anything else was classified as "other".¹ The result was that the clear majority of subjects in both conditions created thematic categories, 87% in the neutral and 67% in the enhanced instructions conditions. All the remaining categories were the expected taxonomic categories, with one exception, which was a different thematic grouping. If this subject had been categorized as thematic, there would have been 73% thematic responses in the enhanced condition.

The small difference between the two conditions was not reliable [$\chi^2(1, n = 30) = 1.67, p > .10$]. It should be emphasized that the experiment was not designed to find differences between the two instructions: The explicit instructions were used to discover whether the (expected) high level of thematic responding was due to a misunderstanding of what a category is. What is impressive

about the results is that even when subjects were given an explicit taxonomic definition of a category, two thirds of them nonetheless provided thematic responses. Clearly, this is inconsistent with the idea that adults have shifted to a taxonomic mode of category formation.

Similarity Post-Test

One possible reaction to these results would be to question whether the taxonomic categories used were very strong ones. The vehicle category has been used in many studies, and the category of people/professions is also quite salient, because the difference between people and inanimate objects is a major ontological distinction of the sort that even kindergartners take as important in categorization (Keil, 1989, chap. 10). The storage location category is less salient and is probably not as familiar to subjects. The question is, then, whether these taxonomic categories were less cohesive than superordinate categories used in past sorting studies or in categorization experiments more generally.

In order to answer this question, I sampled three items from each of 19 categories normed by Rosch (1973) to compare them with the present items (the 20th category, vehicles, was part of my own materials). I used Rosch's materials because they have been very widely mined as stimulus materials in subsequent experiments, and because they provide many category exemplars ranked by typicality. I chose the 10th, 20th, and 30th items out of the 60 provided for each category, based on the typicality ranking. This selection provided items of moderately high typicality and excluded any possibly borderline items.² I constructed a similarity test that included all pairs of items from within each category plus an equal number of cross-category pairs for contrast (these were not of interest). The question was whether the similarity of items in "standard" superordinate categories used in many experiments would be significantly greater than that for the categories used in Experiment 1. If the taxonomic categories used were particularly weak, then their items should not be perceived as similar. Sixteen subjects provided ratings on a 1–7 scale.

The results were that items from Rosch's (1973) superordinates were rated 4.3 on the average, which may be compared with 4.0 for the items used in Experiment 1. Both items are in the middle of the typicality range, and the difference is nonsignificant [$t(15) = 1.66, p > .10$]. Clearly, the small difference in category cohesiveness could not explain the rejection of taxonomic categorization in Experiment 1.

EXPERIMENT 2

Another concern about earlier comparisons of taxonomic and thematic categorization has to do with the consistency of the organization within the stimulus set. For example, recall that Annett (1959) used a set of 16 pictures: four animals, vehicles, plants, and pieces of

furniture. A few of the items could have been seen as thematically related, such as the bird and tree or the butterfly and flower. However, if subjects made such groupings, the other stimuli would have had an inconsistent organization. For example, the furniture items were not obviously related to any other items, and so they probably would have been grouped together—that is, taxonomically. Furthermore, the remaining two animals did not have any apparent thematic connections, and so they would have had to have been grouped together as animals. The result would be a number of groupings with very different sizes and justifications

Most educated adults would be able to identify this as being the “wrong answer” on a test. They would expect that the experimenter had constructed items so that they could be divided up in a consistent and neat manner—and they would have been right, because Annett did use four taxonomic categories of equal size for the selection of these items. Thus, part of the developmental sequence found in these tasks might have been caused by adults’ unwillingness to make groupings of different sizes and bases.

In Experiment 2, I investigated this possibility by modifying the stimuli used in Experiment 1 so that the thematic organization could not be applied consistently to all the items. This was achieved by changing one of the taxonomic categories so that its items would not enter into the thematic relations—namely, the locations were exchanged with mammals. I expected subjects to group these items together as being animals or mammals—that is, to make a taxonomic category. The question, then, was whether subjects would still make thematic groupings of the remaining items. Would they continue to place pilot and jet, fisherman and boat, and chauffeur and limousine together, as they did the large majority of the time in Experiment 1? Or would they now feel that the taxonomic categorization of three animals suggested that the entire set of stimuli should be organized taxonomically? Note that the main dependent measure was not the overall type of sorting, but rather the sorting of the items that were common across the two experiments.

Method

The stimuli and procedures were very similar to those of the neutral condition in Experiment 1. The only difference was that the locations were omitted, and three animals—a skunk, raccoon, and woodchuck—were used instead. These were depicted by detailed color drawings reproduced from an animal encyclopedia. The locations were selected to be dropped because they seemed to have the weakest thematic connections to the other stimuli. Storage areas are peripheral to the operation of the vehicles in question, whereas the operators (pilot, fisherman, and chauffeur) are necessary to make the vehicles work, and these professions in turn are defined in part by the kind of vehicle they operate. Sixteen University of Illinois undergraduates served for pay or in order to fulfill a class requirement.

Results

As expected, the majority of subjects, 88%, grouped the three animals together, because they did not have ap-

parent thematic relations to the other stimuli. The main question was how many subjects paired the other items into thematic categories. The animal items were completely disregarded in this analysis. Overall, 31% of the subjects formed thematic pairings of pilot–jet, fisherman–boat, and chauffeur–limousine, which was fewer than the 87% in the neutral condition of Experiment 1 [$\chi^2(1, n = 30) = 9.76, p < .005$]. Of the remaining subjects, all but 1 (62%) grouped the critical items taxonomically. Thus, even though these items and the instructions were identical to those that led to very high thematic sorting in Experiment 1, the presence of the animals blocked a thematic response for the other stimuli, suggesting that subjects had a strong preference to respond consistently. When the preferred organization could not be applied to the entire stimulus set, subjects did not apply it to the subset of items that could be sorted that way, even though this was the majority of items. Also, note that the finding that most subjects grouped the critical items taxonomically argues against the proposal that the taxonomic categories were weak in Experiment 1, since these categories also appeared in Experiment 1.

Although the animals did promote taxonomic responding, almost a third of the subjects still did respond thematically. Four of those 5 subjects simply created a mixed sorting scheme in which they grouped the animals together (taxonomically) and then grouped the other items thematically. These subjects apparently did not feel a strong desire to respond consistently. The remaining thematic subject placed the animals with the boat–fisherman or limousine–chauffeur by claiming that they were land or water related. This sort was therefore consistently thematic. Finally, 1 other subject divided all the items into two rather strange thematic categories. (Because they did not match the predefined thematic categories, this scheme was scored as “other.”) Overall, 75% of the subjects gave a consistent form of sorting, either taxonomic or thematic—and 100% did so in Experiment 1—suggesting that adult subjects do have a preference for consistent sorting.

GENERAL DISCUSSION

The results help to explain why past research has often found a thematic-to-taxonomic shift in sorting tasks. First, the stimulus sets in many past studies have been designed taxonomically, and a savvy subject would be able to identify the intended organization and reconstruct it. In Experiment 1, when the stimuli were equally susceptible to taxonomic and thematic sorting, subjects no longer showed a taxonomic preference. In fact, they showed a strong thematic preference. Thus, the absence of clear thematic links in previous stimulus materials is probably an important reason why adults did not form thematic categories. No doubt the exact proportion of thematic or taxonomic sorting depends on the strength of the two forms of organization in a given stimulus set. Past experiments have often had weak thematic links,

whereas the present study clearly had strong ones. Second, even if a stimulus set did contain some thematically related items, adults resist mixing very different ways of sorting a single stimulus set. The addition of a few strongly taxonomically related stimuli greatly reduced the formerly predominant thematic sorting. Neither of these problems was present in the Lin and Murphy (2001) triad stimuli, and so these results help to explain why their results showed significant thematic sorting, in contrast to much of what was found in the past literature.

These results have implications for the usefulness of the sorting task. The need for consistent sorting is a task demand rather than a reflection of conceptual structure. For example, subjects apparently feel that the pilot and airplane should be classified together (Experiment 1) but resist doing so when other items require a different organization (Experiment 2). Further evidence for the drive for consistency can be seen in category formation studies with artificial stimuli. In many studies, it has been found that subjects strongly prefer to use a single stimulus dimension whenever that is possible (Ahn & Medin, 1992; Spalding & Murphy, 1996). Unidimensional sorting is the most consistent form of responding possible. To the degree that sorting is influenced by such concerns, then, it does not reveal conceptual structure.

In summary, the idea of a thematic-to-taxonomic shift is wrong. Many exceptions to this putative pattern have been found in children in previous studies, and in more recent studies, including this one, exceptions have been found with adults. Although I am criticizing the thematic-to-taxonomic shift, this does not mean that there are no interesting differences between children's and adults' concepts or sorting. Clearly, children have difficulty in identifying the superordinate concepts (see Markman, 1989; Rosch et al., 1976), which have been the taxonomic categories used in most studies, and this is one reason why they have resorted to thematic sorting even when the stimuli were not particularly amenable to it. Greenfield and Scott (1986), for example, found that 3-year-olds could explain 92% of their thematically paired items but only 25% of their taxonomically paired items. Furthermore, children are probably less concerned with consistency in their grouping. It seems likely that this tendency is a function of schooling, which also is correlated with taxonomic responses (Luria, 1976; Sharp et al., 1979). The difference between children's and adults' responses in this task may reflect important cognitive changes, but it is not a shift from thematic to taxonomic conceptual organization.

Why do adults use thematic categories? A very brief answer is that thematic categories do carry important information about object properties, and this information may be particularly helpful for planning and understanding events (see Barsalou, 1991; Lin & Murphy, 2001). Although adults clearly have categories such as vehicles and occupations, they simultaneously have categories such as things found at a birthday party. Items may be cross-classified into both taxonomic and thematic categories in

the adult conceptual system, and adults are probably quite adept at selecting the relevant form of organization for a given task (Ross & Murphy, 1999).

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the dock with the chauffeur and limousine). Because the justification given was also thematic (the limousine would be parked at the dock, which looked like a garage), this was coded as a thematic response. No other subject had any problem with any picture.

2. Three items were dropped, and the next available item chosen. One was dropped because it was obscure and probably unfamiliar to the subjects, one because its name was ambiguous without a context, and one because it shared a word with another item.

NOTES

1. One subject bizarrely claimed that the dock looked like a garage and the garage like a dock, and then classified them thematically (i.e.,

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