Child Development, November/December 2003, Volume 74, Number 6, Pages 1783–1806

An Apple is More Than Just a Fruit: Cross-Classification in Children's Concepts

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This research explored children's use of multiple forms of conceptual organization. Experiments 1 and 2 examined script (e.g., breakfast foods), taxonomic (e.g., fruits), and evaluative (e.g., junk foods) categories. The results showed that 4- and 7-year-olds categorized foods into all 3 categories, and 3-year-olds used both taxonomic and script categories. Experiment 3 found that 4- and 7-year-olds can cross-classify items, that is, classify a single food into both taxonomic and script categories. Experiments 4 and 5 showed that 7-year-olds and to some degree 4-year-olds can selectively use categories to make inductive inferences about foods. The results reveal that children do not rely solely on one form of categorization but are flexible in the types of categories they form and use.

The history of conceptual development contains a number of proposals of a developmental shift from primitive or simpler conceptual structures to more sophisticated and abstract concepts (e.g., Inhelder & Piaget, 1964; Vygotsky, 1962). The motivation for these proposals was both theoretical and empirical. Theoretically, the shift was thought to reflect children's inability to identify and represent abstractions. Young children could not identify the properties common to all animals, for example, ignoring their superficial differences, because of their reliance on concrete properties. Empirically, many researchers found that until the age of 7 or 8, children found it difficult to classify items into categories such as animals, vehicles, or furniture. Instead, they often seemed to group items together by noncategorical relations, such as grouping a man and a car, saying that the man would drive the car. Thus, perhaps children's knowledge of the world is organized around such kinds of relations rather than adultlike categories.

We briefly review this literature along with more recent claims that children do form abstract concepts. We argue that the opposition between two different kinds of classification has oversimplified our understanding of children's conceptual abilities and that children may be able to use simultaneously both categorical and other kinds of relations. We begin by describing the different forms of conceptual organization that past research has identified.

Thematic, Script, and Taxonomic Categories

Researchers in conceptual development have identified several category types that children may use to classify things. Thematic categories group objects that are associated or have a complementary relationship; they often are spatially and temporally contiguous. For example, a dog and its leash form a thematic pair because the leash restrains the dog; cereal and a bowl do as well because the bowl contains the cereal during eating. It is important to note that the dog and leash are not similar; the cereal and bowl do not share many properties. Because thematic relations are readily observed and have an associative basis, they might be easy for children to identify. Script categories are formed when items play the same role (not complementary roles) in a script. A script is a schema for a routine event (e.g., going to the doctor, seeing a movie). For example, eggs and cereal are both in the script category of breakfast foods, not because they are spatially or temporally contiguous (like the leash and dog) but

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This research was supported by a National Science Foundation Graduate Research Fellowship, University of Illinois Dissertation Fellowship, and Grants MH41704 (National Institute of Mental Health) and SBR 97-20304 (National Science Foundation). We are grateful to Brian Ross for detailed advice on this research and constructive feedback on an earlier draft. We are grateful to Karl Rosengren for helpful input and Renée Baillargeon, Kevin Miller, and Cameron Gordon for discussions regarding this research. Special thanks go to Kristy Brooks, Amy Gaither, Mychelle Denney, and Kevin Frederick for their invaluable research assistance. We also thank the children, parents, and teachers who were involved in this research.

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 0009-3920/2003/7406-0014

because they play the same part in an event schema (what is eaten at breakfast). (As a result, some call these slot-filler categories.)

Taxonomic categories are so called because they are usually organized into hierarchies of increasingly abstract categories, such as terrier-dog-mammal-animal. However, for the present purposes, the critical aspect of taxonomic categories is that they are based on common properties or similarity. Dogs are in the same category because they have four legs, bark, breathe, have fur, and so on. (These common features allow a hierarchical structure in which more specific categories have all the properties of more general categories plus further, distinguishing properties; see Murphy, 2002, chap. 6). Most categories picked out by common nouns are taxonomic: chair, fish, telephone, cloud, party, and vehicle, for example, are all taxonomic categories whose members tend to share certain properties. In sum, taxonomic categories are based on shared properties or, more generally, similarity among the category members.

Early work on concepts assumed that taxonomic categories were the only, or the only "correct," form of classification possible (as clearly seen in Hull, 1920; or Inhelder & Piaget, 1964, p. 7). Thus, the finding that preschool children often group objects using thematic or script categories suggested that they possess a primitive conceptual system. Although thematic and script categories are different, they share the property that they are primarily defined by external relations rather than by internal properties (Markman, 1989, p. 21). The dog and leash do not both bark, are not both made of leather, do not both eat meat, and so on, yet they form a coherent grouping because the leash is spatially and temporally contiguous to the dog during its walk. Similarly, an egg and cereal are both breakfast foods because they have a common relation to an external event (eating breakfast), not because they both come from a chicken or contain wheat. In contrast, a taxonomic category such as animals is not defined by a situation in which an object occurs, nor its relation to other kinds of objects. Instead, something is an animal if it has properties such as being alive, reproducing, breathing, and so on. It is possible that the external relations involved in thematic and script categories are easier for children to identify than the similarities underlying taxonomic categories (see Markman's, 1989, discussion of collections). Lucariello, Kyratzis, and Nelson (1992, p. 980) have suggested that script categories are easier to form because they are based on experienced events rather than abstractions across items that may not occur together.

As we noted, preschool children tend to group items together in ways other than the usual taxonomic category. For example, several researchers found that young children group items based on thematic relations (Greenfield & Scott, 1986; Kagan, Moss, & Siegel, 1963; Olver & Hornsby, 1967; Smiley & Brown, 1979). Other studies found that young children group items based on their role in scripts and that script categories may be important in other tasks such as memory and free association (Nelson, 1986, 1988; Lucariello et al., 1992). These studies often found that children develop taxonomic categories by around age 7 or 8.

Proposals for a shift in the nature of children's classification have been criticized in three ways. First, several studies found that young children can form taxonomic categories. Clearly, they have no difficulty in learning basic-level categories such as dog, telephone, chair, tree, and so on, even at very early ages (Horton & Markman, 1980; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). But children can learn and use even superordinate categories under certain conditions (e.g., Markman, 1989; Waxman & Gelman, 1988). Second, several studies found that children are not as strongly interested in thematic relations as previously believed, contrary to the traditional claim (Denney, 1975; Denney & Moulton, 1976; Waxman & Namy, 1997). Third, recent studies found that adults use thematic and script categories when the relations are sufficiently strong (Lin & Murphy, 2001; Murphy, 2001; Ross & Murphy, 1999). These results with adults make it difficult to argue that such categories are primitive.

In the adult concept literature, there is increasing recognition of the fact that items can be cross-classified into more than one category (Barsalou, 1991; Murphy, 1993; Ross & Murphy, 1999). In addition to the usual taxonomic categories that people use, such as dog and animal, they know a variety of other kinds of categories that could include the same items, such as other, more specialized taxonomic categories (e.g., carnivore, pet), ad hoc or goal-derived categories (e.g., things to carry out of a burning house; Barsalou, 1983, 1991), thematic categories, and script categories. Although taxonomic categories are particularly useful, other modes of categorization can also be very useful. Markman (1989) pointed out that children must learn thematic and script categories such as things that are found at a birthday party, things you bring to school, breakfast foods, and so on, as part of learning about the activities in their culture. The child who brings a bat but no ball to the playground is going to have a hard time playing baseball. Rather than outgrowing such categories, adults may continue to use them alongside taxonomic categories (Murphy, 2001).

The present study addressed the issue of cross-classification in children's concepts, focusing on taxonomic and script categories of foods. We used the domain of food as a test case for two main reasons. First, food is cross-classified into many categories and into taxonomic and script categories in particular. It is straightforward to identify taxonomic categories for foods because they have familiar names such as *fruit* and *meat*. Script categories are not as entrenched, although some do have familiar names, such as *snack* and *dessert*. Furthermore, several foods are found in multiple script categories, as muffins might be eaten at breakfast or as a snack, for example. Ross and Murphy (1999) found that adults spontaneously grouped foods both taxonomically and according to script relations. For example, adults in their study considered a bagel to be both a bread (taxonomic) and breakfast food (script). In fact, food is the only domain that we know of that has been shown to have both strong taxonomic- and script-based categories in adults. However, it has yet to be seen whether young children also cross-classify foods.

The taxonomic categories we tested in the present study were those that arose from Ross and Murphy's (1999) results, and they were superordinate categories such as meats, fruit, and vegetables. (The basic level for our food items, as shown by naming, would be more specific categories such as cookie, chicken, or broccoli.) Thus, this level of taxonomic classification is similar to that studied in previous studies of conceptual development in object categories, such as vehicles, tools, insects, and water animals (e.g., Mandler, Bauer, & McDonough, 1991; Rosch et al., 1976; Smiley & Brown, 1979; Waxman & Gelman, 1988).

Second, a limitation of past research on categorization is the relative lack of focus on domains that children know a lot about and that are connected to their greater knowledge of the world. Although many studies have examined real-world categories such as animals (e.g., Carey, 1985; Keil, 1989; Markman, 1989), these categories are still at the periphery of most children's daily lives and everyday thinking, especially those who live in urban settings (Medin & Atran, in press; Coley, 2000). The domain of food, however, is one that is highly central to children's lives and everyday thinking (Birch, Fisher, & Grimm-Thomas, 1999) and is an integral part of children's broader knowledge about health and illness (Rozin, 1990).

Although there is clearly a limitation in using categories from a single domain (addressed further in the General Discussion), we focused on food because of the cross-classification found in adult studies. If we discover that children can also cross-classify in this domain, it will demonstrate that there is no necessary progression from one form of categorization to the other, showing that children have the potential for conceptual flexibility.

The Present Experiments

Our study investigated script and taxonomic categories using the domain of food. Our goal was to discover whether children are able to categorize simultaneously foods using these two very different bases and, if not, to find out which one develops first. Given that adults are clearly able to classify foods in two different ways (Ross & Murphy, 1999) and that both script and taxonomic relations are informative, we expected to find considerable overlap in children's use of these categories rather than one of them replacing the other. We focused on tasks that directly reflect concept use, namely, categorization and category-based induction, rather than indirect measures of categories, such as word association or memory (cf. Lucariello & Nelson, 1985). If children are able to use both forms of categorization, this will indicate a flexibility in their conceptual skills that has been ignored in the debate over a shift from one form of categorization to another.

Because generalization from one object to other objects is a critical function of categorization, in Experiments 4 and 5, we also investigated conceptual flexibility in an induction task. For example, if you believed that bread is unhealthy, would you also conclude that muffins are unhealthy? Although taxonomic categories have been heavily studied in category-based induction tasks, script categories have seldom been studied. Ross and Murphy (1999) found that adults use different food categories to make different types of inductions. Adults demonstrated inductive selectivity by making more inferences about the composition of foods for taxonomic categories and more inferences about when foods are eaten for script categories (see also Heit & Rubinstein, 1994). Few developmental studies have addressed whether children use their category knowledge to generalize properties selectively. Gelman and Markman (1986) and Gelman (1988) showed that children generalize internal physiological structure across category members but do not generalize superficial properties that differ across examples (e.g., weight or accidental properties such as "is dirty"). However, children do not always show a sensitivity to which properties should be induced for different categories (e.g., Gelman, 1988; Gelman & O'Reilly, 1988). Later research found some sensitivity to category type. For example, Kalish and Gelman (1992) found that when inferring information about the properties of fragility and texture, 3- and 4-year-olds considered material composition as a crucial category. For example, when asked if a wooden pillow was hard or soft, children focused on the material as opposed to the object category and answered that it was hard (see also Deák, 2000). The present investigation adds to this body of research by examining children's selective use of taxonomic and script categories in inductive inferences.

In addition to the more familiar types of categories, we also explored evaluative categories, in which foods have the same positive or negative evaluation. Evaluative categories are not based on similarity, like taxonomic categories, nor do they necessarily occur in similar settings. For example, the evaluative category of healthy foods may include fruits, vegetables, dairy products, and fish, which are not in the same taxonomic category and are eaten in a wide variety of settings. Although affective reactions to different stimuli have long been studied within social psychology (e.g., Duckworth, Bargh, Garcia, & Chaiken, 2002; Zajonc, 1980), stimuli that receive the same affective response have seldom been studied as categories and tested in conceptual tasks (Niedenthal, Halberstadt, & Innes-Ker, 1999, is a recent exception). Our studies provide an exploratory look at evaluative categories in a developmental context.

Evaluative categories seem especially pertinent to the domain of foods, in which people identify foods as disgusting (e.g., grasshopper, brussel sprouts), dangerous (e.g., wild mushrooms), or healthy (e.g., spinach; Rozin, Hammer, Oster, & Horowitz, 1986). We focused on healthy and unhealthy foods, which could be drawn from the set of foods used in our other categories (unlike dangerous foods, for example) and which are salient categories for adults. Note that these categories are not based purely on emotion, as foods may receive their evaluation for different reasons (ice cream because it tastes good, broccoli because it is healthy). Thus, evaluative food categories are not purely affective but have considerable content as well. This is similar to the evaluative category of "weed trees" documented by Medin, Lynch, Coley, and Atran (1997), which are associated with properties such as being weak-wooded and dropping many twigs. Whether children classify foods evaluatively and whether they use such categories for induction have apparently not been investigated.

Three questions guided the present examination. First, do children have taxonomic, script, and evaluative categories, and do they develop at different rates or simultaneously? Second, do children cross-classify food into these categories? That is, can children classify an individual item into more than one category? These first two questions are of particular interest in the context of research that has claimed that children undergo a shift in their categorization style. Third, do children selectively use taxonomic, script, and evaluative categories to make inductive inferences about food? This is an important question because inductive inferences are a basic function of categories, and the possibility that children cross-classify food may pose a challenge to the induction process.

To investigate these questions, we conducted a series of five experiments. Experiment 1 examined whether 4- and 7-year-olds and adults classify foods into taxonomic, script, and evaluative categories. The task was extended to 3-year-olds in Experiment 2. Experiment 3 examined children's classification of the same foods into more than one category. Experiments 4 and 5 examined 4- and 7-year-olds' and adults' use of script and taxonomic categories as the basis for inductive inference.

Experiment 1

Experiment 1 was designed to discover whether children classify foods into taxonomic, script, and evaluative categories and at what age this ability appears. Categorization studies have tended to use conflict picture triads, in which there is a target and a taxonomic and thematic choice, for example, pitted against each other (e.g., dog: leash vs. cow). In these studies, children were required to select either the taxonomic or thematic choice, but not both. The results have generally shown that young children favor the thematic or script choice over the taxonomic choice, whereas older children and adults favor the taxonomic choice (e.g., Lucariello et al., 1992). However, the conflict picture triads do not provide children the opportunity to select both choices even though both are related to the target; therefore, these findings may reflect preferences rather than knowledge. Indeed, Smiley and Brown (1979) found that adults and children as young as 6 knew both the taxonomic and thematic relations in their stimuli, even if they consistently chose one of them in conflict trials. Clearly, selecting a thematic choice does not show that children do not understand the taxonomic relation. Experiment 1 included conflict triads as a comparison with previous research.

In addition to the conflict triads, Experiment 1 included nonconflict triads that did not pit two categories against each other. The nonconflict triads were composed of a target; an alternative that shared a taxonomic, script, or evaluative relationship with the target; and an unrelated alternative, for example, corn: carrot (taxonomic choice) versus juice (unrelated choice). This task permitted independent tests of children's knowledge of taxonomic categories and (in other trials) script relations. If children have multiple categories, then they should select the taxonomic alternatives on the taxonomic trials, script alternatives on the script trials, and the evaluative alternatives on the evaluative trials. Category performance on one category type does not affect performance on the others, as in conflict triads. If the traditional view of children's concepts is correct, script categories should appear before taxonomic categories.

Evaluative categories have not been tested before in this paradigm, and one can derive opposing predictions about them. Perhaps evaluative categories, which do not require a detailed analysis of the category's content, are a more primitive form of categorization that will appear before taxonomic categorization. Alternatively, perhaps children lack the knowledge of food and physiology that underlies health judgments about food; therefore, such categories will appear after taxonomic categories. Or, perhaps evaluative categories will appear at the same time as taxonomic categories.

In any test of this sort, there is always some category that includes the "wrong" item. For example, in the taxonomic versus thematic triad of items such as needle: thread versus pin (Smiley & Brown, 1979), even the thematically related items (needle–thread) are also members of general taxonomic categories such as artifacts or physical objects. However, children and adults both prefer to use a specific category when it is available rather than relying on abstract categories, such as artifacts or living things. As all the items in our studies were foods, participants were not able to choose one alternative over the other based on the fact that it and the target item are both foods. They had to use more specific relations, either taxonomic or script based. Using the food category as a basis for responding would result in random choices, and it will be seen that this never occurred.

Method

Participants. Participants were 32 children: sixteen 4-year-olds ($M = 4, 5$, *range* = 4,0–5,0; 7 boys and 9 girls) and sixteen 7-year-olds ($M = 7;1$, *range* = 6,8–7,6; 8 boys and 8 girls). Sixteen adults also participated ($M = 20$; 4 males and 12 females). An additional set of 15 adults also provided ratings of the stimuli. The participants were predominately European-American and were recruited from a middle-class community located in the Midwestern United States. In particular, child participants were recruited from schools, and adult participants were recruited from a university.

Materials. We used several resources to help us generate a list of foods that were familiar to children. We referred to children's picture and word-learning books. Research has found that even infants and toddlers produce and comprehend a large repertoire of food and drink words (Fenson et al., 1994). We also relied on child and parent informants. First graders not involved in the primary experiments were informally interviewed during their lunch period at an elementary school. Children were asked to give examples of taxonomic and script categories of foods (e.g., "Can you give some examples of dairy products?" "Can you give some examples of breakfast foods?") and were asked whether they were familiar with particular foods (e.g., "Do you know what a muffin is?"). Also, we informally interviewed parents of preschool- and school-aged children who were not involved in the experiments. Parents were asked about their child's experience and knowledge of particular foods (e.g., "Does your child know what Twinkies are?" "Does your child eat hot dogs at lunch?"). Research suggests that children know a lot about foods, especially because the typical child eats three meals a day, plus snacks, and is often exposed to advertisements for foods (Birch et al., 1999).

Combining these sources with the results of Ross and Murphy (1999) allowed us to identify items that share taxonomic, script, or evaluative categories without having a salient relation in one of the other types. It was not necessary for our design that each target food be in only one script (or taxonomic) category. (Indeed, as we have pointed out, objects are seldom in only one category because of cross-classification.) All that was necessary was that the target category be salient enough to be identified within the triad. That is, if muffin is paired with popcorn, their common membership in the snack category will become salient if participants encode both of them as snacks. If muffin's membership in other possible script categories makes categorization more difficult, we should find delayed categorization of script relative to taxonomic categories. As described, we took various steps to ensure that our items were readily identifiable as members of the tested categories (Experiments 4 and 5 provide verification that we were successful in this goal).

One hundred and two 2.5 in. × 3 in. (6.35 cm × 7.62 cm) color photographs of food were collected from Internet sources and food products. The photographs could not include more than one food (e.g., tray of fruit), and the target food needed to be easily recognizable. Photographs were arranged into 34 triads consisting of a target and two choices. An attempt was made to select pictures that did not have a strong resemblance so that perceptual similarity would not dominate the choices.

Each triad was printed on a separate sheet of 8.5 in. × 11 in. (21.6 cm × 27.9 cm) white paper with labels of the foods. There were 12 taxonomic, 12 script, 4 evaluative, and 6 conflict triads. Each of the foods in the triads had a typed label. The taxonomic triads included a target (e.g., corn), a taxonomic choice (e.g., carrot), and an unrelated choice (e.g., juice). The taxonomic categories were familiar categories such as fruit, meat, and breads. The script triads included a target (e.g., bacon), a script choice (e.g., pancake), and an unrelated choice (e.g., Jell-O). Script categories were based on setting or time of eating, such as breakfast foods. The evaluative triads included a target (e.g., Twinkie), an evaluative choice (e.g., Cheetos), and an unrelated choice (apple). Evaluative categories consisted of prototypical healthy or unhealthy foods.

The related and unrelated choices were counterbalanced across triads: The script choice for one triad was the unrelated choice for another script triad. Thus, the results could not be explained by a preference for the related items. The conflict triads included a target (e.g., ice cream), a taxonomic choice (e.g., cheese), and a script choice (e.g., cookie). See Appendix A for a complete list of the triads.

We asked 10 adults to rate the targets and their category matches to ensure that our items were typical and familiar category members and that these factors did not vary systematically across the category types. The scales ranged from 1 (*low*) to 7 (*high*). For the typicality ratings, adults were told to rate each food in terms of how typical an instance of the given category it is. The ratings were uniformly high and did not differ significantly among the taxonomic, script, and evaluative categories ($M = 5.99$, $SD = 0.66$; $M = 5.80$, $SD = 0.69$; $M = 6.23$, $SD = 0.85$, respectively). For the familiarity ratings, adults rated the degree to which they were familiar with a food as belonging to a given category. Again, there were no significant differences between the taxonomic, script, and evaluative categories ($M = 6.25$, $SD = 0.62$; $M = 5.90$, $SD = 0.97$; $M = 5.70$, $SD = 1.45$, respectively).

In addition, 5 adults rated the visual similarity of each target and its two choices separately (e.g., bacon and pancake, bacon and Jell-O). Participants were told that "we are interested in whether the food pairs look like each other in these particular photographs." The scale ranged from 1 (*not at all visually similar*) to 7 (*very visually similar*). There was not a significant difference between the similarity of targets and their category choices ($M = 1.88$, $SD = 0.40$) and the similarity of targets and the unrelated items ($M = 1.38$, $SD = 0.21$). Given this nonsignificant difference and the low absolute level of visual similarity in both groups, we were not concerned that the appearance of the pictures would bias children's answers.

The 34 triads were placed in a three-ring binder. There were three blocks of trials with a fixed presentation: (a) warm-up; (b) taxonomic, script, and evaluative triads; and (c) conflict triads. The trials within each block were presented in one of two random orders. The conflict trials were always tested last because of their potential for biasing other trials. The conflict trials force participants to choose between taxonomic and script categories, and this might cause them to emphasize one and ignore the other in the nonconflict trials. Because all of the category types occurred in the nonconflict trials, this did not bias any response in the conflict trials.

Procedure. Children were tested individually for approximately 15 min in a quiet area of their school. The first block of the experiment consisted of two easy warm-ups to familiarize children with the procedures. For example, children heard, "This is a cinnamon donut. This is a chocolate donut and this is broccoli. Now, is the chocolate donut or the broccoli the same kind of food as the cinnamon donut?" If children selected the unrelated picture (i.e., broccoli), the researcher corrected the child and repeated the warm-up until the child understood the procedures. The second block consisted of 12 taxonomic, 12 script, and 4 evaluative trials. The third block consisted of 6 conflict trials. In each of these trials, the researcher labeled the pictures and asked which food is the same kind of food as the target, as in the warm-up task. If a child did not make a clear choice, the researcher repeated the question. The researcher did not provide children with feedback about their answers.

Adults participated in a paper-and-pencil version in a large group. Adults did not see the food photographs but were asked to read and respond to names of foods.

Results

We scored the nonconflict trials by assigning a 1 to choices that belonged to the same category as the target and a 0 to the unrelated choice. For the conflict trials, the taxonomic choices were assigned a 1 and the script choices a 0. We then summed the trials into their respective category types and transformed the scores into proportions. Because the scores of the nonconflict trials reflect accuracy (sensitivity to the category relationship tested), and the scores of the conflict trials reflect a preference (both choices are "correct"), we analyze them separately throughout this article.

Nonconflict triads. We conducted a 3 (age: 4-year-olds, 7-year-olds, adults) × 3 (category type: taxonomic, script, and evaluative) analysis of variance (ANOVA) for the nonconflict trials. The dependent variable was accuracy of food choice. Accuracy increased with age, as 4-year-olds were 70% accurate, whereas 7-year-olds and adults were 85% and 91% accurate, respectively, $F(2, 45) = 14.12$, $MSE = 0.56$, $p < .05$. There was a significant difference between 4-year-olds and the older groups but not between 7-year-olds and adults, Tukey's (HSD) test honestly significant different, $p < .05$. There was neither a significant main effect of category type nor a Category × Age interaction. See Figure 1 for the percentage of category choices by age and category type. All of the age groups performed reliably better than chance for each category type, $ts(15) > 3.0$, $ps < .05$. Thus, children as young as 4 had all three category types.

To determine whether the results were due to one or two foods, we separated out the different food groups within each of the category types. Although there are not enough items within each category to allow reliable cross-category comparisons, the apparent differences can serve as suggestions for future research. Table 1 lists each food category and each age group's accuracy in classifying into it. The table suggests that some taxonomic, script, and evaluative foods are understood better than others. Breads and grains seemed to be particularly difficult for the children, perhaps because they are perceptually diverse. Lunch foods and snacks seemed difficult for the 4-year-olds, perhaps reflecting differences in eating habits across age groups. Children are more likely to have hot meals at lunch than our college student participants, and their snacks probably are less dependent on vending machines. Finally, 4-year-olds seemed to have limited awareness of healthy foods. Perhaps they are more likely to hear comments such as, "You've eaten enough junk food today" than to hear comments on the healthy properties of foods.

Conflict triads. Results from the conflict trials were similar to past studies that have pitted two forms of

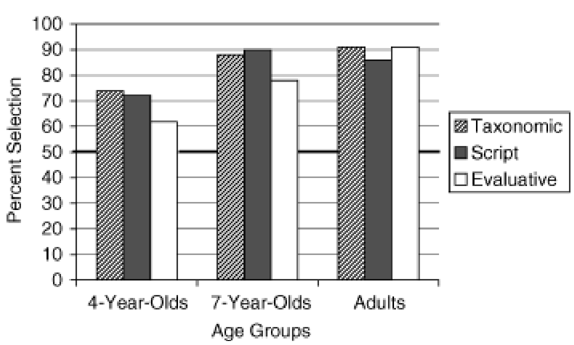

Fig. 1. Percentage of taxonomic, script, and evaluative category choices in Experiment 1.

Table 1
Experiment 1: Mean Accuracy (Standard Deviations) of Categorizing Items Into Food Categories as a Function of Age

	4-year-olds	7-year-olds	Adults
Taxonomic			
Beverages	.87 (.028)	1.00 (0)	1.00 (0)
Bread and grains	.56 (.025)	.59 (.027)	.93 (.017)
Dairy	.68 (.030)	.78 (.025)	.78 (.025)
Fruit	.84 (.023)	1.00 (0)	.96 (.012)
Meat	.78 (.031)	1.00 (0)	.96 (.012)
Vegetables	.71 (.031)	.90 (.020)	.93 (.017)
Script			
Breakfast	.68 (.040)	.81 (.025)	.62 (.034)
Lunch	.59 (.037)	.93 (.017)	.96 (.012)
Dinner	.71 (.036)	1.00 (0)	.93 (.017)
Birthday	.87 (.022)	.96 (.012)	.96 (.012)
Dessert	.75 (.031)	.87 (.022)	.90 (.020)
Snack	.68 (.035)	.84 (.030)	.81 (.030)
Evaluative			
Healthy	.56 (.030)	.75 (.036)	.90 (.020)
Junky	.71 (.036)	.78 (.036)	.96 (.012)

Note. Four-year-olds and 7-year-olds were above chance on all of the taxonomic foods except breads and grains, $ts(15) > 2$, $ps < .05$. Adults were above chance on all of the taxonomic foods, $ts(15) > 4$, $ps < .05$. Four-year-olds were above chance on all of the script foods except breakfast and lunch, $ts(15) > 2$, ps < .05. Seven-year-olds were above chance on all of the script foods, $ts(15) > 4$, $ps < .05$. Adults were above chance on all of the script foods except for breakfast foods, $ts(15) > 3$, ps < .05. Seven-year-olds and adults were above chance on both the healthy and junky foods, $ts(15) > 2$, $ps < .05$. Four-year-olds were above chance on junky evaluative foods, but not on healthy evaluative foods, $t(15) = 2.40$, $p < .05$.

categorization against one another. Seven-year-olds, $t(15) = 3.22$, $p < .05$, were above chance on their taxonomic choices ($M = 0.62$, $SD = 0.15$), 4-year-olds ($M = 0.44$, $SD = 0.10$) and adults ($M = 0.56$, $SD = 0.20$) were not. Within children, then, these results show the usual finding that children do not consistently choose taxonomic relations until around 7 years of age. Although it is tempting to view the difference between 4- and 7-year-olds as reflecting a change in cognitive abilities, 4-year-olds' above-chance performance on the nonconflict trials argues against such an explanation. That is, given that 4-year-olds were 74% correct on the nonconflict taxonomic trials, we cannot conclude from the conflict trials that they did not know the taxonomic categories. Similarly, such a conclusion would be absurd for adults. Instead, it seems likely that the 4-year-olds and adults (but not the 7-year-olds) found the script relations as salient or important as the taxonomic relations.

Discussion

The goal of this experiment was to examine whether children have multiple category types, including taxonomic, script, and evaluative categories. The answer to this question is yes. By age 4, children do have taxonomic, script, and evaluative categories. The results of the present study run counter to past claims that 4-year-olds undergo a qualitative shift in their categorization abilities (e.g., Greenfield & Scott, 1986; Kagan et al., 1963; Lucariello et al., 1992; Nelson, 1986, 1988; Olver & Hornsby, 1967). An explanation for the difference in these results is that past research has typically used conflict trials in which taxonomic and script categories are pitted against each other (e.g., Lucariello et al., 1992; Sell, 1992). Our conflict triads also found a (nonsignificant) preference for script categories in 4-year-olds. However, our nonconflict triads allowed children the opportunity to categorize foods in multiple ways. Children as young as 4 years of age classified foods into taxonomic, script, and evaluative categories on the nonconflict trials. There was no sign that script categories are acquired before taxonomic categories.

Thus, the conclusion of prior research that younger children think in terms of script or thematic categories before they understand taxonomic categories is based on a conflation of preference and categorization. Seven-year-olds show a preference for taxonomic over script categories that 4-year-olds do not, as shown in the conflict triads (and by Lucariello et al., 1992; Smiley & Brown, 1979), but children at both ages understand both kinds of categories and use them in categorization, as shown in the nonconflict triads.

One possible concern about our results is whether we were successful in identifying items that were in taxonomic categories but not script categories. For example, perhaps butter and yogurt co-occur in some script that we did not successfully identify in our stimulus construction procedure. This possibility is addressed by our induction experiments (see Discussion of Experiment 5).

Experiment 2

Experiment 2 examined the early emergence of taxonomic and script categories by extending a modified version of Experiment 1 to 3-year-olds. Experiment 1 showed that by 4 years of age, children have taxonomic, script, and evaluative categories, but it leaves open the possibility that script categories emerge before taxonomic categories at an earlier age. Examining the development of these categories in younger children could help address claims of the developmental shift from script to taxonomic categories. Perhaps 3-year-olds will show the ability to categorize foods only into script categories, as this shift would predict.

Method

Participants. Participants were sixteen 3-year-olds ($M = 3{,}6$, *range* $= 3{,}1-3{,}8$; 9 boys and 7 girls). Children were drawn from the same demographic population as in Experiment 1.

Materials. The 12 taxonomic and 12 script picture triads from Experiment 1 were used with 3-year-olds. To accommodate the attention spans of 3-year-olds, we did not include the evaluative or conflict triads. In addition, a large doll named Jane was used to make the experiment gamelike for the younger children.

Procedure. Children were tested in a quiet area of their day care or in a laboratory setting. The researcher told children, "Jane needs help figuring out which foods are the same kinds of food." After completing an easy warm-up trial borrowed from Experiment 1, the children were presented with the taxonomic and script trials. For each of the trials, the researcher labeled the foods and asked, "Is Y or Z the same kind of food as X?" These trials were presented in one of two random orders.

Results and Discussion

We scored the data as in Experiment 1. The 3-year-olds were 60% correct on the taxonomic trials and 60% correct on the script trials, both of which differed from chance, $t(15) = 2.5$, $p < .05$; $t(15) = 2.05$, $p < .05$. We also examined the individual taxonomic foods: beverages ($M = 0.56$, $SD = 0.30$), bread and grains ($M = 0.43$, $SD = 0.44$), dairy products ($M = 0.78$, $SD = 0.31$), fruits ($M = 0.65$, $SD = 0.35$), meats ($M = 0.75$, $SD = 0.36$), and, vegetables ($M = 0.43$, $SD = 0.40$). Similarly, we examined the individual script foods: breakfast ($M = 0.53$, $SD = 0.28$), lunch ($M = 0.40$, $SD = 0.37$), dinner ($M = 0.62$, $SD = 0.38$), birthday ($M = 0.78$, $SD = 0.36$), dessert ($M = 0.62$, $SD = 0.28$), and snack ($M = 0.62$, $SD = 0.38$). Three-year-olds were above chance (ps $< .05$) only on the taxonomic categories of dairy products and meats and on the script category of birthday foods, though, as before, there is little power in the tests of individual categories.

We also compared the 3-year-olds' data with the data from Experiment 1 by combining them in a 4 (age) $\times 2$ (category type) ANOVA. There was a main effect of age, $F(3, 60) = 19.53$, $MSE = 0.65$, $p < .05$. Three-year-olds were significantly different from 4-year-olds, 7-year-olds, and adults, $p < .05$, by Tukey's HSD test, demonstrating that even though 3-year-olds were above chance, there is significant category learning from 3 to 4 years. There was no main effect of category nor a Category $\times$ Age interaction.

These results suggest that by 3 years, children have both taxonomic and script categories, and that one type of category does not dominate the other. In conjunction with the results of Experiment 1, these results show a steady improvement in children's acquisition of different categories from 3 to 7 years. The use of nonconflict trials revealed that taxonomic and script categories are emerging simultaneously in 3-year-olds. These results do not reveal a developmental shift from script to taxonomic categories. Given that 3-year-olds' level of performance was just above chance, at 60% on both the taxonomic and script trials, the possibility that a shift occurs before this age seems unlikely.

Experiment 3

Based on the results of Experiments 1 and 2, we concluded that children have multiple categories in the domain of food. However, what we do not know is whether children realize that a single food can belong to more than one of these categories. In the previous experiments, we did not systematically test each food in multiple categories. There are indeed many ways to categorize a single food, as in the case of muffins, which can be considered a grain, a snack, a breakfast or lunch food, and a healthy, or even a junk food, depending on its ingredients. Ross and Murphy (1999) found that adults cross-classify foods; apple was categorized as a fruit, snack, and healthy food. The question of whether children would do so addressed their flexibility as categorizers. Although Experiments 1 and 2 showed they can use two different categorization systems within a single domain, the experiments did not show that children can treat the same item as a member of two different categories, especially two categories with very different bases. True cross-classification requires that different systems of categorization be applied to the same items.

The purpose of Experiment 3, then, was to examine children's cross-classification of food. Because children were best at identifying the script and taxonomic categories (see Table 1), we constructed nonconflict triads for these two category types, using a common set of target items. Specifically, twelve foods were used as the targets in both the taxonomic (e.g., ice cream: butter vs. sandwich) and script (ice cream: cake vs. potato) triads. If children cross-classify, they should select the choice that shares a categorical relationship with the target in both taxonomic and script triads. A limitation on this prediction is that children might be unfamiliar with one of the categories and could therefore fail to cross-classify—not because of any problem with cross-classification, per se, but because of ignorance. For example, a child might be perfectly willing to classify ice cream into different categories but simply is not aware that it is a dairy food. And, indeed, in Experiment 1, 4-year-olds made about 30% errors both in taxonomic and script categories; therefore, one could hardly expect that they would correctly classify foods into both categories near to 100% of the time.

How, then, should cross-classification be tested? It is clearest to frame the problem in the negative: What will children do if they cannot cross-classify? If cross-classification is difficult, there should be a negative relation between the two tasks, such that items that are correctly classified taxonomically should be incorrect on the script trials, and vice versa. Thus, we gave children the same item in two different classification tasks and performed a test of independence to discover whether there is a negative relationship between taxonomic and script classification. That is, we hoped to discover whether children who think of ice cream as a dessert would then find it difficult to think of it as a dairy product.

Method

Participants. Thirty-two children participated: sixteen 4-year-olds ($M = 4{,}0$, $range = 4{,}0 - 5{,}0$; 6 boys and 10 girls) and sixteen 7-year-olds ($M = 7{,}6$, $range = 7{,}0 - 8{,}0$; 6 boys and 10 girls). Sixteen adults also participated ($M = 19{,}8$; 7 males and 9 females). A separate group of 15 adults also completed ratings of the items. Participants were recruited from the same demographic population as in the previous experiments.

Materials. The pictures of foods were selected and prepared the same way as in Experiment 1. Twelve foods were used as the targets in both the 12 taxonomic and 12 script triads. For example, the taxonomic triads included a target item (e.g., ice cream), a taxonomic choice (e.g., butter), and an unrelated choice (e.g., sandwich). The script triads included a target (e.g., ice cream), a script choice (e.g., cake), and an unrelated choice (e.g., potato). The categorical and unrelated choices were counterbalanced across triads (e.g., the categorical choice for one triad became the unrelated choice for another triad). See Appendix B for a complete list of the triads.

As in Experiment 1, 10 adults rated the typicality and familiarity of the targets and their category matches to ensure that these factors did not vary among category types. The scales again ranged from 1 to 7. There was no significant typicality difference between the taxonomic and script categories ($M = 6.02$, $SD = 0.47$; $M = 5.69$, $SD = 0.72$), nor was there a familiarity difference ($M = 6.11$, $SD = 0.67$; $M = 5.66$, $SD = 0.84$).

As in Experiment 1, 5 adults also completed visual similarity ratings of the stimuli to ensure that neither of the choices in each triad appeared significantly more similar to the target. The level of visual similarity was low overall, and there was no significant difference between the targets and their category choices ($M = 2.4$, $SD = 0.67$) and the targets and their unrelated choices ($M = 1.85$, $SD = 0.26$).

The 24 triads were placed in a three-ring binder. There were two blocks. The first block included 12 targets placed into six taxonomic triads and six script triads. The second block included the same 12 targets but in triads from the untested category. The order of trials was random within blocks and was reversed for approximately half of the participants.

Procedure. Children were tested individually in a quiet area of their school. Children initially completed a warm-up task in which they were asked to categorize a cat into two different categories. The first warm-up was: ''This is a tabby cat. Is a bear or a Persian cat the same kind of thing as the tabby cat?'' The second warm-up was: ''This is a tabby cat. Is a dog or elephant the same kind of thing as the tabby cat?'' If children selected the incorrect pictures (i.e., bear or elephant), the researcher corrected the children and repeated the warm-up until it was clear that they understood the procedures. Next, children completed the 24 test trials. For each of these trials, the researcher labeled the pictures and asked which choice was the same kind of food as the target, as before. If a child did not make a clear choice, the researcher repeated the question. No feedback was given in the test trials.

Adults participated in a paper-and-pencil version in a group. They did not see the food photographs but were asked to read and respond to names of foods.

Results

We assigned a 1 to choices that belonged to the same taxonomy or script category as the target and a 0 to unrelated choices, and we converted the scores into proportions. We then conducted a 2 (category type: taxonomic and script) $\times$ 3 (age: 4-year-olds, 7-year-olds, and adults) ANOVA. As in the previous studies, performance on the taxonomic and script trials was relatively similar for each age group. There was no effect of category type. Four-year-olds were 66% accurate on the taxonomic and 60% on the script trials. Seven-year-olds were 89% accurate on the taxonomic and 83% on the script trials. Adults were 89% accurate on both the taxonomic and script trials. Clearly, there is no sign of a script-to-taxonomic shift.

There was a main effect of age, $F(2, 45) = 21.24$, $MSE = 0.65$, $p < .05$. Overall, 4-year-olds were less accurate than 7-year-olds and adults, who were about equally accurate, as shown by Tukey's HSD tests, ps $< .05$. We also compared participants' performance to chance (50%) and found that all age groups were above chance on both the taxonomic and script trials, ts$(15) > 2.3$, ps $< .05$.

The accuracy of the 7-year-olds and adults was so high that participants in these groups must have been classifying the same items into both taxonomic and script categories. However, at 66% and 60% accuracy for taxonomic and script triads, the 4-year-olds might have been classifying different items correctly in the two category types much of the time. Thus, it is possible that they were not cross-classifying individual items to any great degree.

We investigated this possibility by asking if children were avoiding cross-classifying items. That is, if they got ice cream correct on the script triad, this should have decreased their likelihood of getting it correct on the taxonomic triad, reflecting their inability to think of ice cream as being in two different categories. In short, if children cannot cross-classify, their performance should be negatively correlated across triads. We set up as a null hypothesis the possibility that classification on the two category types was independent. Under this hypothesis, we can calculate the number of items that each participant should get correct on both problems, to wit, P (correct taxonomic) $\times$ P (correct script) $\times$ 12 (items). The result of this calculation was that children should get 4.87 items correct on both tests, on average. If the children were unable to cross-classify, the number of items they got correct on both tests should have been significantly less than this, as they should have tended to get different items correct on the two tests.

In fact, the average number of items that a child correctly classified into both categories was 4.75, virtually identical to the number predicted by the independence assumption, $p > .05$. Clearly, children did not exhibit any tendency to classify items into only one of the categories. Instead, it seems likely that their knowledge of the two kinds of categories develops independently.

Discussion

These results provide further evidence that 4-year-olds are not limited to script categories and that children do not undergo a shift from script to taxonomic categories with development. The results extended the findings of Experiments 1 and 2 by demonstrating that children as young as 4 can classify the same object into taxonomic and script categories. These results suggest that young children's categorization of objects is flexible. Past research suggesting that children undergo a shift from either thematic to taxonomic (e.g., Inhelder & Piaget, 1964) or from script to taxonomic categories (Nelson, 1988) has typically pitted two category types against each other while ignoring the possibility that children might be able to use more than one form of categorization. However, a few recent studies have shown that children are more flexible in their categorization than once assumed. The results of Experiment 3 are consistent with these studies. For example, Blaye and Bonthoux (2001) recently showed that by age 5, children can flexibly categorize an object into a taxonomic and thematic category when they are cued to do so. In this study, children were allowed to categorize spontaneously a target item taxonomically or thematically. One week later, children were presented with a drawing of a scene that primed children to use a different form of categorization than before (e.g., a thematic scene if the child had spontaneously categorized the item taxonomically). Our results show that children can cross-classify even without any hint or prime. Other research has also found that even 3-year-olds have different words for a single object at varying levels of a taxonomy to which the object belongs (Blewitt, 1994; Deák & Maratsos, 1998; Waxman & Hatch, 1992), although superordinate categorization is not strictly speaking cross-classification.

In the current study, children categorized items into taxonomic and script categories separately. Thus, the results show that at minimum children can represent an item in terms of taxonomic and script relations at different times. A further question, which we cannot answer, is whether children can simultaneously think of the same object as belonging to a taxonomic and script category. Clearly, it would be helpful to have access to more than one category representation simultaneously. If a lactose-intolerant child is trying to decide what to eat for dessert, considering the categories of dessert and dairy food simultaneously will get the child much further in making an appropriate decision than if only the one category was activated. We suspect that the ability to coordinate two different categories in this way depends on the entrenchment of the categories. If chicken automatically activates the concepts of dinner food and meat, and if these are familiar concepts, it may be possible for children to entertain them simultaneously. However, it is not possible to discover this in the usual paradigms of categorization.

Experiment 4

Experiment 3 demonstrated that children can cross-classify foods, but the fact that food can belong to more than one category may pose a problem for inductive inferences. How do children know which category to use when making an inductive inference about particular properties of food? In a study with adults, Ross and Murphy (1999, Experiment 6) found an interaction between category and inference type, but this depended to some degree on the procedure used. This interaction was relatively small when adults were asked to judge the probability that certain taxonomic and script categories have various biochemical and situational properties. For example, adults were asked whether a category of food (e.g., fruit, breakfast foods) relative to other foods is low, medium, or high in vitamins. Another example was asking adults whether a category of food (e.g., fruit, breakfast foods) relative to other foods is eaten during the morning, afternoon, or evening. After making a response, adults were also asked to rate the probability that their answer is correct. Adults provided slightly higher induction judgments to the taxonomic categories (e.g., fruit) for biochemical properties (e.g., has vitamins) than to situational properties (e.g., is eaten during a certain time of day). But they gave significantly higher ratings to the script categories (e.g., breakfast) for the situational properties than for the biochemical properties.

The interaction was larger when Ross and Murphy (1999, Experiment 7) directly pitted taxonomic and script categories in conflict triads, requiring adults to compare the two categories and select the one that provided a better basis for a particular inference. They found that adults tended to choose the taxonomically related item for biochemical inferences and the script-related item for situational inferences. For example, when told that a target food had a fictitious enzyme, adults said that a food that shared a taxonomic category with the target was more likely to have the enzyme than a food that shared a script category with the target. In contrast, when told that a target food was eaten on a fictitious holiday, adults said that a food that shared a script category with the target was more likely to also be eaten on the holiday. We used both types of test (conflict and nonconflict) to see which, if either, would be better at revealing children's inductions and to see if the results would parallel those of Ross and Murphy (1999) with adults.

The goal of Experiment 4 was to investigate children's selective use of taxonomic, script, and evaluative categories to make inductive inferences of foods. Children participated in either the biochemical or situational condition. Children in the former condition were asked to make biochemical inferences about the ingredients of foods, whereas children in the latter condition were asked to make situational inferences about when foods should be eaten. Children in both conditions received the nonconflict (taxonomic, script, evaluative) and conflict triads from Experiment 1. The nonconflict triads included a target food and two choices, an alternative that shared a categorical relationship with the target and an unrelated alternative. The conflict triads included a target food and alternatives that shared a taxonomic and script relationship with the target.

If children distinguish the types of inductions that are appropriate for different kinds of categories—that is, if they exhibit inductive selectivity—in the nonconflict trials they should make more biochemical inferences for the taxonomic categories than for the script categories. In contrast, they should make more situational inferences for the script categories. The current experiment also examined whether children use evaluative categories for biochemical or situational inferences, or both. To date, no research has documented the type of inferences this category type supports. We speculated that evaluative categories in the nonconflict triads could be used to make biochemical inferences, because foods are typically defined as healthy or junky based on their shared biochemical properties such as ingredients and nutritional value (e.g., sugar and fat content). Past research has shown that children exhibit some sensitivity to the kinds of properties that they will infer across categories, but their sophistication in matching properties to categories takes some time to develop (Gelman, 1988; Gelman & Markman, 1986; Gelman & O'Reilly, 1988). However, past work has not explicitly contrasted script and taxonomic categories in the induction task.

For the conflict triads, we might also expect that children should choose the taxonomic choice when making biochemical inferences but the script choice when making situational inferences. Given Ross and Murphy's (1999) study with adults, it is possible that the results will be stronger in the conflict than the nonconflict triads.

Method

Participants. Participants were twenty-eight 4-year-olds ($M = 4,4$, *range* $= 4,1-4,9$; 12 boys and 16 girls), twenty-eight 7-year-olds ($M = 7,6$, *range* $= 6,9-8,0$; 10 boys and 18 girls), and 28 adults ($M = 21$; 10 males and 18 females). Half of the participants in each age group were randomly assigned to the biochemical condition and the other half to the situational condition. Thirty adults also rated the materials. The demographic information for the participants is similar to that of the previous experiments.

Materials. The same food triads from Experiment 1 were used in Experiment 4. We wanted to ensure that these materials could be used for inferences that were based on categorical relationships between the targets and their category alternatives. For example, we wanted to ensure that if milk was the target and the choices were water and beef, that water would be selected because water and milk share a categorical relationship, not because those were the only two items that appeared to have any relation at all. Therefore, we pretested the target and related items to ensure that they would provide a basis for induction.

We had adults rate a total of 24 pairs of foods: 12 taxonomic targets and their taxonomic choices (e.g., cereal–bread) and 12 script targets and their script choices (e.g., cake–ice cream). The evaluative targets were not included because we were attempting to replicate the results of Ross and Murphy (1999), who used only script and taxonomic categories (but see the main results). Half of the adults were told that the target food had an ingredient, a biochemical property, and then were asked to rate how certain they felt that the choice also had this ingredient. The other half of the adults were told that the target food was eaten on a holiday, a situational property, and then were asked to rate how certain they felt that the choice was also eaten on this holiday. Adults rated their certainty on a probability scale ranging from 0 to 100. The food pairs were presented in two random orders for each group of adults.

The mean probability ratings were subjected to a 2 (property: biochemical and situational) × 2 (category type: taxonomic and script) ANOVA. The taxonomic and script categories had similar inferential power, as indicated by a lack of a main effect of category type. See Table 2 for the probabilities by property and category type. There was a main effect of property, $F(1, 28) = 20.56$, $MSE = 195.52$, $p < .05$, moderated by a Category Type × Property interaction, $F(1, 28) = 27.37$, $MSE = 44.44$, $p < .05$. The biochemical property led to higher probabilities for taxonomic categories than for script categories, whereas the situational property led to higher probabilities for script categories than for taxonomic categories. These probabilities suggest that the targets and their script or taxonomic alternatives in Experiment 1 have a categorical relation that supports inductions. Thus, we replicated the results of Experiment 6 of Ross and Murphy (1999) with the present items and validated the use of the triads from Experiment 1 in the current experiment.

Table 2
Adult Probability Ratings of Induction by Property and Category type in Experiment 4

	Category type		
	Taxonomic	Script	Mean
Property			
Biochemical	51	39	45
Situational	58	65	61
Mean	54	52	

Procedure. Children were tested individually in a quiet area of their classroom or in a laboratory setting in one of two conditions: biochemical or situational. As in Experiment 1, there were three blocks of trials in each condition. The first block included two easy warm-up trials. Children in the biochemical condition heard, for example, "This is a robin. This is a bear and this is a blue jay. The robin has a body part called an omentum inside. Do you think the bear or blue jay probably has an omentum inside too?" Children in the situational condition heard that the robin "makes a sound called a tekker in the morning." If a child selected the bear, the researcher corrected the answer and repeated the warm-up until it was clear the child understood the procedures.

After the warm-up trials, children in the biochemical condition heard the following: "Now I'm going to tell you about a place that some people live.… The foods that people eat in this faraway place have different ingredients…. This game is about ingredients of foods. Some foods have a certain ingredient, but not all foods do. Sometimes foods even have more than one ingredient, too. So can you help me figure out which foods have a certain ingredient in them and which foods do not?" Children in the situational condition heard the same description except that they were told that there was a foreign country where people eat foods on different holidays.

These descriptions were adapted from Experiment 7 of Ross and Murphy (1999). Novel words were used for the ingredients and holidays because we were interested in the inferences children make from the new information that was provided in the experiment. We did not want children to base their answers on associations that they might have between actual ingredients, holidays, and foods.

The second block included taxonomic, script, and evaluative trials, whereas the third block included conflict trials. For the second block of trials, children in the biochemical condition were told that a target food had a novel ingredient and were asked to select another food that also had that ingredient (e.g., "Pary is an ingredient in grapes. Do you think a strawberry or bread probably also has Pary in it too?"). Children in the situational condition, in contrast, were told that a food was eaten on a novel holiday and were asked to select another food that was also eaten on that holiday (e.g., "Cake is eaten on a special holiday called Dax. Do you think ice cream or soup is probably eaten on Dax too?"). If a child did not make a clear choice, the researcher repeated the question. The trials within each of the blocks were presented in one of two random orders.

Adults were not shown the photographs but were asked to read and respond to the questions with food names presented in a paper-and-pencil format.

Results and Discussion

To test children's inductive selectivity, we first conducted a 2 (property: biochemical and situational) $\times$ 3 (age; 4-year-olds, 7-year-olds, adults) $\times$ 3 (category type: taxonomic, script, and evaluative) ANOVA on the data from the nonconflict triads. Recall that the nonconflict triads included a target and a categorically related choice and an unrelated choice. If children have inductive selectivity, they should select the category choice more when it was appropriate for the induction. For example, for biochemical inferences children should select the category choice on the taxonomic and (perhaps) evaluative triads but should be less likely to do so on the script triads. Similarly, on the script triads participants should select the category choice for situational inferences but should do so less often on the taxonomic and (perhaps) evaluative triads.

There was a reliable age effect, $F(2, 78) = 24.73$, $MSE = 1.13$, $p < .05$: Overall, 7-year-olds ($M = 0.77$, $SD = 0.18$) and adults ($M = 0.82$, $SD = 0.17$) selected the food that shared a categorical relationship with the target significantly more often than did 4-year-olds ($M = 0.60$, $SD = 0.19$), Tukey's HSD test, $p < .05$. Participants selected the food that shared a categorical relationship with the target more often when making biochemical inferences ($M = 0.76$, $SD = 0.19$) than situational inferences ($M = 0.70$, $SD = 0.21$), $F(1, 78) = 4.56$, $MSE = 0.20$, $p < .05$. There was no main effect of category type nor an interaction of Category Type $\times$ Age.

There was a Category Type $\times$ Property interaction, $F(1, 132) = 4.79$, $MSE = 0.15$, $p < .05$, which was subsumed by the three-way interaction among category type, property, and age, $F(4, 132) = 4.0$, $MSE = 0.1$, $p < .05$. Figure 2 illustrates that 4- and 7-year-olds lacked inductive selectivity, in that children tended to pick the category choice regardless of whether the biochemical or situational inference was appropriate. Unlike the children, adults made significantly more biochemical inferences for the taxonomic than for the script categories, $t(13) = 4.7$, $p < .05$, and more biochemical inferences for the evaluative than the script categories, $t(13) = -3.88$, $p < .05$. Adults made significantly more situational inferences for the script than for the taxonomic categories, $t(13) = -4.3$, $p < .05$. There was also a trend toward a difference between the script and evaluative categories, $t(13) = 1.9$, $p = .08$. There was no significant difference between the taxonomic and evaluative categories.

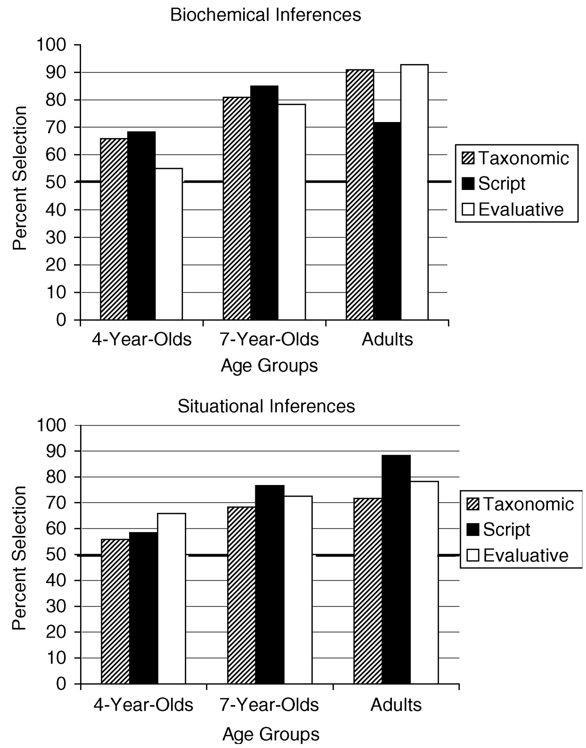

Fig. 2. Percentage of taxonomic, script, and evaluative category choices selected for biochemical and situational inferences in Experiment 4.

We examined the conflict triads by comparing participants' taxonomic choices to chance, 50%. Recall that the conflict triads included a taxonomic choice pitted against a script choice. We expected that if children have inductive selectivity, they should pick the taxonomic choice when making biochemical inferences and the script choice when making situational inferences. Figure 3 shows that the results from the conflict trials conform to the results of the nonconflict trials: Adults had a preference for taxonomic categories when they made biochemical inferences, $t(13) = 4.94$, $p < .05$, but this preference was reversed when they made situational inferences, $t(13) = -3.60$, $p < .05$. Four- and 7-year-olds showed no such preferences.

Overall, the results from the adults are consistent with Ross and Murphy (1999), revealing that adults have inductive selectivity. Adults made more biochemical inferences for the taxonomic and evaluative categories than for script categories. In contrast, adults made more situational inferences for the script than the taxonomic categories and (margin-

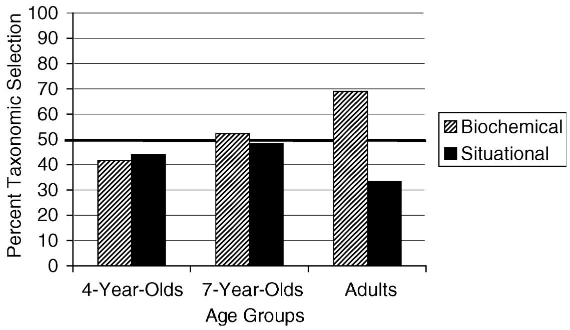

Fig. 3. Percentage of taxonomic choices selected for biochemical and situational inferences in the conflict trials of Experiment 4.

ally) than the evaluative categories. However, our results did not reveal that children have inductive selectivity. Children made a similar number of biochemical and situational inferences for the taxonomic, script, and evaluative categories. Thus, the results show that children can use all three kinds of categories from which to draw inferences, which is an important result, as induction is a major function of categorization (Gelman & Markman, 1986, 1987; Murphy, 2002). However, the results also suggest that children are not very good at distinguishing what kinds of properties are most appropriate for these different category types.

Experiment 5

One explanation of the results of Experiment 4 is that children do not have inductive selectivity. The goal of Experiment 5 was to examine this possibility more fully. Experiment 4 included mainly nonconflict triads (28), which included an alternative that shared a categorical relationship with the target and an unrelated alternative. The nonconflict triad task required children always to choose a food even if they believed an inference did not make sense for that triad. For example, situational inferences make sense for script triads, but they make less sense for taxonomic triads. However, children were not given the option of not selecting a food in these cases. Given this circumstance, children might have attempted to select the best choice possible, which may have been to select the food that shared the same script, taxonomic, or evaluative category as the target regardless of the property type. This strategy would tend to reduce any selectivity based on property type. A similar explanation was suggested in a recent study by Diesendrcuk and Bloom (2003, Experiment 2). In this study, although children were more likely to generalize relevant properties (e.g., ''It was made especially to play with cats'') as opposed to irrelevant properties (e.g., ''My uncle gave this to me'') to items that shared the same shape as the targets, children still made many irrelevant property generalizations. Diesendruck and Bloom (2003, Experiment 2) suggested that when children were asked to generalize irrelevant properties, they may have tried to pick the best answer possible under the forced-choice circumstances, which was the shape choice.

In contrast, conflict triads directly pit a taxonomic against a script choice, and one of them is always appropriate. Although Experiment 4 did contain conflict triads, they were small in number (only 6) relative to the nonconflict triads. We increased the number of conflict trials to 15 in Experiment 5 to give the children a greater opportunity to reveal any knowledge of which properties should be induced from different categories. We did not include evaluative categories in Experiment 5 to increase the power of our script–taxonomic comparison. If children have inductive selectivity, they should select the taxonomic choice in the biochemical condition and the script choice in the situational condition. Finally, we slightly modified the wording in the procedure to make it more child friendly.

Method

Participants. The participants were thirty-two 4-year-olds ($M = 4{,}5$, $range = 4{,}0–5{,}1$; 16 boys and 16 girls), thirty-two 7-year-olds ($M = 7{,}6$, $range = 6{,}7–8{,}3$; 14 boys and 18 girls), and 32 adults ($M = 19$; 16 males and 16 females). The participants were drawn from a similar population as in the previous experiments.

Materials. The stimuli were selected and prepared in the same way as in the previous experiments. The photographs were arranged into 15 conflict triads (shown in Appendix C) in which there was a target and a taxonomic and a script choice pitted against each other. Adults again completed visual similarity ratings of the stimuli. There was not a significant difference between the targets and their taxonomic choices ($M = 3.41$, $SD = 1.00$) and the targets and their script choices ($M = 3.68$, $SD = 0.74$).

Procedure. A researcher tested children in a quiet area of the classroom. Children participated in either the biochemical or situational condition. The directions children heard in Experiment 5 were a simplified version of those from Experiment 4. Instead of using the word *ingredient*, we used the words *stuff inside*. Also, instead of using the word *holiday*, we used the phrase *special time*. In particular, children in the biochemical condition heard the following directions: ''I'm going to tell you about a place where some people live that's very far away from here.... This game is about the stuff inside foods that these people eat. Some foods have the same stuff inside and some foods have different stuff inside. So can you help me figure out which foods have the same stuff inside?'' Children in the situational condition heard the following directions: ''This game is about the foods that these people eat during special times. Some foods are eaten during the same special times and others are eaten during different special times.''

Children in both conditions completed an initial warm-up trial, followed by the 15 conflict triads. The triads were presented in one of two random orders.

Results

Experiment 5 investigated whether children selectively generalize properties depending on the type of category. To compare responses as a function of property, we assigned a 1 to the taxonomic choices and a 0 to script choices for both the biochemical and situational conditions. We then converted these scores into proportions and conducted a 3 (age; 4-year-olds, 7-year-olds, adults) $\times$ 2 (property; biochemical, situational) ANOVA on these data. There were many more taxonomic choices for the biochemical ($M = 0.69$, $SD = 0.23$) than for the situational ($M = 0.20$, $SD = 0.61$) properties, $F(1, 90) = 275$, $MSE = .02$, $p < .05$. There were significantly more taxonomic choices for biochemical than for situational properties for each age group examined separately, $ts(30) > 3$, $ps < .05$. Overall, adults and 7-year-olds made more taxonomic choices than did 4-year-olds, $F(2, 89) = 9.0$, $MSE = 43.4$, $p < .05$. Four-year-olds differed significantly from 7-year-olds and adults, but 7-year-olds and adults did not differ from each other, Tukey's HSD, $p < .05$.

Figure 4 shows that these main effects were moderated by a Property $\times$ Age Group interaction, $F(2, 90) = 38.6$, $MSE = .02$, $p < .05$. The adults and 7-year-olds gave very different responses based on the property type, whereas 4-year-olds had a fairly small difference. Instead, they tended to choose the script-related item regardless of property.

We also compared participants' taxonomic choices to chance (50%). Seven-year-olds and adults, but not 4-year-olds, were significantly above chance on their taxonomic choices for the biochemical properties, $ts(15) > 5$, $ps < .05$. The opposite pattern was true for the situational properties. Four-year-olds, 7-year-olds, and adults chose the taxonomic choices less often than chance for the situational properties, $ts(15) < -9$, $ps < .05$.

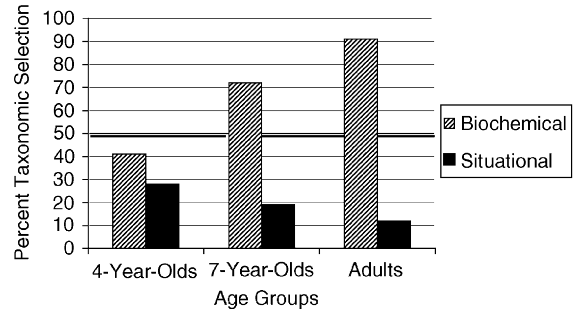

Fig. 4. Percentage of taxonomic choices selected for biochemical and situational inferences in Experiment 5.

Discussion

The purpose of Experiment 5 was to reexamine whether children can selectively use their categories for induction by testing conflict triads pitting taxonomic against script categories. The results from Experiment 5 suggest that 7-year-olds understand that biochemical inferences are most appropriate for taxonomic categories, whereas situational inferences are most appropriate for script categories. Although 4-year-olds were not above chance on their taxonomic choices for the biochemical properties, there was still a significant difference in their performance across the two property types: They made significantly more taxonomic choices for the biochemical than for the situational properties, $t(30) = 3.36$, $p < .05$. This suggests that 4-year-olds are beginning to develop their ability for inductive selectivity. These overall results fall in line with research demonstrating that children know that certain categories support certain inductive inferences (Deák, 2000; Kalish & Gelman, 1992).

The fact that 4-year-olds were more accurate on the situational properties also suggests that children may be able to make inductive inferences from script categories earlier than taxonomic categories. However, this result could also simply reflect a preference for the script relation, which would be consistent with their performance on conflict triads in Experiment 1 and previous research. Future research could examine how to improve 4-year-olds' ability to make appropriate inductive inferences for taxonomic categories (e.g., priming children with category labels for the target foods).

The results may also be related to the findings of Ross and Murphy (1999), who studied induction with similar categories in adults. As described earlier, they found some evidence for selective induction when their participants made probability ratings from individual categories, but the effects were noticeably stronger in conflict trials. An analogous result can be found in our Experiments 4 and 5. In Experiment 4, we found evidence for selective induction with nonconflict triads in adults only. In Experiment 5, with conflict triads, the effect with adults was much stronger (see Figure 4), and we now found clear selectivity in 7-year-olds. Thus, the conflict triads were more powerful in revealing this effect.

That said, it should also be noted that neither kind of task is perfect. In the nonconflict triad, participants may be tempted to choose the item that is related somehow to the target even if it is not an appropriate category for making the given induction. If one must choose between two items that do not seem likely to share the induced property, participants may simply decide to choose any item that has a noticeable relation. In contrast, the conflict task emphasizes the difference between two kinds of items by presenting them simultaneously and forcing participants to choose the better one. This task seems to do better at revealing inductive selectivity, but whether the same results would be found when a single item is tested (e.g., ''Do I think that this particular muffin has carbohydrates?'') has yet to be seen.

As a final note, the results of this experiment, along with the pretest with adults reported in the Method section of Experiment 4, verify that we were successful in identifying items that were related by taxonomic or script category in our experiments. That is, the fact that adult participants (and 7-year-olds in Experiment 5) gave stronger biochemical inductions to our taxonomic items and stronger situational inductions to our script items gives independent evidence that we successfully identified the categories of the food types. If there was any concern that our taxonomic items might also have had strong script relations, or vice versa, the present results contradict this possibility.

General Discussion

The Piagetian view that children do not have taxonomic concepts has been largely discarded in recent years. Much research on this topic has been devoted to finding ways of demonstrating children's early appreciation of taxonomic concepts (Markman, 1989; Waxman & Gelman, 1988). Others have argued that Piaget's results really reflect children's use of script-based concepts, which often include members of the same taxonomic category. These script-based categories may eventually develop into complete taxonomic concepts (e.g., Nelson, 1988). Such disputes tend to create an exclusive approach to categorization in which researchers attempt to discover which form of organization children use. Our approach has been to ask whether children use multiple kinds of concepts by measuring them independently rather than assuming that one form predominates.

Taxonomic, Script, and Evaluative Categories

Three questions guided our investigation. First, do children have taxonomic, script, and evaluative categories, and does one of them predate the others? The answer to the first part of this question is yes. Experiment 1 found that 4-year-olds, 7-year-olds, and adults have taxonomic, script, and evaluative categories of food. Experiment 2 revealed that 3-year-olds have both taxonomic and script categories. The answer to the second part of this question is that the categories appear to develop simultaneously. Unlike much research that forced children to choose either a taxonomic or script or thematic response, our results did not show any advantage for the script category. The 3-year-olds were equally accurate with both types of category.

The results from Experiments 1 and 2 differ from research concluding that young children use script categories but lack taxonomic categories until after approximately age 7 (e.g., Lucariello et al., 1992; Lucariello & Nelson, 1985; Nelson & Nelson, 1990; Sell, 1992; Yu & Nelson, 1993). One reason for this difference is that past studies have used conflict triads that pit taxonomic and script categories against each other, whereas the present studies used nonconflict picture triads in which children were allowed to categorize items into both categories. In conflict triads, preference and categorization ability are conflated—there is no way for participants to reveal knowledge of both kinds of category. Thus, this technique cannot reveal cross-classification, as our results did.

Another possible explanation is that our experiments used tasks more directly related to categorization, as opposed to memory or word-association tasks. It is possible that script (and thematic) categories have an advantage in such noncategorization tasks because of factors such as associative structure affecting memory recall (e.g., Blewitt, 1993; Blewitt & Krackow, 1992; Blewitt & Toppino, 1991). Krackow and Gordon (1998), for example, concluded that script categories had an advantage over taxonomic categories in memory and word-association tasks because past studies used script categories that are high on typicality and associativity (e.g., shirt–pants), whereas the taxonomic items were selected so as not to be associated. This advantage disappeared when Krackow and Gordon (1998) used script categories that were low on typicality and associativity (e.g., vest–pants) in a cued-recall task. Thus, the apparently earlier appearance of script categories in children's concepts may be due to these aspects of the most popular tasks used in prior research.

Note that we are not claiming that script categories are not an early and salient form of organization of children's concepts. In fact, we find evidence for them in children as young as 3. Instead, we are arguing that both script and taxonomic forms of organization are prevalent in children's concepts, and past findings of a progression from one to the other may reflect a change in preference. This result is consistent with recent claims that children's preference for thematic over taxonomic category choices in the triad task may reflect a preference rather than a conceptual shift (Lin & Murphy, 2001; Smiley & Brown, 1979; Waxman & Namy, 1997).

Although we did not find the traditionally claimed developmental shift, this does not imply that there is no improvement with age. Certainly, the results from Experiments 1 and 2 show that from 3 to 7 years there is a steady improvement in children's ability to categorize foods into taxonomic and script categories. However, this improvement occurs about equally across category types. The only qualitative difference was on conflict trials, when 7-years-olds categorized foods more often into taxonomic categories than into script categories in Experiment 1 (i.e., the usual preference for taxonomic choices in school-aged children; Smiley & Brown, 1979). The reason for this change in preference is beyond the scope of the present article, but it may have to do with formal education (see Markman, 1989; Murphy, 2002, chap. 10; Smiley & Brown, 1979, for discussion).

We found that children and adults were both sensitive to evaluative categories of healthy and unhealthy foods, although there was perhaps a greater developmental difference here than for the other categories. An important question about evaluative categories is whether they are constructed simply on the basis of affective value (healthy is good; unhealthy is bad) or have additional content. We address this in light of the induction results.

Cross-Classification

Our second question was, do children cross-classify foods into these categories? The answer is yes. Experiments 1 and 2 examined whether children have multiple systems of categories, finding that script and taxonomic categories exist simultaneously in the food domain at all age groups tested. Evaluative categories also were found in 4-year-olds to adults. Experiment 3 showed that 4- and 7-year-olds can categorize a single food into both a taxonomic and script category, such as considering milk as a dairy product and a snack. Again, these results suggest that children do not rely on a single form of categorization in which one type of category eventually replaces the other. The results from the present study are consistent with the findings of Blaye and Bonthoux (2001), who found that children can change their initial form of categorization from taxonomic to thematic or vice versa when provided with a contextual cue. Our results are the first to document this phenomenon with taxonomic and script categories, particularly when no prime or hint is provided for children.

Cross-classification is an important conceptual ability. As children gain greater knowledge of the world, they become aware that the same entity can be perceived in different ways, ranging from specific to general, and differing in the particular perspective brought to bear on it. For example, thinking of someone as a mother, a woman, an adult, an accountant, a tennis player, an extravert, and so on, may be important to understanding the complex behavior of a single person; thinking of a truck as a moving van, a mode of transportation, a manufactured object, a large mass, an economic asset, or a source of pollution may be necessary to dealing with it on different occasions. Thus, it is essential to our full understanding of the world that we be able to cross-classify items and use different categories to derive relevant information.

Future research should examine the mechanisms that underlie children's ability to cross-classify items flexibly. It is possible that polynomy, the ability to produce several words for a single object, is related to children's cross-classification. Research has found, for example, that very young children have multiple words for a single object (Blewitt, 1994; Deák & Maratsos, 1998; Waxman & Hatch, 1992) and that depending on the goals of the conversation, children are able to choose labels reflecting different conceptual perspectives on a single item (Clark, 1997).

Inductive Selectivity

Our third question was, do children selectively use taxonomic, script, and evaluative categories to make inductive inferences about food? The answer to this question is complex. Although we did not find evidence for children's inductive selectivity in Experiment 4, we did find evidence in Experiment 5, which included only conflict triads that pitted taxonomic against script categories. Experiment 5 showed that 7-year-olds make more biochemical inferences for taxonomic categories and more situational inferences for script categories. These results are consistent with the small body of research suggesting that children have inductive selectivity (e.g., Deák, 2000; Kalish & Gelman, 1992).

Across Experiments 4 and 5, however, we found little evidence for inductive selectivity in 4-year-olds. Because children of this age can classify items into both kinds of categories, that does not seem to be their problem in induction. Instead, we suspect that the requirements of matching the property to the category are what make selectivity difficult. That is, the child must sometimes make an induction from cake to ice cream, say, but sometimes must not make an induction, depending on what property is being probed. Recognizing that different properties are relevant for different categorical inductions and inhibiting the positive response for inappropriate properties (e.g., saying that two snacks do not share a biochemical property) may have been too difficult for the 4-year-olds. The exact reason for 4-year-olds' failing this task needs to be examined in future work.

Murphy and Ross (1999) examined inductions for items that were in two categories. They found that adults often paid attention to both categories when making their inductions. For example, participants read about the level of amino acids in fruits and snacks (among other properties and other categories). When they were asked to decide the level of amino acids in apples (which are both a fruit and a snack), they showed evidence of using the levels in both categories to produce an answer. Their procedures differed in several respects from the present induction tasks, which were more like the traditional task of Gelman and Markman (1986) and the subsequent cognitive development literature. Nonetheless, their results point out that multiple categories of an item can in some circumstances be simultaneously taken into account and coordinated. Eventually, children must learn not to decide whether an apple is a fruit or a snack but to take both categories into account in making an accurate induction.

An important contribution of Experiments 4 and 5 is the finding that children can use script categories as a basis for induction. So far, the majority of research examining children's inductive inferences has focused on taxonomic categories, and the role of script categories in induction has not been well documented (see Krackow & Gordon, 1998). Our results suggest that script categories are useful for induction, and clearly by age 7, children use script categories preferentially for situational inferences.

Experiment 4 is the first study to investigate the type of inference evaluative categories support. We speculated that evaluative categories would be used to make biochemical inferences because healthy or junky foods typically share properties such as ingredients and nutrients. Indeed, in Experiment 4, we found that adults strongly made biochemical inferences for evaluative categories, but they also made situational inferences, although less strongly (see Figure 2). These results reveal that evaluative categories have considerable content beyond simple positive affect. Less-than-healthy foods such as ice cream and cake both share nutritional ingredients and are often served as desserts. For adults, then, evaluative categories provide a basis for inferences. There is increasing evidence that everyday categories have components of goals and ideals (Barsalou, 1985, 1991; Lynch, Coley, & Medin, 2000; Medin et al., 1997), and evaluative food categories seem similar to some of these examples, such as Medin et al.'s (1997) weed trees. Unlike purely affective categories, these evaluative categories carry considerable content and thus can provide the basis for significant inductions. Future research needs to explore when children begin to use evaluative categories for these types of inferences.

Although Experiment 4 demonstrated that evaluative categories can be used to make biochemical and situational inferences (which are associated with taxonomic and script categories, respectively), the question remains whether evaluative categories support a particular type of inductive inferences that other categories do not. There is reason to believe, for example, that evaluative categories may be used to make inductive inferences about the bodily consequences of eating these foods, especially because food is integrated into children's knowledge of health and illness (e.g., Fallon, Rozin, & Pliner, 1984; Rozin, 1990; Springer, Ngyuen, & Samaniego, 1996).

Food Categories

We used food as a test case in our experiments. It is possible that children are particularly precocious in dealing with food categories, given their interest and importance in the lives of children. However, that would not invalidate our results, given that the essential question is whether children have the competence to form taxonomic, script, and evaluative categories and to use them appropriately. There will always be content differences in the acquisition of categories because of a lack of knowledge and experience (Mervis, 1987). Thus, it would not be surprising if 4-year-olds did not know taxonomic categories of financial instruments or types of search algorithms. The finding that 3-year-olds have both taxonomic and script categories in the domain of food demonstrates their competence in both forms of conceptual organization, even at this early age.

It is possible that other domains would not show the same results as we have obtained. If children do not know of script relations involving animals, for example, they would of course have to use only taxonomic or evaluative categories. Some might therefore argue that we should have used a wide variety of stimuli from different domains so that our results would be more generalizable. However, our choice of foods was directed by the knowledge that there are both script and taxonomic organizations possible within this domain and that adults know of and use both of them (Ross & Murphy, 1999). That has not been extensively documented with animals, clothing, furniture, and so on. Therefore, if we had not found cross-classification in a diverse set of stimuli, it would not be clear whether this was due to children's lack of ability or to the lack of one or the other structure in some of these domains. By using a domain in which both kinds of classification can be—and are—used, our results could be more revealing of children's abilities. If future studies reveal that children do not cross-classify furniture or animals, say, this would be informative about children's conceptual knowledge of those domains. However, to discover such effects, individual domains must be studied in some detail rather than mixing together items from different domains.

We certainly believe that further investigation using different kinds of categories is called for. However, we would argue that the striking pattern of multiple kinds of conceptual organization used from age 3 years through adulthood was only observable by our use of a domain in which different category organizations have been well documented.

Conclusion

In conclusion, the present studies suggest that children can cross-classify items into multiple categories and use these categories for inductive inferences. By 3 years, children have multiple categories of food, including taxonomic and script categories. By 4 years, children also have evaluative categories and can cross-classify foods into more than one category. Furthermore, 7-year-olds and to some extent 4-year-olds realize that certain categories of food provide better support for certain inductive inferences. That is, children have inductive selectivity. These results suggest that young children are not restricted to a single form of categorization, as suggested by traditional accounts of children's conceptual development. Even young children can categorize aspects of their world flexibly, laying the groundwork for their ability to cross-classify as adults.

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Appendix A

Food Triads for Experiments 1, 2, and 4

	Target	Choice 1 (category)	Choice 2 (unrelated)
Taxonomic			
Beverages	Soda pop	Juice	Potato
Beverages	Water	Milk	Strawberry
Breads and grains	Cereal	Bread	Beef
Breads and grains	Pasta	Muffin	Yogurt
Dairy foods	Butter	Yogurt	Carrot
Dairy foods	Pudding	Cheese	Orange
Fruits	Grapes	Strawberry	Bread
Fruits	Watermelon	Orange	Fish
Meats	Ham	Beef	Muffin
Meats	Turkey	Fish	Milk
Vegetables	Corn	Carrot	Juice
Vegetables	Green beans	Potato	Cheese
Script			
Breakfast foods	Waffle	Egg	Cupcake
Breakfast foods	Bacon	Pancake	Jell-O
Lunch foods	Hot dog	Chicken nuggets	Pancake
Lunch foods	Sandwich	Soup	Ice cream
Dinner foods	Chicken	Pizza	Cracker
Dinner foods	Spaghetti	Hamburger	Peanuts
Birthday foods	Cake	Ice cream	Soup
Birthday foods	Candy	Cupcake	Chicken nuggets
Desserts	Cookie	Jell-O	Egg
Desserts	Brownie	Pie	Pizza

Snack foods	Pretzel	Peanuts	Pie
Snack foods	Raisins	Cracker	Hamburger
Evaluative			
Healthy foods	Banana	Spinach	Cheetos
Healthy foods	Celery	Apple	Chips
Junk foods	Twinkie	Cheetos	Apple
Junk foods	Chocolate	Chips	Spinach

Target	Taxonomic	Script
Ice cream	Cheese (dairy)	Cookie (dessert)
Grapes	Apple (fruit)	Cracker (snack)
Milk	Soda pop (beverages)	Muffin (breakfast)
Potato	Celery (vegetable)	Turkey (dinner)
Chicken nuggets	Ham (meats)	Sandwich (lunch)
Cake	Bread (Breads and grains)	Candy (birthday)

Appendix B

Food Triads for Experiment 3

Target	Category choice	Unrelated choice
Milk	Cheese (dairy)	Noodles
Milk	Cookies (snack)	Bologna
Ice cream	Butter (dairy)	Sandwich
Ice cream	Cake (birthday/dessert)	Potato
Turkey	Sausage links (meat)	Cookies
Turkey	Stuffing (dinner)	Pineapple
Meatballs	Bologna (meat)	Pretzel
Meatballs	Pizza (dinner)	Juice
Pancake	Noodles (grains)	Potato chips
Pancake	Fried egg (breakfast)	Peanut butter
Cereal	Bread (grains)	Watermelon
Cereal	Bacon (breakfast)	Water
Shake	Juice (beverage)	Soup
Shake	Cupcake (birthday/dessert)	Cereal
Soda pop	Water (beverage)	Cheese
Soda pop	Potato chips (snack)	Broccoli
Apple	Watermelon (fruit)	Stuffing
Apple	Sandwich (lunch)	Fried egg
Grapes	Pineapple (fruit)	Sausage links
Grapes	Pretzel (snack)	Bacon
Salad	Broccoli (vegetables)	Cupcake
Salad	Soup (lunch)	Butter
Celery	Potato (vegetables)	Pizza
Celery	Peanut butter (snack)	Cake

Appendix C

Food Triads for Experiment 5

Target	Taxonomic	Script
Cheese	Shake (dairy)	Cracker (snack)

Milk
Butter
Sausage links
Waffle
Roll
Ice cream
Cream Cheese
Bologna
Turkey
Toast
Pancake
Bread
Meatballs
Oatmeal

Butter (dairy)
Cheesecake (dairy)
Steak (meat)
Pretzel (grains)
Cookie (grains)
Milk (dairy)
Shake (dairy)
Steak (meat)
Bacon (meat)
Cracker (grains)
Pretzel (grains)
Cereal (grains)
Bologna (meat)
Noodles (grains)

Cookie (snack)
Toast (breakfast)
Pancakes (breakfast)
Sausage links (breakfast)
Soup (dinner)
Cake (birthday)
Bagel (lunch)
Bread (lunch)
Gravy (dinner)
Fried egg (breakfast)
Syrup (breakfast)
Peanut butter (lunch)
Spaghetti (dinner)
Juice (breakfast)