Cross-Classification and Category Representation in Children’s Concepts

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Items commonly belong to many categories. Cross-classification is the classification of a single item into more than one category. This research explored 2- to 6-year-old children’s use of 2 different category systems for cross-classification: script (e.g., school-time items, birthday party items) and taxonomic (e.g., animals, clothes). The results of Experiments 1 and 2 show that by a young age, children are able to cross-classify items into both category systems. Experiment 3 found that children mentally represent cross-classified items as simultaneously belonging to both taxonomic and script categories. Experiment 4 found that children often, but do not always, spontaneously activate taxonomic and script cross-classifications. Overall, the results demonstrate that from an early age children form and use both taxonomic and script categories for cross-classification.

Keywords: cross-classification, categorization, category representation, category accessibility

Researchers in conceptual development have identified a number of different categories that children use for classifying different items. For example, taxonomic categories are based on similarity or shared common properties (e.g., dogs breathe and bark). These common properties allow a hierarchical structure in which items at the subordinate level have all the properties of items at the basic level and the more abstract superordinate level, plus further distinguishing properties (e.g., poodle–dog–mammal; Horton & Markman, 1980; Markman, 1989; Markman & Hutchison, 1984; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976; Waxman & Gelman, 1988). Script categories include items that play the same role in a routine or event such as breakfast time or a birthday party (e.g., Lucariello, Kyralizis, & Nelson, 1992; K. Nelson, 1986, 1988; see also Mandler, Fivush, & Reznick, 1987). Items in a script category need not be spatially or temporally contiguous (e.g., cereal and oatmeal are interchangeable in a breakfast script such that one can be eaten without the other). Script categories are somewhat different than thematic categories; items in a thematic category are classified together because they play complementary roles and co-occur in time and space (e.g., cat–yarn, spoon–bowl; e.g., Greenfield & Scott, 1986; Smiley & Brown, 1979).

Recently, there has been increased recognition within the adult concept literature that people use categories not only for classification but also cross-classification. Whereas classification involves categorizing a single item into just one category, cross-classification involves flexibly categorizing a single item into more than one category. Research has shown that adults spontaneously form categories that often include the same items such as taxonomic (e.g., grains; Ross & Murphy, 1999), script (e.g., breakfast foods; Ross & Murphy, 1999), thematic (e.g., cereal-bowl; Lin & Murphy, 2001; Murphy, 2001), and even ad hoc or goal-derived (e.g., things to eat in a hurry; Barsalou, 1983, 1991) categories. In one study, Ross and Murphy (1999) found that adults spontaneously grouped foods according to both taxonomic (e.g., dairy products, meats, vegetables) and script (e.g., appetizers, desserts, and dinner foods) relations. For example, adults considered a bagel to be both a grain (taxonomic) and a breakfast food (script).

Spontaneous cross-classification with common categories such as taxonomic, script, and thematic has not been examined extensively within the conceptual development literature, and thus there is currently little understanding of the development of this ability in children. Although a number of important studies have shown that children can form these different categories (see Murphy, 2002, for a review), few studies have shown that children can cross-classify a single object into these categories. For example, studies have typically required children to form different categories using different sets of items (e.g., Lucariello et al., 1992; Smiley & Brown, 1979). Also, many studies have typically used a between-participants design, showing that different groups of children can form different categories under certain circumstances or contexts (e.g., Waxman & Namy, 1997; although see Blaye & Bonthoux, 2001).

True cross-classification, however, entails categorizing a single object into more than one type of category by the same individual. A major developmental task for children, then, is to learn how to cross-classify items. If an item potentially belongs to many categories, it is essential for children to know these categories in order to fully understand the item and to interact with it appropriately. Theoretically, cross-classification is of critical importance in cognitive development because it reflects the degree to which children flexibly organize and coordinate different systems of categorization when considering the same items.

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The Present Research

The present research examines the emerging use of both taxonomic and script systems of categorization for thinking about the same items. In particular, in a series of four experiments, this research focuses on children’s ability to spontaneously cross-classify items based on taxonomic and script relations. One goal of the present research was to replicate and extend the work of Nguyen and Murphy (2003). These researchers examined cross-classification in 4-year-olds, 7-year-olds, and adults by focusing on taxonomic (e.g., vegetables, meats) and script (e.g., breakfast foods, dessert) relations within the domain of food. Nguyen and Murphy (2003) found that by age 4 years, children spontaneously cross-classify foods into both taxonomic and script categories, classifying ice cream, for example, as a dairy product and as a dessert on different occasions. By using a diverse set of items, Experiment 1 of the present research was designed to replicate the findings of Nguyen and Murphy (2003) with food and to extend these findings to other domains. The items for Experiment 1 came from a variety of domains in addition to food, including animals, clothing, and furniture. It is important to examine other domains beyond food to ensure that the results of Nguyen and Murphy (2003) were not due to some idiosyncrasy of that domain. Given that children have the ability for cross-classification, and that children are knowledgeable about other domains, considerable overlap was expected to be found in children’s cross-classification across domains.

An additional goal of the present research was to document the developmental trajectory of cross-classification by focusing on 2- to 6-year-olds and adults as a developmental endpoint. Although Nguyen and Murphy (2003) only looked at 4- and 7-year-olds, there is closely related research on cognitive flexibility, particularly the ability to switch classification strategies or responses as a result of changing context cues or task demands, that provides support for the possibility that cross-classification emerges at an early age. For example, a number of studies have found improvements in children’s executive functioning and flexible rule use between the ages of 3–5 years, as documented by a card sorting task in which children must sort cards based on two conflicting rules (e.g., sorting based on color first and then based on shape; e.g., Frye, Zelazo, & Palfai, 1995; Zelazo, Frye, & Rapus, 1996; see also Jacques & Zelazo, 2001, 2005). Research has also shown that even 3-year-olds can shift between different rules in a card sorting task under some circumstances (e.g., Bohlmann & Fenson, 2005; Deák, Ray, & Pick, 2004; Perner & Lang, 2002). Other research has also found that 4-year-olds can hold two rules in mind and resist the temptation to make a preponent response when the inhibitory demand is reduced in a task (e.g., saying semantically unrelated words such as “dog” in response to a picture of a sun; “pig” to a picture of a moon, instead of saying semantically related words such as “night” and “day,” respectively; Diamond, Kirkham, & Amso, 2002).

Additional evidence for cognitive flexibility comes from the infant cognitive development literature. In particular, research has found that even very young children and infants are responsive to changing context cues and task demands. For example, Ribar, Oakes, and Spalding (2004) have shown that infants can form new category representations, depending upon the particular stimuli that they are initially presented with during the familiarization phase of a study. For example, when infants were familiarized with land animals that had variable coloring, they subsequently formed an inclusive category that included a variety of land animals. However, when infants were familiarized with black-and-white land animals, they subsequently formed a more exclusive category of black-and-white land animals. Additional research has also shown that very young children and infants will categorize objects differently, depending upon the objects’ perceptual properties (e.g., classifying objects with eyes based on shape and texture but eyeless objects based on shape only; Jones, Smith, & Landau, 1991) as well as their functional parts (e.g., categorizing animals and furniture together when they have legs but categorizing animals with vehicles when they do not have legs; Rakison & Butterworth, 1998; Rakison & Cohen, 1999).

Another goal of the present research was to explore how children mentally represent taxonomic and script category systems, that is, how they conceptualize items that are cross-classified into these categories. In particular, Experiment 3 examined whether children can represent a cross-classified item as belonging to both taxonomic and script categories simultaneously. In this experiment, children were asked to verify the joint category membership of cross-classified items. This is somewhat different than asking whether children are able to cross-classify an item into a taxonomic and script category on different occasions. For example, when a child sees ice cream, can the child think of it as being both a dairy product and a dessert at the same time? Certainly it would be helpful to represent ice cream in both ways simultaneously. If a child who is lactose intolerant is trying to pick out a treat, thinking of ice cream as not only a dessert, but also a dairy product simultaneously, will help the child make a wiser choice.

Although this aspect of cross-classification was not previously addressed by Nguyen and Murphy (2003), related research on children’s language provides support for the possibility that children are able to mentally represent an item as belonging to both a taxonomic and script category simultaneously. Several researchers have found that young children commonly accept and produce multiple terms for a single referent (e.g., labeling a cat as a cat, a pet, and animal; e.g., Blewitt, 1994; Clark & Svaib, 1997; Mervis, Golinkoff, & Bertrand, 1994; Waxman & Hatch, 1992). Clark (1997) has argued that a child’s word choice reflects different conceptual perspectives on a single item. Depending upon the goals of the conversation, a child may want to take on one conceptual perspective (e.g., cat) or several different conceptual perspectives (e.g., cat, pet, animal) on a single item. Also, Deák and Maratos (1998) have shown that children can use two or more labels to describe representational objects that have distinct functions such as a crayon shaped like a dinosaur, saying it is a dinosaur and crayon at the same time. In addition, Hansen and Markman (2005) have found that children can provide contrasting labels for deceptive items such as a sponge painted as a rock, saying that it looks like a rock but is really a sponge. Others have also found that children frequently coin novel compound nouns by combining two words together that mark the specific subcategories of a more general category (e.g., lion–book, duck–book; Clark, Gelman, & Lane, 1985; Gelman, Wilcox, & Clark, 1989).

The final goal of the present research was to explore category accessibility, which is closely related to the issue of category representation. Category accessibility is especially relevant when considering cross-classified items because a single item may act-
vate more than one category. For example, when children see a cross-classifiable item such as an apple, does this lead them to spontaneously access their knowledge of both fruit and things to take on a picnic? Whether children do so may impact how they interpret the item and comprehend the current situation. Experiment 4 of the present research explores category accessibility in children.

Because this aspect of cross-classification was not previously addressed by Nguyen and Murphy (2003), research on adults can be used as insight and as a basis for predictions. In one study, Ross and Murphy (1999) used a priming paradigm to examine the accessibility of script and taxonomic categories of food. Adults in this study were asked to rate the similarity of pairs of food words (unaccompanied by pictures) preceded or not by a category label (e.g., breakfast food: bagel–bacon). So that differences in typicality would not affect the results, an independent group of adults had previously rated these foods; the foods from the two categories had equally high levels of typicality. Ross and Murphy (1999) found that the words for the taxonomic and script foods usually activated the categories on their own, suggesting that these categories are spontaneously activated much of the time for adults. However, Ross and Murphy (1999) also found that the labels had somewhat more of an effect on the ratings of the script pairs of foods, suggesting that the activation of script categories may not be as strong as that of taxonomic categories (see also Barsalou, 1982). This priming effect was also replicated when Ross and Murphy (1999) used another version of this priming paradigm in a follow-up study. This effect of priming was interpreted as reflecting the degree to which different categories of food used in cross-classification are well established in memory. To test the category accessibility of taxonomic and script categories with children, a similar priming procedure was used in Experiment 4 of the present investigation (see also Ackerman, 1988; Ceci & Howe, 1978; Melkman, Tversky, & Baratz, 1981; Steinberg & Anderson, 1975). Given the findings with adults, it was predicted that children would activate taxonomic and script categories much of the time but that the presence of category labels would also result in a priming effect, depending upon how well a category representation is embedded in memory.

To summarize, the present research is a series of four experiments that aim to understand the emerging use of taxonomic and script systems of categorization for cross-classification. Experiments 1 and 2 examined the development of children’s cross-classification of items from different domains. Given the findings of Nguyen and Murphy (2003), it was predicted that children could spontaneously cross-classify items from different domains into taxonomic and script categories. In light of the body of research on cognitive flexibility with young children and infants, it was predicted that cross-classification would emerge at an early age. Experiment 3 explored whether children can represent a cross-classified item as belonging to both taxonomic and script categories simultaneously. Also, in light of the body of research on children’s language, it was predicted that children are able to represent an item as simultaneously belonging to both categories. Finally, Experiment 4 explored whether these categories are spontaneously activated when children think about cross-classified items. Given the findings of Ross and Murphy (1999) with adults, it was predicted that the activation of cross-classifications would depend upon the degree to which the individual categories are well established in memory.

**Experiment 1: Cross-Classification**

Experiment 1 was designed to replicate and extend Nguyen and Murphy’s (2003) finding that children can cross-classify foods into taxonomic and script categories. Experiment 1 included nonconflict trials that were composed of a target, an alternative that shared a taxonomic or script relationship with the target, and an unrelated alternative. Specifically, eight objects that came from the domains of food, clothing, vehicles, toys, furniture, animals, people, and buildings were used as the targets in both the taxonomic and script triads. For example, in one trial, children were asked if a rubber duck was the same kind of thing as a puzzle (taxonomic choice) or a police officer (unrelated choice). In another trial, children were asked if the rubber duck was the same kind of thing as soap (script choice) or paper (unrelated choice).

This task permitted independent tests of children’s knowledge of taxonomic and (in other trials) script relations as well as cross-classification. When examining cross-classification it is essential to establish that children know the categories that are being tested. Thus, if children fail to cross-classify, the results can be attributed to a lack of cross-classification abilities as opposed to ignorance regarding the categories. If children form taxonomic and script categories, then they should select the script alternatives on the script trials and taxonomic alternatives on the taxonomic trials. In addition, if children cross-classify, then they should select the choice that shares a categorical relationship with the targets in both taxonomic and script trials.

**Method**

**Participants.** Participants were 42 children: fourteen 3-year-olds (mean age 3.66 years, range = 3.44–3.92; 6 boys and 8 girls); fourteen 4-year-olds (mean age 4.47 years, range = 4.01–4.98; 6 boys and 8 girls); and fourteen 6-year-olds (mean age 6.57 years, range 6.00–7.10; 3 boys and 11 girls). Fourteen adults also participated (mean age 18.62 years, range = 18.05–20.23; 2 males and 12 females). An additional set of 34 adults also provided ratings of the stimuli. The participants were predominately middle-class European-Americans recruited from schools or day cares and a university located in the southeastern United States.

**Materials.** Color photographs (2.5 × 3 in. [6.35 × 7.62 cm]) of items from different domains were collected from Internet sources. Photographs were arranged into 16 trials consisting of a target, category choice, and an unrelated choice. To prevent perceptual similarity from dominating the choices, a group of 16 adults were asked to rate the visual similarity between the targets and the category choices and the targets and the unrelated choices on a scale ranging from 1 (not at all visually similar) to 7 (very visually similar). The targets had equally low visual similarity between their category choices (M = 1.19, SD = 0.29) and their unrelated choices (M = 1.01, SD = 0.03).

Several steps were also taken to ensure that the items were readily identifiable as typical and familiar members of the tested categories. A different group of 18 adults were asked to rate the typicality and familiarity of the targets and the category choices, separately. The scale ranged from 1 (not at all typical/familiar) to
other age groups, Tukey's HSD tests, $ps < .05$, 95% confidence intervals ($C_{L95}$) = 11–35%. There was also a significant difference between 4-year-olds and adults, Tukey's HSD test, $p < .05$, $C_{L95}$ = 0–15%. There was not a significant difference between 6-year-olds and these two age groups, however. Categorization ability also varied by category type: script ($M = 93\%$, $SD = 13\%$) and taxonomic ($M = 85\%$, $SD = 16\%$), $F(1, 52) = 13.16$, $MSE = 0.15$, $p < .05$, $\eta^2_p = 0.20$. There was not an interaction between age group and category type. All group ages were above chance (50%) on both the taxonomic and script trials, $ns(13) > 3.0$, $ps < .05$, two-tailed tests. Order effects were also examined to see if the performance on the first trial of an item interfered with performance on the second trial of that item. There were no order effects, however. Performance was similar on both sets of trials when each age group was considered separately ($ps > .05$). Thus, the first set of analyses reveal that children have knowledge of both taxonomic and script categories by age 3 years.

Yet, do children use these categories for cross-classification? True cross-classification involves an individual categorizing a single item into both a taxonomic and script category. The goal of the second set of analyses was to examine cross-classification. Thus, a 1 was assigned when children cross-classified, selecting both the taxonomic and script category choices for the same target. Otherwise, a zero was assigned when children did not cross-classify, selecting only one of the category choices or neither for the same target. These scores were then summed and converted into percentages. An ANOVA was then conducted on these data with cross-classification being the dependent variable. The results reveal that cross-classification improved by age group: 3-year-olds ($M = 50\%$, $SD = 16\%$); 4-year-olds ($M = 82\%$, $SD = 14\%$); 6-year-olds ($M = 92\%$, $SD = 14\%$); and adults ($M = 97\%$, $SD = 5\%$), $F(3, 52) = 36.70$, $MSE = 0.62$, $p < .01$, $\eta^2_p = 0.67$. There was a significant difference between 3-year-olds and all of the other age groups, Tukey's HSD tests, $ps < .05$, $C_{L95}$ = 19–60%. There was also a significant difference between 4-year-olds and adults, Tukey's HSD test, $p < .05$, $C_{L95}$ = 2–28%. There were no other significant difference between 6- and 4-year-olds as well as between 6-year-olds and adults. Performance on each trial was also examined individually to see whether the results were due to particular domains. There were no apparent differences, however. All of the age groups had above-chance (25%) performance, $ns(13) > 5.0$, $ps < .05$. Chance was set at 25% because there are four possible response patterns across the taxonomic and script trials for a given target (correct–correct, correct–incorrect, incorrect–correct, incorrect–incorrect) and successful cross-classification is one of these patterns (correct–correct).

Taken together, these results demonstrate that by age 3 years, children are able to cross-classify items from a variety of domains into taxonomic and script categories. These results replicate the findings of Nguyen and Murphy (2003) with older children and the domain of food. These results also extend these researchers' findings to younger children and different domains beyond food, including animals, clothing, furniture, toys, etc. The present findings are consistent with a number of studies that have documented signs of cognitive flexibility in childhood (e.g., Bohlmann & Fenson, 2005; Déak, Ray, & Pick, 2002; Déak et al., 2004; Perner & Lang, 2002).

### Table 1

<table>
<thead>
<tr>
<th>Category type</th>
<th>3-year-olds</th>
<th>4-year-olds</th>
<th>6-year-olds</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxonomic</td>
<td>63 (13)</td>
<td>86 (12)</td>
<td>95 (6)</td>
<td>97 (5)</td>
</tr>
<tr>
<td>Script</td>
<td>79 (15)</td>
<td>95 (9)</td>
<td>96 (13)</td>
<td>100 (0)</td>
</tr>
</tbody>
</table>
Experiment 2: Cross-Classification With 2-Year-Olds

Experiment 1 revealed that children as young as age 3 can classify items into taxonomic and script categories and use these categories for cross-classification. However, it is possible that the ability to cross-classify with taxonomic and script categories appears at an earlier age, especially given previous work on flexible categorization in infancy and early childhood (e.g., Jones et al., 1991; Rakison & Butterworth, 1998; Rakison & Cohen, 1999; Ribar et al., 2004). This would be important to know in order to document the emergence and development of cross-classification in childhood. The aim of Experiment 2 was to examine cross-classification in a younger age group, particularly 2-year-olds, using a modified version of the procedure from Experiment 1. If 2-year-olds have knowledge of taxonomic and script categories and are able to cross-classify items into these categories, then they should demonstrate above-chance performance.

Method

Participants. Participants were fourteen 2-year-olds (mean age 2.61 years, range = 2.15–2.99; 6 boys and 8 girls). The participants were predominately middle-class European-Americans and were recruited from day cares located in the southeastern United States.

Materials. Half of the 16 nonconflict triads from Experiment 1 were used in Experiment 2 to accommodate the attention spans of 2-year-olds. These triads were randomly selected and are indicated with asterisks in Appendix A. The color photographs in the triads were reduced in size to approximately 1.25 × 1.5 in. (3.17 × 3.81 cm) and printed on 5.5 × 8.5 in. (13.97 × 21.59 cm) pieces of paper. This was done so that the triads could be placed into a small three-ring binder that would fit on children’s laps. As before, there were two blocks of triads. The first block included four targets placed into 2 taxonomic and 2 script triads. The second block included the same four targets but in triads from the untested category.

Procedures. A slightly modified version of the procedure in Experiment 1 was used in Experiment 2. An additional step was added to the beginning of the procedure to allow young children the opportunity to practice pointing to pictures. Children were presented with pictures of three familiar television characters (Barney, Big Bird, and Winnie the Pooh), one at a time. Children were asked, for example, “Where is Barney? Point to Barney.” Afterwards, children were presented with the two warm-up trials from Experiment 1 and then the eight test trials. The trials were presented in one of two random orders. The order of the two blocks was also counterbalanced.

Results and Discussion

The data were scored and analyzed as in Experiment 1. The first set of analyses focused on 2-year-olds’ ability to classify items into taxonomic and script categories. The results showed that 2-year-olds were able to classify items into taxonomic (M = 67%, SD = 24%) and script (M = 66%, SD = 23%) categories and that performance on these two types of categories did not differ significantly, t(13) = −0.20, p > .05. The results also showed that performance on the first trial of an item did not interfere with performance on the second trial of an item, t(13) = 2.11, p > .05. Overall, 2-year-olds’ performance was just above chance (50%) on both taxonomic and script categories, t(13) > 2.5, ps < .05, CI95 = 2–32%, demonstrating that they had knowledge of these two types of relations.

The second set of analyses focused on whether 2-year-olds use both types of category relations for cross-classification. The results reveal that 2-year-olds are indeed able to cross-classify items into both taxonomic and script categories (M = 41%, SD = 23%). There were no apparent domain differences in children’s cross-classification when each trial was examined individually. Overall, 2-year-olds’ level of cross-classification was just above chance (25%), t(13) = 2.59, p < .05, CI95 = 2–29%.

What insights do the findings from Experiments 1 and 2 offer about the emergence and development of cross-classification? To examine how the results from 2-year-olds compare to those of older children in Experiment 1, I conducted an analysis focusing on just the eight trials used in Experiment 2. The results of this analysis showed a clear developmental pattern, F(4, 69) = 29.87, MSE = 0.90, p < .05. Adults, 6-year-olds, and 4-year-olds performed significantly better than 3- and 2-year-olds, Tukey’s HSD tests, ps < .05. Adults, 6-year-olds, and 4-year-olds performed significantly better than 3- and 2-year-olds, Tukey’s HSD tests, ps < .05, CI95 = 13–74%. There was not a significant difference between adults, 6-year-olds, and 4-year-olds, or between the two younger age groups, ps > .05.

Yet, a concern in making this direct comparison across the two experiments is that if performance on a task is generally worse at the beginning (as children are trying to understand the demands of the task), the reduced number of trials in Experiment 2 might place 2-year-olds at an unfair disadvantage when compared to older children from Experiment 1. Perhaps a fairer comparison is to focus on 2-year-olds’ performance relative to older children’s performance on the first eight trials that they were presented with in Experiment 1. However, when this comparison was made, the same developmental pattern was obtained, F(4, 69) = 20.49, MSE = 0.31, p < .05. As before, adults, 6-year-olds, and 4-year-olds performed significantly better than 3- and 2-year-olds, Tukey’s HSD tests, ps < .05. There was also not a significant difference between adults, 6-year-olds, and 4-year-olds, or between the two younger age groups, ps > .05.

Overall, the results of these two sets of analyses are quite similar, suggesting that the ability to classify and cross-classify items into taxonomic and script categories emerges by age 2 years and that important developments in these abilities occur between the ages of 3 and 4 years. Although it would be difficult to test children under age 2 using the current procedure, future research should use an age appropriate procedure to examine the development of cross-classification in infancy.

Experiment 3: Category Representation

The results of Experiments 1 and 2 show that when an item is presented in a taxonomic and then a script trial (or vice versa) sequentially, children can cross-classify the item into both categories. This finding suggests that children are able to represent a single item in terms of taxonomic and script relations at different times. However, are children capable of maintaining both taxonomic and script representations for a single item simultaneously? Although this question has yet to be tested with taxonomic and script categories, related research documenting representational
flexibility in early childhood offers support for the possibility that children are capable of representing a single item based on both types of relations simultaneously. For example, research has demonstrated that children can use two or more labels at the same time, denoting different types of category membership, to distinguish the appearance and reality of deceptive objects (e.g., rock–sponge, Hansen & Markman, 2005) and to describe representational objects with distinct functions (e.g., dinosaur–crayon, Deák & Markman, 1998). Research has also demonstrated that children as young as age 2 frequently create compound nouns by combining two nouns together in order to label the different subcategories of a single category (e.g., race–car, taxi–car; Clark et al., 1985; Gelman et al., 1989).

Thus, Experiment 3 was designed to address the issue of simultaneous category representations with taxonomic and script categories. In this experiment, children were asked to verify the joint category membership of items that were given a category label that combined individual taxonomic and script labels. For example, children were asked, “Are pajamas bedtime clothes?” This approach is somewhat different than showing children a picture of pajamas and asking, “Are these pajamas clothes? Are these pajamas for bedtime?” which would assess children’s ability to represent an item in two ways on different occasions but not necessarily at the same time. The prediction was that if children are capable of representing a single item as belonging to both taxonomic and script categories simultaneously, children should be attentive to both parts of the category label.

**Method**

**Participants.** Participants were 42 children: fourteen 3-year-olds (mean age 3.65 years, range = 3.41–3.92; 6 boys and 8 girls), fourteen 4-year-olds (mean age 4.68 years, range = 4.22–5.14; 6 boys and 8 girls), and fourteen 6-year-olds (mean age 6.67 years, range = 6.13–7.10; 6 boys and 8 girls). Two-year-olds were not included because of their relatively limited amount of cross-classification in the previous experiment. Fourteen adults also participated (mean age 18.63 years, range = 17.96–21.01; 3 males and 11 females). The participants were predominately European-American and were recruited from middle-class communities located in the midwestern and southeastern United States. In particular, children were recruited from schools and day cares whereas adults were recruited from universities.

**Materials.** The materials included a series of 16 “yes” or “no” questions about the joint category membership of cross-classified items, unaccompanied by pictures. All of the items were derived from Experiment 1 (see Appendix B). Half of the items were created by combining the appropriate taxonomic and script category labels for each of the targets from Experiment 1. The script category always modified the taxonomic category in these combinations. Previous work examining children’s understanding of grammatical compound nouns (e.g., Clark & Barron, 1988) and children’s naming practices with script categories (Lucariello et al., 1992; K. Nelson & Nelson, 1990) guided the decision to structure the joint labels in this way. For example, in Experiment 1, pajamas belonged to the taxonomic category of clothes and the script category of bedtime things, and in the present experiment children were asked, “Are pajamas bedtime clothes?”

The other half of the items were created by combining inappropriate taxonomic and script category labels for various nontargets from Experiment 1, in which the taxonomic category was correct, but the script category was incorrect, and vice versa. For example, in Experiment 1, library was in the taxonomic category of buildings but not in the script category of bedtime. In the present experiment, children were asked if a library is a bedtime building. These questions were included to allow children the opportunity to say “no” and to see if children were responding “yes” to only one category.

**Procedure.** Children were tested individually in a quiet area of their school or daycare by a researcher. The researcher initially presented children with a warm-up task to allow children an opportunity to practice answering “yes/no” questions. The warm-up task consisted of two questions. For the first question, the researcher pointed to a picture of a blue square and asked, “Is this a blue square?” For the second question, the researcher pointed to a picture of a white circle and asked, “Is this a red circle?” If children responded incorrectly to a question (i.e., “no,” “yes,” respectively), then the researcher provided corrective feedback and then repeated the question. After the warm-up task, children were asked a series of 16 test questions (e.g., “Are pajamas bedtime clothes?”). If children did not respond, the researcher repeated the question. No feedback was given. The questions were presented in one of two random orders. Adults were tested in a group by a researcher, using a paper and pencil version of the children’s task.

**Results and Discussion**

The data were scored by assigning a 1 to correct answers (i.e., “yes” to items with appropriate category labels; “no” to items with inappropriate category labels) and a zero to incorrect answers (i.e., “no” to items with appropriate category labels; “yes” to items with inappropriate category labels). The scores were then converted into two summary scores, one for items with appropriate category labels and one for items with inappropriate category labels. These scores were converted into percentages. The data are presented in Table 2. A 4 (age group: 3-year-olds, 4-year-olds, 6-year-olds, adults) × 2 (category label: appropriate, inappropriate) repeated measures ANOVA was then conducted on these data. The results indicated a main effect of category label, $F(1, 52) = 33.99, MSe = 0.68, p < .05, \eta^2_p = 0.39$ (appropriate > inappropriate) and age group, $F(3, 52) = 15.89, MSe = 0.27, p < .05, \eta^2_p = 0.47$ (adults = 6-year-olds = 4-year-olds > 3-year-olds). These main effects were mediated by an interaction between category label and age group, $F(3, 52) = 7.59, MSe = 0.15, p < .05, \eta^2_p = 0.30$. A follow-up analysis to this interaction was conducted to compare the performance between the different age groups. The four age

<table>
<thead>
<tr>
<th>Category Label and Age Group</th>
<th>3-year-olds</th>
<th>4-year-olds</th>
<th>6-year-olds</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appropriate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxonomic true</td>
<td>69 (38)</td>
<td>88 (23)</td>
<td>98 (6)</td>
<td>94 (10)</td>
</tr>
<tr>
<td>Script true</td>
<td>41 (27)</td>
<td>71 (32)</td>
<td>84 (18)</td>
<td>89 (18)</td>
</tr>
</tbody>
</table>
groups performed equally well on the items with appropriate category labels, but there were significant age group differences on the items with inappropriate category labels, $F(3, 55) = 3.04, MSE = .006, p < .05$. Adults, 4-year-olds, and 6-year-olds, who did not differ significantly from each other, performed better than 3-year-olds on items with inappropriate category labels, Tukey’s HSD tests, $ps < .05$. An additional follow-up analysis to the interaction was also conducted to compare performance between the items with the two types of category labels. Each age group (with the exception of 4-year-olds) performed better on items with appropriate versus inappropriate category labels, $t(13) > 2, ps < .05$. Four-year-olds performed similarly on both types of items ($p > .05$).

Performance on items with appropriate and inappropriate category labels was also compared to chance (50%). Four-year-olds, 6-year-olds, and adults were above chance on all of the items, $t(13) > 2, ps < .05$. Three-year-olds were only above chance on the items with appropriate category labels, $t(13) = 15.06, p < .05$.

The finding that 4-year-olds, 6-year-olds, and adults were above chance on both types of items suggests that, for these age groups, a partially true category label was insufficient and provides support for the conclusion that older children and adults are attending to both taxonomic and script labels simultaneously. In other words, older children and adults are able to represent a cross-classified item as belonging to both a taxonomic and script category at the same time. However, 3-year-olds’ chance-level performance on the items with inappropriate labels suggests that younger children were inconsistently rejecting these labels, perhaps indicating that children were answering “yes” most of the time regardless of whether the labels were appropriate or inappropriate. To examine 3-year-olds’ performance more closely, I conducted an analysis of children’s “yes” responses. Three-year-olds’ percentage of “yes” responses for items with appropriate, inappropriate (script-true), and inappropriate (taxonomic-true) labels was: 93%, 31%, and 59%, respectively. Three-year-olds tended to say “yes” significantly more often for items with appropriate labels than for items with either type of inappropriate label, $t(13) > 4, ps < .05$, CI$_{95}$ = 17–89%. There was not a significant difference between “yes” responses for the two types of items with inappropriate labels ($p < .05$) indicating at least some sensitivity in 3-year-olds to both taxonomic and script categories simultaneously.

To be sure, I also conducted an additional analysis of 3-year-olds’ individual response patterns. Three-year-olds were classified into one of three response pattern groups based on binomial probability ($p < .05$): (a) consistently accurate (12–16 accurate responses out of 16), (b) inconsistent (6–11 accurate responses), and (c) consistently inaccurate (0–5 accurate responses). Fifty-seven percent of the 3-year-olds (8 out of 14 total) were classified as consistently accurate. Forty-three percent (6) of the 3-year-olds were classified as inconsistent (3 of these children tended to respond “yes” over 75% of the time). None of the 3-year-olds was classified as consistently inaccurate. Thus, over half of the 3-year-olds were quite accurate at responding to items with appropriate and inappropriate labels. These findings provide additional confirmation that there is at least some sensitivity to both taxonomic and script categories for cross-classified items in younger children.

Thus, Experiment 3 demonstrates that by age 4 years, and to some degree age 3 years, children consider both taxonomic and script systems of categorization simultaneously when thinking about the same items. This finding is consistent with several studies that have shown that children can entertain more than one label for an item at the same time (e.g., Clark et al., 1985; Déak & Maratos, 1998; Gelman et al., 1989; Hansen & Markman, 2005).

**Experiment 4: Category Accessibility**

So far, Experiments 1–2 have shown that children are capable of cross-classifying a single item into a taxonomic and script category. Experiment 3 showed that children are also capable of mentally representing a cross-classified item as belonging to both categories simultaneously. However, a crucial issue that has yet to be examined is the accessibility of the taxonomic and script categories that children use to cross-classify an item. When children encounter an item that belongs to both a taxonomic and script category, to what degree are these categories spontaneously activated and made accessible for cross-classification? This is an important question because children’s perspective on an item can be influenced by which type(s) of category information gets activated. As described earlier, research on adults has revealed that the categories used in cross-classification are not always accessible. This research has demonstrated that the presence of category labels can prime the activation of cross-classifications that are not usually activated on their own. For example, script categories tend to show some priming effect whereas taxonomic categories do not (Barsalou, 1982; Ross & Murphy, 1999).

In Experiment 4 of the present research, a priming task was also used to test whether children spontaneously activate taxonomic and script categories when thinking about cross-classified items. Children were initially primed with either a category label, arbitrary label, or no label. The arbitrary labels were included to see if priming effects are unique to category relevant labels. Then, children were asked to indicate whether items in a taxonomic (e.g., rubber duck–puzzle) or script (e.g., rubber duck–soap) pair are similar. Given the research on adults (e.g., Barsalou, 1982; Ross & Murphy, 1999), it seems likely that at least one, if not more of these categories, will be affected by the presence of category labels. Thus, if children do not always spontaneously activate taxonomic or script cross-classifications, then the presentation of labels should have some effect on children’s similarity ratings. However, this effect should be limited to appropriate category labels because arbitrary labels are irrelevant to identifying category membership. Thus, performance in the arbitrary label condition should be similar to performance in the no label condition.

**Method**

**Participants.** The participants were 54 children: 27 three-year-olds (mean age 3.57 years, range = 3.00–3.98; 13 boys and 14 girls); 27 four-year-olds (mean age 4.55 years, range = 4.10–5.02; 17 boys and 10 girls) and 27 six-year-olds (mean age 6.22 years, range = 5.50–7.04; 17 boys and 10 girls). Twenty-seven adults (mean age 19.0 years, range = 18.55–21.05; 12 males and 15 females) also participated. Participants were randomly assigned to one of the following three conditions: category label, arbitrary label, or no category label.

**Materials.** The materials were derived from Experiment 1. The triads from Experiment 1 were converted into pairs, consisting of a target and a correct category choice. Thus, there were eight
taxonomic pairs and eight script pairs. There were also eight unrelated pairs that served as fillers (shampoo–fork, jump rope–cheese, Christmas tree–police, school–pillow, sofa–paper, socks–airplane, doctor–bag, candle–dog). The picture pairs were printed on 8.5 × 11 in. (21.6 × 7.9 cm) pieces of paper and arranged in a three-ring binder.

Procedure. Children were tested individually by a researcher in a quiet area of their school or daycare. The procedure was introduced to children as a fun game in which they would be presented with a series of two pictures and would be asked whether the items in the pictures are alike. Children initially completed a warm-up task, so that they could practice answering “yes” and “no.” In the warm-up task children were presented with four pairs of pictures (rose–daisy, rose–chair, shovel–rake, shovel–book), one at a time, and for each pair, children were asked if the items in the pictures are alike. Children were provided with corrective feedback during the warm-up task as necessary.

After the warm-up task, children were presented with a series of 24 pairs of pictures, one at a time. Children in the category label condition were initially primed with a label for each picture pair. For example, taxonomic trials received a taxonomic label, “We’re going to talk about toys now, can you say toys? Are a rubber duck and puzzle like each other?” Script trials received a script label, “We’re going to talk about bath-time things now, can you say bath-time things? Are a rubber duck and soap like each other?” The fillers received either a taxonomic or script label that corresponded to only one of the items in the pair, as the items in the pair were otherwise unrelated. In contrast, children in the arbitrary label condition were provided with labels that did not correspond to the pairs of items. For example, children heard, “We’re going to talk about buildings now, can you say buildings? Are a rubber duck and puzzle like each other?” Finally, children in the no-category label condition were not primed with a category label. Rather, they were presented with the test questions immediately. For example, “Are a rubber duck and puzzle like each other?” Adults were tested by the researcher in a group using a paper and pencil version of the procedures used with children.

Results and Discussion

The data were scored by assigning a 1 when participants made “related” responses, that is, reported that pairs of taxonomic or script items are similar. A score of zero was assigned otherwise. Summary scores were then created for the taxonomic and script trials and then converted into percentages. The data are presented in Table 3. A 4 (age group: 3-year-olds, 4-year-olds, 6-year-olds, adults) × 3 (category trial: taxonomic, script, unrelated) × 3 (priming condition: label, arbitrary label, no label) repeated-measures ANOVA was then conducted on these data. The results reveal three main effects: (a) age group, $F(3, 96) = 5.84, MSE = 0.65, p < .01, \eta^2_p = 0.15$ (adults = 6-year-olds = 4-year-olds > 3-year-olds); (b) category trial, $F(2, 192) = 284, MSE = 10.5, p < .01, \eta^2_p = 0.74$ (script > taxonomic > unrelated); and (c) priming condition, $F(2, 96) = 4.39, MSE = 0.48, p < .05, \eta^2_p = 0.08$ (category > arbitrary = no label). There were also two interactions. The first interaction was between category trial and age group, $F(6, 192) = 10.67, MSE = 0.39, p < .05, \eta^2_p = 0.25$. Because the aim of Experiment 4 was to examine the extent to which taxonomic and script categories are spontaneously activated, of particular interest is the second interaction between category trial and priming condition, $F(4, 192) = 13.34, MSE = 0.49, p < .05, \eta^2_p = 0.21$. Thus, two sets of follow-up analyses were conducted on this interaction. The first set examined performance within each of the conditions separately. In the absence of priming in the no label condition, script categories were spontaneously activated more often than taxonomic and unrelated categories. This pattern of results was also true in the presence of priming in the arbitrary label condition. In both conditions, there were significant differences between all three category trials, $t(35) > -4, ps < .05, CI_{95} = 7–29\%$. However, in the presence of priming in the category label condition, both script and taxonomic categories were activated more often than unrelated ones. There was not a significant difference between script and taxonomic category trials, but there was a significant difference between these two trial types and the unrelated ones, $t(35) > -4,$

<table>
<thead>
<tr>
<th>Condition</th>
<th>Totals</th>
<th>3-year-olds</th>
<th>4-year-olds</th>
<th>6-year-olds</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxonomic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No label</td>
<td>57 (30)</td>
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<td>44 (22)</td>
<td>51 (23)</td>
<td>51 (29)</td>
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<tr>
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<td>51 (33)</td>
<td>63 (23)</td>
<td>55 (20)</td>
</tr>
<tr>
<td>Category label</td>
<td>86 (18)</td>
<td>75 (25)</td>
<td>85 (17)</td>
<td>88 (16)</td>
<td>98 (4)</td>
</tr>
<tr>
<td>Script</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No label</td>
<td>74 (34)</td>
<td>82 (33)</td>
<td>69 (33)</td>
<td>84 (27)</td>
<td>58 (41)</td>
</tr>
<tr>
<td>Arbitrary label</td>
<td>74 (26)</td>
<td>77 (21)</td>
<td>70 (31)</td>
<td>79 (20)</td>
<td>69 (31)</td>
</tr>
<tr>
<td>Category label</td>
<td>91 (17)</td>
<td>90 (15)</td>
<td>85 (22)</td>
<td>89 (20)</td>
<td>98 (4)</td>
</tr>
<tr>
<td>Unrelated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No label</td>
<td>23 (33)</td>
<td>68 (33)</td>
<td>16 (19)</td>
<td>0 (0)</td>
<td>6 (9)</td>
</tr>
<tr>
<td>Arbitrary label</td>
<td>25 (32)</td>
<td>61 (26)</td>
<td>21 (36)</td>
<td>15 (20)</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Category label</td>
<td>13 (23)</td>
<td>23 (15)</td>
<td>27 (38)</td>
<td>0 (0)</td>
<td>1 (4)</td>
</tr>
</tbody>
</table>
The second set of follow-up analyses examined performance on each of the category trials across the three conditions. The results indicate that performance on the unrelated category trials did not vary as a function of condition. However, performance on the taxonomic category trials did vary as a function of condition, \( F(2, 107) = 14.70, \text{MSE} = 1.00, p < .05 \). This pattern of results was also true for script category trials, \( F_2(2, 107) = 4.63, \text{MSE} = 0.33, p < .05 \). For both taxonomic and script trials, the presence of category labels had the largest priming effect compared to arbitrary labels or no labels, Tukey’s HSD tests, \( ps < .05, \text{CI}_{95} = 1–44\% \). There was not a significant difference between the presence of arbitrary labels or no labels. Thus, these results suggest that the priming effect is limited to category labels that appropriately identify the category membership of an item.

A caveat needs to be made about the category trial by priming condition interaction. This interaction showed that category labels had a large influence on taxonomic categories; without priming, participants made fewer “related” responses on taxonomic versus script trials, but this difference disappeared when participants were primed with category labels. These results contrast with those of Ross and Murphy (1999). These researchers actually found the opposite pattern of results with adults: Category labels had little priming effect on taxonomic categories of food but rather had some effect on script categories of food.

The reason for this difference in results is most likely due to the fact that these two studies used taxonomic categories from different levels of abstraction. The taxonomic categories in the present study were at the superordinate level (e.g., animals, furniture, vehicles), whereas the taxonomic categories in Ross and Murphy (1999) were at the basic level (e.g., fruits, vegetables, meats). Much research has shown that young children learn basic level taxonomic categories easier and earlier than superordinate level categories (see Murphy, 2002, for a review). Thus, in this study, the taxonomic categories were at a disadvantage because they were at the superordinate level, not the basic level. Indeed, the data bear this out; participants in the no label condition provided “related” responses on taxonomic category trials only 57% of the time.

This level of performance could suggest that taxonomic categories are not as accessible as script categories. However, this interpretation is highly unlikely given the previous results of Ross and Murphy (1999) and the overwhelming evidence documenting the presence of taxonomic categorization in early childhood (e.g., Horton & Markman, 1980; Markman, 1989; Markman & Hutchinson, 1984; Rosch et al., 1976; Waxman & Gelman, 1988).

Alternatively, this level of performance seems to indicate more convincingly that the “alike” phrasing of the test question set a threshold that was too high, even for adults. First, although items in a superordinate level taxonomic category belong to the same category, they may not necessarily be alike, especially in terms of concrete properties. In fact, items in a superordinate level (vs. basic) taxonomic category are quite heterogeneous in that they usually have only a few properties in common, and these tend to be relatively abstract (see Murphy, 2002). Second, the “alike” phrasing was not neutral with respect to taxonomic and script categories. Indeed, research has shown that the specific wording of instructions influences children’s preference for different types of categories by emphasizing some, but not other, relations (e.g., Bauer & Mandler, 1989; Dék & Bauer, 1995, 1996; Scheuner, Bonthoux, Cannard, & Blaye, 2004; Waxman & Nanny, 1997). In particular, the “like each other” wording may have emphasized script, but not taxonomic, relations in the present study (see Greenfield & Scott, 1986).

With that said, it is also important to point out that the fact that a significant priming effect was found for taxonomic as well as script categories does not mean that these categories were never activated on their own. Although general conclusions cannot necessarily be made about the relative strength of taxonomic and script categories, what can be concluded is that these categories are indeed spontaneously activated on their own much of the time. Looking at the absolute levels of performance in the no label condition, the participants were still 66% accurate without priming. Of course, the categories were not evoked all of the time, as the presence of a category label improved performance 89%, which is an increase of 23% in “related” responses. Thus, overall, it appears that children do have a fairly well-established mental structure for different types of categories early on. However, as children continue to learn different types of categories for an item, these categories may become more deeply entrenched in memory.

**General Discussion**

**Summary of Findings**

Three questions guided the present examination. First, do children cross-classify items from different domains into taxonomic and script categories? The answer to this question is yes. The results from Experiments 1 and 2 replicate those of Nguyen and Murphy (2003), who found evidence for cross-classification within the domain of food. The results from Experiments 1 and 2 also extend Nguyen and Murphy (2003) by demonstrating that children not only cross-classify foods but also animals, clothing, furniture, and toys. These results suggest that cross-classification involving taxonomic and script organization is not domain specific. Rather, in this case, cross-classification is potentially applicable to any domain in which it is possible for the same items to be organized based on both taxonomic and script relations. As seen in Experiments 1 and 2, the degree to which cross-classification occurs, of course, depends on how familiar children are with one or more of these relations and the relevance of both relations to the current situation (in this case, an experimental setting). These experiments also document the developmental trajectory of cross-classification. The results show that by age 2–3 years, and with improvements around age 4 years, children have knowledge of both taxonomic and script organization and use these two very different systems of organization for cross-classification. These results build upon past research that has identified taxonomic and script organization in children (e.g., Lucariello et al., 1992; K. Nelson, 1986, 1988). These results are also consistent with a number of studies that have shown similar age-related changes in children’s cognitive flexibility associated with the development of the prefrontal cortex (see Jacques & Zelazo, 2005, for a review), perhaps pointing to broader cognitive changes that are occurring during this period of development.

Second, do children think that an item can simultaneously belong to both taxonomic and script categories? The answer to this question is yes by age 4 years and somewhat by age 3 years. In
Experiment 3, 4- and 6-year-olds were able to verify the joint taxonomic and script membership of a single item, whereas 3-year-olds showed some limited sensitivity to both categories. Overall, these results are consistent with several studies that have shown that children can produce more than one label for a single referent (e.g., Blewitt, 1994; Clark, 1997; Clark & Svaib, 1997; Dedik & Maratos, 1998; Hansen & Markman, 2005; Mervis et al., 1994; Waxman & Hatch, 1992).

Third, do children readily activate taxonomic and script categories when thinking about a cross-classified item? The answer to this question is yes, most of the time. In Experiment 4, children were often quite accurate without any priming, which suggests that the taxonomic and script categories were evoked spontaneously most of the time. But these categories were not evoked spontaneously all of the time, because accuracy did improve with the presence of category labels. Thus, these results indicate that although children have a fairly well-established mental structure to draw from during cross-classification, it is also somewhat sensitive to priming as children continue to learn the many ways to cross-classify a single item.

Future research should continue to investigate category representation and accessibility as it is especially germane to the realm of social cognition. Research has revealed that when adults cross-classify people, they do not always activate all of the relevant information such that priming one category (e.g., Chinese for Chinese woman) can inhibit the activation of the other category (e.g., woman; Macrae, Bodenhausen, & Milne, 1995). Although Experiment 4 examined category activation, it did not examine inhibition per se. Thus, it remains to be seen whether a taxonomic or script prime will activate one, but inhibit the activation of another, category during cross-classification. Whether taxonomic or script primes do so could potentially provide insight into children’s spontaneous form of induction is category-based, children may also be quite capable of flexibly using both types of information, category membership and similarity, as a basis for induction.

In fact, an area of growing interest in cognitive development is inductive selectivity, or the ability to flexibly choose different categories for different types of inferences. In one study, Kalish and Gelman (1992) showed that when thinking about objects with overlapping material and object categories (e.g., wooden pillow), children considered the material category but not the object category as crucial to inferring information about the properties of fragility and texture (e.g., saying that a wooden pillow is hard but not soft). In another study, Nguyen and Murphy (2003) also found that children use taxonomic categories of food to make biochemical inferences about the internal properties of foods, whereas children use script categories of food to make situational inferences about when foods are eaten. Research from the adult concepts literature suggests at least three possibilities for how people might decide which category to use as a basis for induction. One possibility is that experience and knowledge within a particular domain guides decisions about which category to use for inferences (Heit & Rubinstein, 1994; Medin, Lynch, Coley, & Atran, 1997). Another possibility is that decisions about inferences are influenced by the distinctiveness of the categories. For example, L. J. Nelson and Miller (1995) found that the more distinctive category of skydiver, but not dog owner, is used as a basis for inferences about people who are both dog owners and skydivers. Finally, a third possibility is that category coherence, the degree to which members of a category hang together in a meaningful way, affects decisions about induction with cross-classified items (Patalano, Chin-Parker, & Ross, 2006). Indeed, cross-classifications pose an interesting challenge to inductive inferences, and much is to be learned about how children make decisions about which category to use.

Cross-Classification and Induction

The present results have important implications for children’s induction or the ability to generalize information from one category member to another. Children’s induction is currently an area of much debate within the conceptual development literature, particularly the mechanisms underlying children’s inductive inferences. One perspective is that children’s early induction is category-based, that is, when faced with an induction problem, children will spontaneously identify an item as belonging to a particular category and then use this category knowledge as a basis for making inferences (see Murphy, 2002, for a review). Another perspective is that children’s early induction is similarity-based. The view is that children’s spontaneous form of induction is driven by the perceptual similarity between items, and because items in a category are typically perceptually similar, children will use this similarity to generalize properties to other category members in an induction task (Fisher & Sloutsky, 2005; Sloutsky & Fisher, 2004a, 2004b). The results from Experiment 4 provide support for the category-based view of induction. The results showed that taxonomic and script categories are spontaneously activated much of the time, suggesting that children have access to these categories for induction. In addition, the results of Experiments 1–3 with cross-classification raise the possibility that although children’s spontaneous form of induction is category-based, children may also be quite capable of flexibly using both types of information, category membership and similarity, as a basis for induction.

Cross-Classification and Conceptual Organization

Taxonomic and script categories capture very different types of information about items; taxonomic categories are based on shared similarity between items, whereas script categories are derived from the roles that items play in a routine or event. How might children mentally organize these two types of categorization systems? Because items can be cross-classified into both categories, children might organize these category relations in a type of nonhierarchical network described below. Similar networks have also been described in the past by other researchers, including Lakoff (1986) and Ross and Murphy (1999). A nonhierarchical network is less structured than a hierarchical or taxonomic network. Although parts of the nonhierarchical network may be organized hierarchically, this network is distinct in that items are connected to many categories. Therefore, categories coexist and are noncompeting. Consider the case of an apple that could be connected to the taxonomic category of fruits and the script category of picnic foods. Individual items in the network are then related to each other through shared category membership. Thus, a sandwich and apple may be related because they are both picnic foods. The lack of order effects in Experiments 1 and 2 provide support for the coexistence of taxonomic and script categories.

Because there is not a sole entry point into this nonhierarchical network, how do children decide how to cross-classify an item?
For example, how does a child decide whether to categorize an apple as a fruit or picnic food? One possibility is that children’s decisions may be influenced by the context of the situation. The results of Experiment 4 suggest that context may influence children’s decisions when a category is not yet well established in memory. For instance, if the category of picnic foods is not deeply entrenched, then this category may only be activated in certain contexts such as when an apple and sandwich are seen together in a picnic basket. Otherwise, if an apple and lemon are seen together at the grocery store, then the category of fruit may be activated. Another possibility is that children’s decisions are also goal directed. For example, if a child is helping to plan a picnic, then an apple and sandwich may immediately come to mind. In fact, there is increasing evidence in the adult concepts literature that everyday categories have components of goals (e.g., things to take out of burning house, Barsalou, 1982, 1983, 1985, 1991).

Can different connections be simultaneously activated for a single item in a nonhierarchical network? For example, can an apple be represented as a picnic fruit at the same time? The results from Experiment 3 would argue yes. Additional supporting evidence comes from studies that have demonstrated that children are willing to accept more than one label for an item at a time (e.g., Deák & Maratsos, 1998) and commonly combine two nouns together to form novel compound nouns (e.g., Clark et al., 1985; Gelman et al., 1989). Being able to activate more than one connection at a time could be extremely useful. If a child who is allergic to cats is trying to figure out what pet to adopt, it would be helpful to know that a kitten is both a cat and pet. However, the usefulness of being able to activate different category relations simultaneously may depend upon whether children can effectively coordinate and use the information provided by the categories. If a kitten activates the concepts of cat and pet, and if children can make sense of these concepts, then it may be possible for children to successfully entertain the thought that a kitten is a pet that is a cat.

As mentioned, there are also parts of the nonhierarchical network that are structured hierarchically, particularly in the case of taxonomic categories. To what extent are children able to negotiate these parts of the network? One the one hand, classic research by Piaget, showing that children fail class-inclusion problems with hierarchically nested categories, suggests that children do not understand that an item can belong to both a class and a subclass simultaneously (e.g., a pine tree is a tree; Inhelder & Piaget, 1964; Piaget, 1952). On the other hand, subsequent research has shown that several task variables can be manipulated to improve young children’s performance on class inclusion problems, such as using collection nouns (e.g., forest, army) that highlight the part–whole relations of the items in a set (Markman & Seibert, 1976). Moreover, other research has shown that even 2- to 3-year-olds will refer to a single object by using different words from varying levels of a taxonomy, saying that something is both a dog and animal, for example (e.g., Clark & Svaib, 1997; Deák & Maratsos, 1998; Waxman & Hatch, 1992). Thus, there appears to be evidence that children are indeed able to maneuver the hierarchical aspects of the network. As we continue to gain an understanding of children’s cross-classification, future research could explore this nonhierarchical network and provide direct tests of its different features.

References
## Appendix A

### Stimuli for Experiments 1 and 2

<table>
<thead>
<tr>
<th>Target</th>
<th>Correct</th>
<th>Incorrect</th>
</tr>
</thead>
<tbody>
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<td><strong>Script</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pajamas</td>
<td>Blanket (bedtime)</td>
<td>Candles (birthday)</td>
</tr>
<tr>
<td>&quot;Cake</td>
<td>Present (birthday)</td>
<td>Shampoo (bath-time)</td>
</tr>
<tr>
<td>&quot;Bus</td>
<td>Backpack (school)</td>
<td>Christmas tree (Christmas)</td>
</tr>
<tr>
<td>&quot;Rubber duck</td>
<td>Soap (bath-time)</td>
<td>Paper (school)</td>
</tr>
<tr>
<td>Table</td>
<td>Plate (dinner-time)</td>
<td>Bag (shopping)</td>
</tr>
<tr>
<td>Reindeer</td>
<td>Santa Claus (Christmas)</td>
<td>Doctor (doctor’s office)</td>
</tr>
<tr>
<td>&quot;Nurse</td>
<td>Band-aid (doctor’s office)</td>
<td>Fork (dinner-time)</td>
</tr>
<tr>
<td>Store</td>
<td>Shopping cart (shopping)</td>
<td>Pillow (bedtime)</td>
</tr>
</tbody>
</table>

| **Taxonomic** | | |
| Pajamas | Sweater (clothing) | Dog (animals) |
| "Cake | Hot dog (food) | Socks (clothing) |
| "Bus | Fire truck (vehicles) | Sofa (furniture) |
| "Rubber duck | Puzzle (toys) | Police officer (people) |
| Table | Bed (furniture) | Jump rope (toys) |
| Reindeer | Elephant (animals) | School (buildings) |
| "Nurse | Daddy (people) | Cheese (food) |
| Store | Library (buildings) | Airplane (vehicles) |

*Note.* Nonconflict triads used in Experiment 2 are marked with an asterisk.

## Appendix B

### Stimuli for Experiment 3

<table>
<thead>
<tr>
<th>Appropriate category labels</th>
<th>Inappropriate category labels</th>
</tr>
</thead>
<tbody>
<tr>
<td>pajamas: bedtime clothes</td>
<td>library: bedtime building</td>
</tr>
<tr>
<td>table: dinner-time furniture</td>
<td>puzzle: dinner-time toy</td>
</tr>
<tr>
<td>reindeer: Christmas animal</td>
<td>hot dog: doctor’s office food</td>
</tr>
<tr>
<td>rubber duck: bath-time toy</td>
<td>fire truck: Christmas vehicle</td>
</tr>
<tr>
<td>store: shopping building</td>
<td>presents: birthday animal</td>
</tr>
<tr>
<td>bus: a school vehicle</td>
<td>shampoo: bath-time clothing</td>
</tr>
<tr>
<td>cake: birthday food</td>
<td>backpack: school person</td>
</tr>
<tr>
<td>nurse: doctor’s office person</td>
<td>bag: shopping furniture</td>
</tr>
</tbody>
</table>

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