Evidence for Task-Dependent Categorization in Infancy

LISA M. OAKES, JODIE M. PLUMERT, JEFFREY M. LANSINK, AND JENNIFER D. MERRYMAN
The University of Iowa

Two experiments compared infants' attention to the categorical distinction between people and animals in object-examining and sequential-touching tasks. In Experiment 1, 10- and 13-month-old infants distinguished between animals and people in an object-examining task. In this task, infants are familiarized with individual exemplars from one category, and then their response to exemplars from another category is measured. In Experiment 2, 13- and 16-month-old infants, but not 10-month-old infants, attended to the same distinction in a sequential-touching task. In this task, infants are presented with several exemplars from two categories simultaneously, and the order in which they touch those objects is assessed. Evaluation of infants' touching behavior in Experiment 2 also revealed developmental changes in how they approached this task. The combined results of these two experiments confirm the general trend reported in the literature and begin to provide insight into developmental changes that contribute to infants' ability to apply their categorization skills in different task contexts.

categorization object-examining sequential-touching conceptual development

How infants and children form and represent categories has become the subject of extensive research and debate in recent years (e.g., Jones & Smith, 1993; Mandler, 1988, 1993; Quinn & Eimas, 1986; Younger & Cohen, 1985). Much of this research has focused on what categories infants possess, and when they first form these categories. For example, at what age do infants have categories such as dogs (Cohen & Caputo, 1978), trucks (Oakes, Madole, & Cohen, 1991), animals (Mandler & McDonough, 1993), and furniture (Ross, 1980)? Evaluation of the existing literature, however, reveals that infants consistently respond to categorical distinctions earlier in habituation or familiarization tasks (e.g., Eimas & Quinn, 1994; Mandler & McDonough, 1993; Oakes, 1995) than in sequential-touching tasks (Bauer, Dow, & Hertsgaard, 1995; Mandler & Bauer, 1988; Mandler, Bauer, & McDonough, 1991), suggesting that the conclusions drawn about categorical responding in infancy depend on the particular task used to assess those abilities.

The goal of this investigation was to provide a first step in establishing how features of the task context make it more or less difficult for infants to attend to a particular categorical distinction. Thelen and Smith (1994) argued that we can gain insight into how and why skills change with development by evaluating the contexts in which a particular skill does and does not occur. Clearly, if older infants apply their categorization skills in more contexts than do younger infants, developmental changes in their cognitive abilities must contribute to whether or not they respond categorically in a given task. By evaluating infants' categorical responding in tasks that differ along particular dimensions, for example a familiarization-dishabituation task and a sequential-touching task, we can determine which of their developing cognitive abilities are relevant to the application of their categorization skills. Clearly, therefore, performance in different categorization tasks can inform us about the process of categorization. That is, tasks place differing demands on infants' cognitive resources, and how infants respond to these demands can inform us about the cognitive skills necessary to use categorization skills.
Infants' categorization has primarily been investigated using familiarization-dishabituation procedures and the object-manipulation, or sequential-touching, task. For our purposes, we will contrast the object-examining task (the familiarization-dishabituation task that involves presenting infants with real objects) with the sequential-touching task. These two tasks are similar in that infants are allowed to actually manipulate real objects, but they differ in the ways in which sequential touching differs from all familiarization-dishabituation tasks. In the object-examining task, as in many familiarization tasks, infants first are presented with several exemplars from one category and then they are tested on novel exemplars from the familiar category and novel exemplars from a new category (Mandler & McDonough, 1993; Oakes et al., 1991). Categorization is inferred if infants decrease their attention during familiarization and selectively increase their attention to the novel out-of-category test but not to the novel within-category test. In the sequential-touching task (Mandler & Bauer, 1988; Mandler et al., 1991; Mandler, Fivush, & Reznick, 1987), in contrast, infants are presented simultaneously with several objects from two categories (typically four objects from each category), and their touching behavior is recorded for a 2-min period. Categorization is inferred if infants touch several objects from one category in succession before they touch objects from the other category.

As mentioned earlier, infants attend to similar categorical distinctions at different ages in these two tasks. Specifically, in studies using the object-examining task, 9- to 10-month-old infants attend to distinctions between animals and vehicles (Mandler & McDonough, 1993; Oakes et al., 1991) and land animals and sea animals (Oakes, 1995). In studies using the sequential-touching task, in contrast, these same kinds of distinctions are not attended to until much later in infancy. For example, Mandler and Bauer (1988) found that at 12 months, infants attended to the distinction between dogs and cars, but not until 20 months did infants attend to the distinction between kitchen and bathroom things and between animals and vehicles. Thus, categorization abilities appear to emerge at different ages depending on the task employed, and one cannot draw conclusions about the categories infants of different ages “have” independent of the task in which categorization is assessed.

At least two differences between these tasks may contribute to why younger infants find it easier to use their categorization skills in object examining than in sequential touching. First, the tasks place different information-processing demands on the infant. As in most familiarization-dishabituation tasks, infants are presented with only one object at a time in the object-examining task, whereas they are presented with eight objects simultaneously in the sequential-touching task. Infants may have difficulty processing information about eight novel objects at the same time. If infants choose to investigate only one of the objects at a time, they must choose which object to investigate, and as a result of investigating that object, they may have few information-processing resources left over to note how it is related to the other objects in front of them.

The two tasks also differ in the amount of contextual support they provide for infants’ application of their categorization skills. Tasks that guide children’s attention to the relevant features of the task are considered to embody a higher level of contextual support (Rogoff, 1990). During the familiarization phase of object examining, as is typical for familiarization-dishabituation tasks, infants are presented with objects from only one category, which may help focus their attention on category membership because this relation is what remains constant across successive trials. Sequential touching may be less likely to guide infants’ attention to the categorical relations among the objects because infants are presented with multiple objects from both categories at one time arranged randomly on a tray. In this context, infants may focus on any of the potential relations among the objects—all of the objects are miniature replicas of real objects, some may be similar in size or texture, and thematic relations may exist between individual objects. Because the items are not presented in a systematic order as in familiarization-dishabituation procedures, infants must discover the categorical relations by considering all of the objects present and ignoring the noncategorical relations between specific pairs of objects. It is assumed that infants will focus their attention on category membership, but little guidance is provided to focus infants’ attention in this task,
and as a result, it may be more difficult for them to discover the relation among the objects intended by the experimenter.

This investigation sought to replicate the developmental differences in infants' ability to attend to a particular categorical distinction in different tasks and to begin to provide insight into the source of these developmental differences. Although Mandler and her colleagues have found that infants attend to some kinds of categorical distinctions at a younger age in an object-examining task (Mandler & McDonough, 1993) than in a sequential-touching task (Mandler & Bauer, 1988; Mandler et al., 1991), they have not directly compared how infants of the same age respond to the same categorical distinction in the two tasks. Definitive conclusions about developmental differences in infants' ability to apply their categorization skills to different tasks require using the same stimuli and the same-aged infants. Therefore, we assessed 10- to 16-month-old infants' differentiation of animals and people in both an object-examining task and a sequential-touching task.

The distinction between animals and people was chosen because previous research indicated that our youngest infants could respond to it in the less demanding object-examining task. Our goal was not to establish whether or not infants have the animal–people distinction, but to determine whether infants of different ages will respond to a categorical distinction in a more demanding context (sequential touching) when we have confidence that they respond to that same distinction in a less demanding context (object examining). Ross (1980) found evidence of differentiation of men and animals by infants as young as 12 months using a task similar to the object-examining task, and Mandler and McDonough (1993) and Oakes and colleagues (Oakes, 1995; Oakes et al., 1991) have found that 9- to 10-month-old infants respond to this level of categorical distinction in object-examining tasks. Moreover, although animals and people both belong to the category “animate things,” the animal–people distinction appears to be a global one similar to those that according to Mandler and her colleagues (Mandler et al., 1991; Mandler & McDonough, 1993) emerge first in object-handling tasks. This distinction can be made in a number of ways—infants can use “perceptual” features such as number of legs, nature of the facial features, the presence (or absence) of clothing and its associated coloring, or some other undefined perceptual difference between the two sets, or they can use their “conceptual” understanding of land animals and people (e.g., that they are different kinds of things—see Mandler, 1992) to make this distinction. Note, however, that the basis of the distinction is less important for our purposes than establishing the discrepancy reported in the literature for when infants attend to a particular distinction in the different types of tasks.

In Experiment 1, we assessed 10- and 13-month-old infants' attention to the animal–people distinction using an object-examining task. We predicted that infants at both ages would attend to the distinction in this task. In Experiment 2, we assessed 10-, 13-, and 16-month-old infants' attention to the same distinction in a sequential-touching task. It was expected that only older infants would respond to the animal–people distinction in the sequential-touching task.

EXPERIMENT 1

Method

Participants
Thirty-two 10-month-old and 22 13-month-old infants were recruited for this study following their participation in an unrelated study of event perception. Sixteen 10-month-olds and 6 13-month-olds were excluded from the final analysis because of fussiness (10 10-month-olds and 4 13-month-olds), experimenter error (4 10-month-olds and 2 13-month-olds), or maternal interference (2 10-month-olds).1 The final sample consisted of 16 10-month-olds (age range = 42.14–49.86 weeks, M = 43.33 weeks) and 16 13-month-olds (age range = 55.14–58.28 weeks, M = 56.47 weeks). There were 8 males and 8 females in the 10-month-old group and 9 males and 7 females in the 13-month-old group. Infant names were obtained from the county birth records, and phone numbers were obtained from the local phone book. Parents initially were contacted regarding participation by letter, followed by a telephone call. Infants received a t-shirt for their participation.

Apparatus
Infants were recorded via a Panasonic camcorder, positioned on a tripod facing the infant at a distance of approximately 100 cm, focused to capture the infant's torso, head,
and arms (as well as the high-chair tray and the toys) on screen. Coders observed the videotaped infants' sessions using a Panasonic VCR and monitor and recorded the duration of looking and examining by pressing keys on a Macintosh SE/30 computer.

**Stimuli**

Plastic replicas of exemplars from the animal and people category were used as stimuli for this study (see Figure 1). Five four-legged land animals (black-and-white cow, zebra, brown horse, brown dog, and orange-and-black tiger) and five people (African American woman in green skirt (green woman), Caucasian man in blue shirt (blue man), Caucasian man in pink shirt (pink man), Caucasian woman in purple skirt (purple woman), and Caucasian woman in yellow dress (yellow woman)) were used. All objects were made of hard plastic and were approximately the same size. The animals all were in standing positions, 8 to 15 cm in length, and easily graspable by 10-month-old infants. The people could stand or sit and ranged from 8 to 15 cm tall when standing. Note that both groups were highly variable, and some features were found in both groups. For example, although the people generally tended to be more brightly colored than the animals, the tiger was a bright orange color, and items from both groups had brown or black markings. Because the replicas were somewhat realistic, moreover, the perceptual features that did differentiate between the categories of toys (e.g., number of legs) are similar to perceptual features that differentiate between actual animals and people. Thus, although we assume that infants take advantage of these general differences in perceptual features between the categories, differentiation of the two categories on the basis of an arbitrary perceptual feature such as color would be impossible. Finally, three trucks were used as novel controls. The trucks were all red, yellow, and blue and had moveable wheels as well as one functional part that could be manipulated (e.g., the loader had a scoop that could be moved). The trucks were approximately 10 cm high and 15 cm long.

**Design**

A familiarization-dishabituation design was employed in which infants were familiarized with either animal or people exemplars and then tested with three novel objects: a person, an animal, and a truck. Half of the infants at each age were familiarized with people and half were familiarized with animals. Two test sets were used. Half of the infants in each condition received the blue man and zebra as tests and the other half received the purple woman and the dog as tests. These objects were always novel. Thus, an infant in the people condition might be familiarized with the green woman, purple woman, yellow woman, and pink man, and then tested with the blue man and zebra. The order of the animal and person test was counterbalanced across infants, followed by a test with one of the three trucks.

**Procedure**

The procedure was identical to that used by Oakes and colleagues (Oakes, 1995; Oakes et al., 1991). Infants were seated in a high-chair, with an experimenter seated facing the infant, to his or her left. A parent sat to the right of and slightly behind the infant, remaining out of the infant's sight. Parents were instructed to interact with their infant as little as possible and not to point at or name the toys during the experimental session.

The experiment consisted of 15 trials, each 30 s in duration. The experimenter began each trial by placing one toy on the high-chair tray, attempting to direct the infant's attention toward the toy by saying "[infant's name] look at this." The action and utterance were the same on each trial. The experimenter timed each trial with a hand-held stopwatch and removed the toy after 30 s had elapsed and immediately began the next trial. During the 30-s trials, infants were allowed to manipulate the toy in any way they wished. If the toy fell from the tray, it was immediately replaced by either the experimenter or the mother. No adjustments to the trial durations were made if the toy fell off the tray.

The session was divided into two phases. The familiarization phase consisted of the first 12 trials. During this phase, infants received three blocks of 4 trials with either animals or people, depending on condition. Infants received one trial with each toy in the familiarization set during each familiarization block. The order of presentation was randomized within blocks, with the exception that infants could not receive the same toy in two successive trials (e.g., the same toy could not be presented on the last trial of Block 1 and the first trial of Block 2). The test phase immediately followed familiarization and consisted of three trials with novel toys, an animal, a person, and a truck. The animal and person tests always came first, order counterbalanced across infants, and the truck test was always the last object presented.

**Coding**

Infant behavior on each trial was coded for examining or focused attention (Oakes et al., 1991; Oakes & Tellinghuisen, 1994; Ruff, 1986). Although examining is difficult to define because each infant expresses it differently, it is broadly defined as clearly focused attention (i.e., concentrated looking at the object). Coders use a variety of cues, such as gaze direction, facial cues, and manipulation, to determine whether or not an infant is examining. In general, examining is the portion of infants' looking at the toy when they appear to be concentrating and are learning about the objects (see Oakes & Tellinghuisen, 1994, and Ruff & Saltarelli, 1993, for discussions of examining). Attention during rapid banging or moving of the object is not included in examining. In previous studies, coders have
had little trouble reliably identifying examining (e.g., Madele, Oakes, & Cohen, 1993; Mandler & McDonough, 1993; Oakes et al., 1991; Oakes & Tellinghuisen, 1994; Ruff, 1986; Ruff, Saltarelli, Capozzoli, & Dubiner, 1992).

Coders, unaware of the hypotheses of the study, observed the videotape of each infant's session and recorded the duration of infants' examining on each trial by pressing a key on a Macintosh computer and holding it as long as infants continued to examine. As in previous studies, this procedure yielded high reliabilities. Reliability between two coders for 9 randomly chosen infants was \( r = .93 \), ranging from .82 to .98. Moreover, the average difference between these two coders for 30-s trials was 1.78 s, ranging from 1.17 to 3.24 s.

### Results and Discussion

The familiarization and test phases were analyzed separately. First, we evaluated infants' decrease in attention during familiarization by entering the average of infants' examining on each block of four trials into a repeated-measures analysis of variance (ANOVA) with age (10 vs. 13 months) and condition (people vs. animals) as the between-subjects factors and trial block (1 through 3) as the within-subjects factor. This analysis yielded a main effect of age, \( F(1,28) = 10.04, p < .01 \), as a result of 13-month-olds (\( M = 9.31, SD = 5.24 \)) examining more during familiarization than 10-month-olds (\( M = 6.39, SD = 4.16 \)).

More important for our purposes was the significant block main effect, \( F(2, 56) = 40.24, p < .01 \), with examining decreasing as the objects became familiar. Comparisons among the means using Tukey's HSD confirmed that overall, infants examined the objects more during Block 1 (\( M = 10.97, SD = 3.93 \)) than during Blocks 2 (\( M = 7.50, SD = 3.24 \)) and 3 (\( M = 5.06, SD = 3.75 \)), and more during Block 2 than during Block 3, \( p < .01 \). The effect of condition, and interactions with condition, were not significant, suggesting that no a priori preferences existed for either familiarization set, and that infants habituated at approximately the same rate in both conditions.

A second set of analyses was conducted to evaluate infants' responding during test. The goal was to determine whether 10- and 13-month-olds attended to the categorical distinction between animals and people in an object-examining task. The duration of infants' examining during the last familiarization trial and each test trial are presented in Table 1. The amount of dishabituation to each test was evaluated by conducting two-tailed \( t \) tests comparing the duration of examining during each test trial to the duration of examining during the last familiarization trial. Categorization was inferred if infants dishabituated to novel out-of-category exemplars but not to novel within-category exemplars. Initial \( t \) tests established that infants at both ages dishabituated to the truck test, \( t(15) = 7.30, p < .01 \) for 10-month-olds, and \( t(15) = 3.98, p < .01 \) for 13-month-olds. Thus, at both ages, infants dishabituated to a completely novel object.

The more theoretically relevant comparisons were between the last familiarization and the within-category and out-of-category tests. Both 10- and 13-month-olds dishabituated to the out-of-category test, \( t(15) = 5.72, p < .01 \), and \( t(15) = 4.48, p < .01 \), but not to the within-category test, \( t(15) = 1.01 \), and \( t(15) = 0.86 \), respectively. In addition, the difference between the novel out-of-category test and the novel within-category exemplar was compared directly. Both 10- and 13-month-olds examined the novel out-of-category exemplar more than the novel within-category exemplar, \( t(15) = 4.98, p < .01 \), for 10-month-olds and \( t(15) = 2.97, p < .01 \), for 13-month-olds, indicating that they were more interested in the out-of-category test than in the novel within-category one.

Individual infants' responding also was assessed for categorization by comparing the

### TABLE 1
Examining Times (in Seconds) During the Last Familiarization and Test Trials for Experiment 1 by Age

<table>
<thead>
<tr>
<th>Trial</th>
<th>Last Familiarization</th>
<th>Within-Category</th>
<th>Out-of-Category</th>
<th>Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-Month-Olds</td>
<td>4.29 (5.00)a</td>
<td>5.51 (3.98)b</td>
<td>16.03 (7.46)b</td>
<td>16.58 (8.36)b</td>
</tr>
<tr>
<td>13-Month-Olds</td>
<td>6.65 (8.44)a</td>
<td>6.52 (7.42)b</td>
<td>15.24 (7.16)b</td>
<td>18.00 (6.89)b</td>
</tr>
</tbody>
</table>

Note. Means with different subscripts were significantly different.
First, dishabituation scores were calculated by subtracting the duration of examining during the last familiarization trial from both the duration of examining during the within-category test and the duration of examining during the out-of-category test. A categorization score was calculated by dividing infants’ dishabituation to the out-of-category exemplar by the total amount of infants’ dishabituation to the tests (dishabituation to the out-of-category test plus the dishabituation to the within-category test). Thus, this score represents the percentage of the infants’ total dishabituation to the two tests that is due to the amount of dishabituation to the out-of-category test and is similar to a novelty preference score. Infants were classified as categorizers if their dishabituation to the out-of-category was 60% of the total amount of dishabituation, that is, if the categorization score was greater than .60. Thus, categorizers actually had to dishabituate to the out-of-category exemplar, and they had to dishabituate to it to a greater degree than to the within-category exemplar. We felt that 60% was a conservative estimate of categorization, and we probably underestimated the actual number of infants who “categorized.” In other experiments, researchers have often reported the number of infants who looked “more” at the out-of-category exemplar than at the within-category exemplar, without actually operationalizing “more” (e.g., Mandler & McDonough, 1993). Most infants met the criterion; although more 10-month-olds (81.25%) than 13-month-olds (62.50%) attended to the distinction, this difference was not significant, $\chi^2(1, N = 32) = 1.39$. Thus, as with the comparisons of the examining times, these analyses indicate that both 10- and 13-month-olds attended to the distinction between animals and people in an object-examining task. We addressed this by providing infants with longer sequential-touching sessions and comparing their responses during the initial 2-min segment (which should be the same as previously reported sequential-touching results) and a second 2-min segment (which would begin to tell us about the role of object familiarity on performance in this task). We predicted that only older infants would attend to the categorical distinction in the first 2-min segment, but that younger infants may begin to attend to the distinction during the second 2-min segment.

EXPERIMENT 2

Experiment 1 demonstrated that infants as young as 10 months can attend to the categorical distinction between people and animals in an object-examining task. The goal of Experiment 2 was to determine whether infants would attend to the same distinction in a sequential-touching task at the same age, or whether categorical responding would not appear until later as suggested by prior reports. If the differences previously reported reflect developmental differences in infants’ ability to apply their categorization skills to increasingly complex tasks, then only older infants may attend to this categorical distinction in the sequential-touching task.

One procedural difference between the two tasks that might make the sequential-touching task more difficult is the amount of time infants spend with the objects. A typical sequential-touching session lasts 2 min (Mandler & Bauer, 1988; Mandler et al., 1987, 1991), whereas in the object-examining task in Experiment 1 infants’ categorical responding was tested after 6 min of familiarization with the objects (12 30-s familiarization trials). Younger infants may require longer amounts of time with the objects in order to attend to the categorical distinction. We addressed this by providing infants with longer sequential-touching sessions and comparing their responses during the initial 2-min segment (which should be the same as previously reported sequential-touching results) and a second 2-min segment (which would begin to tell us about the role of object familiarity on performance in this task). We predicted that only older infants would attend to the categorical distinction in the first 2-min segment, but that younger infants may begin to attend to the distinction during the second 2-min segment.
Method

Participants
Twenty-four 10-month-old, 27 13-month-old, and 24 16-month-old infants were recruited for this experiment in the same way as in Experiment 1. Thirty infants were excluded from the final analysis because of fussiness (5 10-month-olds, 9 13-month-olds, and 4 16-month-olds), failure to touch the toys (3 10-month-olds, 1 13-month-old, and 2 16-month-olds), experimenter error (1 10-month-old and 1 16-month-old), or parental (2 13-month-olds and 1 16-month-old) or sibling (1 16-month-old) interference. The final sample consisted of 15 10-month-olds (age range = 41.43-45.71 weeks, M = 43.15 weeks), 15 13-month-olds (age range = 55.00-58.86 weeks, M = 56.65 weeks), and 15 16-month-olds (age range = 68.14-71.28 weeks, M = 69.95 weeks). There were 7 males and 8 females at 10 months, 9 males and 6 females at 13 months, and 6 males and 9 females at 16 months.

Apparatus and Stimuli
Infants' sessions were videotaped using a Panasonic camcorder with elapsed time coded directly onto the videotape of each infant's session. The stimuli were four animals (zebra, cow, horse, and dog) and four people (green woman, purple woman, pink man, and yellow woman) used in Experiment 1, facing an experimenter and camerader with their mothers seated behind them. Once the infant was settled by the experimenter using a hand-held stop watch. If the toy dropped off the tray during the 2-min session. On these occasions, the experimenter quickly replaced it, touching all the toy touched. Only "intentional" touches, those accompanied by looking at the toy, were counted. Accidental touches (e.g., brushing against one toy while reaching for another toy) were not counted. Touches were counted if the infant touched the object with his or her hand, or with another object (e.g., touching the green woman with the pink man). If an infant touched two objects simultaneously, the order of touches was determined by a flip of the coin. Successive touches to the same object were counted as a single touch. Thus, if an infant touched the cow four times in a row, only one touch to the cow would be counted. A second coder recorded the touches for 9 randomly chosen infants. Average agreement between the two coders regarding which items were touched, and the order of the touches, was 88%, ranging from 77% to 100%.

Results and Discussion
Infants' touching behavior was evaluated in three separate sets of analyses. First, we evaluated the number of touches and the number of different objects touched by the different age groups. Because conclusions about categorization depend on infants touching a number of different objects, it is important to establish that infants at the different ages touched similar numbers of objects and to determine that there were no preferences for one category of objects over the other category. Second, we evaluated the length of infants' runs of touches to items from the same category. Categorical responding is inferred if infants' average run-length is greater than one would expect by chance (Mandler & Bauer, 1988; Mandler et al., 1991). Finally, we evaluated individual patterns of infants' touching for successive touches to items from the same category and alternating touches to items from the two categories.

Evaluation of the Number of Touches
Initial analyses were conducted to determine whether (a) the number of touches increased with age, (b) infants exhibited different numbers of touches to the two categories, and (c) touching changed over the 4-min session. The session was divided into two 2-min segments, and the number of touches to each category was determined for each segment. Because previous studies have used only 2-min sequential-touching sessions (e.g., Mandler & Bauer, 1988; Mandler et al., 1987, 1991), only our first 2-min segment is comparable to the results of previous studies. The number of touches to each category during each 2-min segment was entered into a repeated-measures ANOVA with age (10, 13, and 16 months) as the between-subjects factor and segment (first vs. second) and category (animal vs. people) as
the within-subjects factors. This analysis revealed only a main effect of segment, $F(1, 42) = 7.54$, $p < .01$, as a result of infants exhibiting more touches toward objects from each category in the first 2-min segment ($M = 4.90, SD = 2.95$) than in the second 2-min segment ($M = 4.00, SD = 2.37$). (Note that these are the average number of touches to each category, and the total number of touches is actually double this number.) Importantly, there were no interactions with category or age, suggesting that infants exhibited touches to each category, and that they did not touch one category more than the other.

Although infants did not prefer one category over another, they may still have touched more different objects from one category than from the other. If, for example, infants avoided several animals, they would have touched more different people than different animals. This behavior would have consequences for the subsequent analyses given that classification as a “successive toucher” requires that infants touch at least three unique items from one category in succession. The number of unique items infants touched from each category during each 2-min segment was entered into an ANOVA with age, segment, and category as the factors. The only significant effect was the main effect of age, $F(2, 41) = 3.86$, $p < .05$. The 10-month-old infants touched fewer unique items from each category ($M = 2.13, SD = 0.91$) than either the 13-month-old infants ($M = 2.17, SD = 1.08$) or the 16-month-old infants ($M = 2.63, SD = 0.90$). Thus, although the overall number of touches did not increase with age, older infants tended to touch more different objects than did younger infants. In general, however, these analyses confirm that there were no a priori preferences for either category, and that infants at the three ages engaged in approximately the same amount of touching of the toys.

### Evaluation of Infants’ Run-Lengths

The first set of theoretically relevant analyses were those that evaluated length of infants’ runs to items from a category. A “run” is defined as a series of touches to a single category without touching objects from the other category. Runs may be only one touch, if the infant touches a single object from one category and then touches an object from the other category, and they may be as long as the total number of touches exhibited by the infant if the infant only touches objects from one category. The mean run-length for each 2-min segment was calculated for each infant by dividing the sum of all the infant’s runs by the number of runs. To determine whether infants in general touched more objects in a row from one category than would be expected by chance, the mean run-lengths were compared to chance (1.75) using one-tailed $t$ tests (Mandler & Bauer, 1988; Mandler et al., 1987, 1991). In some cases, the mean run-length may be misleading, and the median may provide a clearer indication of infants’ behavior. That is, if infants exhibit many short runs and only one long run, the mean run-length may provide an overestimation of their touching behavior. However, because it is not clear what the median run-length should be by chance, median scores are provided as a comparison to the mean run-lengths, but no analyses were conducted on these scores. The average mean and median run-lengths are presented in Table 2.

<table>
<thead>
<tr>
<th>Age</th>
<th>First Segment</th>
<th>Second Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$ (SD)</td>
<td>Median</td>
</tr>
<tr>
<td>10 Months</td>
<td>2.19 (2.24)</td>
<td>1.97</td>
</tr>
<tr>
<td>13 Months</td>
<td>1.83 (0.73)</td>
<td>1.57</td>
</tr>
<tr>
<td>16 Months</td>
<td>2.54 (1.54)*</td>
<td>2.27</td>
</tr>
</tbody>
</table>

*indicates that means were significantly greater than chance, $p < .05$. 

Note. Mean run-lengths were compared to chance (1.75).
were greater than chance, although the patterns were different at the two ages. Only in the second segment was the mean run-length for the 13-month-old infants significantly greater than chance, t(14) = 2.01, p < .05. Their mean run-length during the first 2-min segment was not different from chance, t(14) = 0.44. Similarly, 13-month-old infants' average median run-length was greater in the second segment. The mean run-length for 16-month-old infants, in contrast, was greater than chance in the first segment, t(14) = 1.90, p < .05, but not in the second, t(14) = 0.99. Similarly, their average median run-lengths was relatively high only in the first segment. Thus, the conclusion from these analyses is that 10-month-olds showed little evidence of categorical responding, 13-month-olds responded to the category only relatively late in the session, and 16-month-olds responded to the category immediately.

Evaluation of Individual Patterns of Systematic Touching

Evaluating patterns of systematic touching exhibited by individual infants provides additional information about their responding in this task. One would expect that when the average mean run-length for a group as a whole was greater than chance, a relatively large number of infants would have engaged in successive touching of the objects beyond what one would expect by chance. It is less clear what an average mean run-length for the group that is not significantly greater than chance means. It could indicate that infants touched the objects randomly, or that they systematically alternated touches to items from the two categories, or that they engaged in a mixture of systematic touching patterns.

Individual touching patterns were evaluated by classifying two types of systematic touching of the objects. First, we established the probability of individual infant's runs of successive touches to items from the same category (Mandler et al., 1987, 1991). Using probabilities obtained from a Monte Carlo program developed by Mandler and her colleagues, we evaluated each run of successive touches involving at least three items from one of the categories for each infant's session. These probabilities reflect the likelihood that a given run would occur by chance considering the total number of touches an infant exhibits in a 2-min period. For example, a run of eight touches involving three different animals in the context of 16 total touches is associated with a probability of p = .009, and a run of 4 touches involving three different items from one of the categories in the context of 16 total touches has a probability of p = .316. Following Mandler and her colleagues (Mandler & Bauer, 1988; Mandler et al., 1987, 1991), we adopted a p = .10 cutoff for significance. An infant was labeled a successive toucher if he or she exhibited at least one run that met this cutoff.

Second, we evaluated infants' runs of alternating touches to the two categories. That is, an infant might touch the green woman, then the dog, then the purple woman, then the cow, then the pink man. Such an infant seems to be noting the contrast between individual items from the two categories, perhaps a necessary first step in recognizing that items from the same category are similar. We developed a Monte Carlo program to assess the likelihood of these alternating runs given the number of touches produced by each infant. This program simulated 5,000 sequences of touches, with the constraint that the same object could never be touched in succession and then calculated the probability of runs of particular lengths involving alternating touches to the two categories. For example, in the context of eight total touches, the likelihood of a run of six touches alternating between the two categories is p = .063. It should be pointed out that in determining the probabilities of these runs, it was not possible to include the constraint that such runs need to involve three or more unique items, although we only classified infants as alternators if their touching met this constraint. As a result, our probabilities somewhat underestimate the actual likelihood that such runs would occur by chance. However, sequences of alternating runs involving only two items occur infrequently by...
chance (although infants often fixate on two toys, alternatively investigating each one), and thus the fact that we could not include this constraint in our program had only a minimal effect on the outcome.2

At each age, most infants exhibited one or the other pattern of touching (see Table 3). At 10 months, both alternating and successive touching patterns were observed, although alternating tended to be more prevalent, particularly in the first segment. In the first segment, 8 10-month-olds engaged in category-related systematic touching, 2 who only exhibited significant successive runs, 4 who exhibited only significant alternating runs, and 2 who exhibited significant runs of both types (see Table 3). Of the 4 10-month-olds who exhibited significant runs of successive touches to items from the same category, all were single categorizers (i.e., infants who exhibit categorizing runs to only one category), 3 who categorized animals and 1 who categorized people. The average length of these runs of successive touches was 6.00 and was associated with an average probability of $p = .07$. The average probability for the 6 10-month-old infants who exhibited significant alternating was $p = .06$. 

In the second segment, 6 10-month-olds engaged in a significant degree of category-related systematic touching, 3 who exhibited only successive runs, and 3 who exhibited only alternating runs. The 3 infants who exhibited significant runs of successive touches (2 single categorizers, both categorized animals, and 1 exhaustive categorizer, exhibiting runs from both categories) had an average run of 4.25 successive touches to items from the same category, and these runs were associated with a probability of $p = .05$. The 3 infants who exhibited significant alternating runs had an average probability of $p = .06$.

Thus, there is limited evidence of 10-month-old infants touching objects from the same category in succession, the traditional evidence of categorization in this task. Ten-month-old infants did tend to alternate touching items from the two categories, however. Interestingly, only 2 infants engaged in a combination of alternating and successive touching (both engaged in both types of touching in the first segment). In sum, although they engaged in limited successive touching to items from the same category, it clearly would be inaccurate to describe the 10-month-old infants as responding randomly during the sequential-touching task. Instead, a number of them engaged in a systematic behavior that may reflect their noting differences among the individual items.

The 13-month-old infants exhibited a different pattern of responding. Although the 13-month-old infants also exhibited a mixture of successive and alternating touching in the first segment, more successive touching than alternating was observed in the second segment. In the first segment, 6 infants engaged in a significant degree of category-related systematic touching, 2 who exhibited only successive runs, 3 who exhibited only alternating runs, and 1

| TABLE 3
<p>| The Number (%) of Infants Classified as Successive Categorizers and Alternators in the First and Second 2-Min Segment During Experiment 2 by Age |</p>
<table>
<thead>
<tr>
<th>Age</th>
<th>First Segment</th>
<th>Second Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Months: Total</td>
<td>8 (53.33)</td>
<td>6 (40.00)</td>
</tr>
<tr>
<td>Successive</td>
<td>2 (13.33)</td>
<td>3 (20.00)</td>
</tr>
<tr>
<td>Alternating</td>
<td>4 (26.67)</td>
<td>3 (20.00)</td>
</tr>
<tr>
<td>Both</td>
<td>2 (13.33)</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>13 Months: Total</td>
<td>6 (40.00)</td>
<td>7 (46.67)</td>
</tr>
<tr>
<td>Successive</td>
<td>2 (13.33)</td>
<td>6 (40.00)</td>
</tr>
<tr>
<td>Alternating</td>
<td>3 (20.00)</td>
<td>1 (6.67)</td>
</tr>
<tr>
<td>Both</td>
<td>1 (6.67)</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>16 Months: Total</td>
<td>9 (60.00)</td>
<td>5 (33.33)</td>
</tr>
<tr>
<td>Successive</td>
<td>6 (40.00)</td>
<td>3 (20.00)</td>
</tr>
<tr>
<td>Alternating</td>
<td>3 (20.00)</td>
<td>2 (13.33)</td>
</tr>
<tr>
<td>Both</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
</tr>
</tbody>
</table>
infant who exhibited significant runs of both types. The 3 infants who engaged in successive touching (2 single categorizers, 1 categorized animals and 1 categorized people, and 1 exhaustive categorizer) had an average run of 4.5 successive touches, associated with an average probability of $p = .05$. The 4 13-month-old infants who exhibited significant alternating runs had an average probability of $p = .07$.

In the second segment, 7 13-month-old infants exhibited category-related systematic touching, 6 who exhibited only successive runs, and 1 who exhibited only alternating runs. The 6 infants who engaged in successive touching (all single categorizers, 2 categorized animals and 4 categorized people), had an average run of 4.71 successive touches and an average probability for these runs of $p = .04$. Five of the 6 infants had probabilities less than $p = .05$. The 1 infant who exhibited significant alternating runs in the second 2 min had an average probability of $p = .05$.

Although our sample is far too small to draw definitive conclusions, it appeared that the 13-month-old infants engaged in successive or alternating touching in the first 2 min, but they engaged primarily in successive touching in the second 2 min. This pattern contributed to our general impression that 13 months represents a transitional age, and that some of the 13-month-old infants were behaving more like 10-month-olds, whereas others discovered the category membership immediately. It is clear, however, that the majority of 13-month-old infants were engaged in systematic touching of the toys.

Finally, 16-month-old infants who engaged in systematic touching also exhibited a mixture of touching patterns, although in the first segment they tended to exhibit successive runs, and in the second segment both patterns were observed. In the first segment, 9 16-month-old infants exhibited a significant degree of category-related systematic touching, 6 who exhibited only runs of successive touches, and 3 who exhibited only runs of alternating touches. The 6 infants who exhibited runs of successive touches (5 single categorizers, 4 categorized animals, 1 categorized people, and 1 exhaustive categorizer) had an average run of 6.57 successive touches to items from the same category, associated with an average probability of $p = .02$. The 3 infants who exhibited alternating runs had an average probability of $p = .05$.

In the second segment, 5 16-month-old infants engaged in category-related systematic touching, 3 who exhibited only runs of successive touches, and 2 who exhibited only runs of alternating touches. The 3 infants who exhibited runs of successive touches (all single categorizers, 2 categorized animals and 1 categorized people) had an average run of 4.00 touches to items from the same category, associated with an average probability $p = 0.04$. All of the 16-month-olds who engaged in successive touching had runs with probabilities less than $p = .05$. The 2 infants who engaged in alternating runs had an average probability of $p = .04$. Interestingly, both of these infants engaged in successive touching in the first segment. Unlike the younger infants, therefore, many 16-month-old infants clearly engaged in successive touching early in the session, and little alternating was observed.

To establish whether the proportion of infants who engaged in one type of touching pattern or the other differed across ages, separate Fisher’s exact tests were conducted comparing the probability of infants who engaged in successive touching and alternating across age groups for each segment. None of these comparisons approached conventional levels of statistical significance. A second set of comparisons was made for the proportion of systematic touchers who engaged in each type of touching pattern. For example, was the proportion of 10-month-old systematic touchers in the first segment who alternated different from the proportion of 16-month-old systematic touchers in the first segment who alternated? Once again, none of these comparisons reached conventional levels of statistical significance. Although these results clearly should be taken as suggestive, it appears that developmental differences exist for how infants approach the sequential-touching task. Specifically, with development, the incidence of alternating decreases and the incidence of successive touching increases.

Conclusions
What do these findings suggest about infants’ categorical responding in the sequential-touching task? Clearly, at the youngest age tested there was little evidence of categorical responding as it is traditionally measured. The mean run-lengths were low, and few infants engaged in systematic successive touching. Interest-
ingly, the youngest infants did engage in one pattern of systematic touching, alternating between the two categories, which shows some awareness of the difference between items from different categories. If one only evaluated infants' successive touching, one would conclude that 10-month-old infants do not engage in systematic behavior in this task. These results suggest that 10-month-old infants are systematic in the sequential-touching task, but in a different way than are older infants.

The two older age groups showed more traditional patterns of responding to the category, although the results are somewhat mixed. For both 13- and 16-month-old infants, the mean run-length was greater than chance in at least one of the two segments. However, overall, the number of infants classified as successive touchers was low. Thus, by 13 months, there is evidence of successive touching to items from the same category, but this evidence is somewhat mixed. First, 13-month-old infants' systematic successive touching of items from the same category emerged relatively late in the session. Only in the second 2 min did the mean run-length differ from chance, and a relatively large number of systematic touchers engaged in successive touching of objects from the same category (although it should be noted that the number of successive touchers was not large). Evaluation of the individual patterns of responding in the first segment suggests that 13-month-old infants initially exhibit mixed patterns of responding, with some infants engaged in successive touching and other infants alternating. At 16 months, evidence of successive touching was found only in the first 2-min segment. During this first segment, the mean run-length differed from chance, and a relatively large proportion of systematic touchers were classified as successive touchers, although the overall number was not large. Alternating was much less frequent in this older age group.

Thus, the combined results from the evaluation of infants' successive and alternating runs suggest that there are developmental differences in how infants approach this task. When presented with an array of eight objects from two different categories, younger infants seem to notice the contrast between individual objects. It is only later in infancy that they respond to the similarity of items within a category.

It should be noted that if we evaluated successive touching in only the first 2 min segment (the most directly comparable to the results reported by Mandler and her colleagues), the results of this experiment suggest that infants do not attend to the animal–people distinction until 16 months of age. During the first segment, only at 16 months did infants' mean run-length differ from chance, and 40% of them were classified as categorizers. This finding is consistent with the results reported by Mandler and her colleagues (e.g., Mandler & Bauer, 1988). That is, Mandler has found that not until the middle of the 2nd year of life do infants attend to distinctions within the same global category in a sequential-touching task (e.g., Mandler & Bauer, 1988). Inspection of the second 2 min segment, however, suggests that 13-month-olds do respond to such distinctions in this task, but with difficulty. Moreover, evaluation of the alternating touching patterns revealed that a large proportion of infants engaged in systematic touching of the objects. Thus, these results suggest that the sequential-touching task as it has traditionally been used does not provide a complete picture of infants' categorization abilities.

GENERAL DISCUSSION

The results of these experiments clearly demonstrate that infants' ability to use their categorization skills develops between 10 and 16 months. As infants grow older, they become increasingly able to apply their categorization skills to a wider range of tasks. In these experiments, both 10-month-old and 13-month-old infants readily distinguished between animals and people in an object-examining task. Only 13-month-old and 16-month-old infants, however, showed evidence of attention to the categorical distinction in a sequential-touching task as assessed by successive touching. Specifically, 13-month-old infants responded to the distinction in the last 2 min, and 16-month-old infants responded immediately to the distinction.

These results underscore the need for caution when drawing conclusions about infants' categorization abilities based on their performance in a single task and raise serious questions about how responding in the sequential-touching task should be evaluated. Clearly, developmental changes occur between 10 and 16 months in infants' use of their categorization
skills. That is, in these experiments, 10-month-old infants clearly attended to the categorical distinction between animals and people only in the object-examining task. Their responding to this distinction in a sequential-touching task was less clear. Ten-month-old infants showed little categorical responding as it is traditionally evaluated (the presence of successive touching), although they did exhibit a different pattern of systematic touching (alternating between the two categories), which may indicate a rudimentary awareness of the categorical distinction in this task.

Thirteen-month-olds showed some awareness of the distinction in both tasks. In the second segment of the sequential-touching task, their mean run-length was greater than chance, and a relatively large number of those infants who engaged in systematic touching were classified as successive touchers. Thus, 13-month-old infants responded to the categorical distinction in both tasks but had difficulty in the sequential-touching task, indicating that they are only beginning to develop the ability to apply their categorization skills in more complex tasks. They required more time in the sequential-touching task than did 16-month-old infants before they engaged in any successive touching of the objects from the same category, suggesting that this relation among the objects was not immediately apparent or salient to them in this context.

Two developmental differences observed in infants' touching behavior in Experiment 2 provide some insight into developmental changes in how infants approach the sequential-touching task. First, although there were no age differences in the overall number of touches, there were differences in the number of different objects touched. Older infants touched more different objects than did younger infants, suggesting that they could simultaneously attend to eight different objects and discover the categorical relation among those objects. Younger infants may have had difficulty both attending to eight different objects and discovering the categorical relation among those objects. During the first 2 min, 13-month-old infants spent more time with the few objects they touched, perhaps recognizing categorical relations through successive investigations with individual objects. Sixteen-month-old infants engaged in successive touching immediately, suggesting that they did not need to discover the categorical distinction as they manipulated and explored the objects.

Second, although most infants at all three ages engaged in systematic touching, the particular type of systematic touching differed across ages. The systematic alternating pattern exhibited by the younger infants may indicate that they initially attended to the contrasts between individual objects. Because alternating decreased between 10 and 16 months, it appears that alternating is a less sophisticated approach to the task. In addition, the mixed responding by the 13-month-old infants suggests that this age is transitional. At 13 months, some infants alternated but did not engage in successive touching, others engaged in successive touching but did not alternate, and others engaged in both touching strategies. Finally, at 16 months, most infants engaged in successive touching in one of the segments, and few infants alternated.

What factors might account for the developmental changes in infants' ability to apply their categorical skills to tasks such as sequential touching? One possible factor is increases in general information-processing abilities. There is little question that infants' information-processing capabilities develop during this time. Moreover, research in other areas of infant cognition suggest that performance is influenced by the information-processing demands placed on infants. For example, infants' perception of causality is influenced by the information-processing demands of the event context (Oakes, 1994; Oakes & Cohen, 1995). In particular, 10-month-old infants attended to the causality of events when shown the same objects on each habituation trial (Oakes, 1994; Oakes & Cohen, 1990), but not when shown different objects engaged in the same type of events on each habituation trial (Cohen & Oakes, 1993). Ten-month-olds apparently have difficulty ignoring the individual objects and attending to the type of event being presented.

Clearly, object examining and sequential touching place different information-processing demands on infants. Infants are presented with different number of objects and, thus, different amounts of information at one time in the two tasks. In the object-examining task, only one object is presented at a time, and as a result, infants process the information about each object individually. Thus, infants need only
process the information about one new object and the categories to which it might belong. Over successive trials with single objects from the same category, infants can recognize the category to which the objects belong.

In the sequential-touching task, in contrast, infants are presented with eight novel objects simultaneously. Thus, the sequential-touching task may present a problem for infants similar to increasing the number of objects in events. In both situations, infants must respond not to the individual objects but rather to the relation between them intended by the experimenter. Dealing with eight novel objects simultaneously may tax infants’ information-processing resources in a number of different ways. For example, younger infants may be unable to divide their attention among eight novel objects. In addition, they may have difficulty remembering objects already explored as they move on to investigate other objects on the tray. Moreover, investigating individual objects may require most of their information-processing resources, and they may have little left over to attend to how the object they are presently exploring relates to the other objects present. As a result of limitations like these, younger infants would likely explore fewer objects at one time, and the categorical relatedness of the objects would be discovered as young infants investigated individual objects. Clearly, younger infants who engaged in systematic alternating touching did so in a manner that does not necessarily reflect attention to the general categorical relatedness among all the objects. Instead, they noted the contrast between two objects in succession, a strategy that might reflect their attending only to few objects simultaneously. Developmental changes in information-processing abilities would allow older infants to deal with multiple objects at the same time. As a result, they could initially investigate individual objects and recognize how those objects are related to the other objects present, and engage in sequential touching earlier in the session.

Decreased reliance on external cues to guide one’s attention to the relevant relation in the task may also contribute to developmental changes in infants’ application of their categorization skills. Note that this is not necessarily independent of general increases in information-processing abilities. When simultaneously presented with eight objects, more external cues may be necessary to guide one’s attention to the categorical distinction than when presented with only one object at a time. To recognize that the objects come from two different categories, one has to ignore the fact that the set as a whole has many features in common. For example, all of the objects in this experiment were approximately the same size, they were all plastic replicas of objects, and they were all toys. In addition, individual pairs of toys shared common features—they may have been similar in color or texture. When these similarities cross categorical boundaries, infants must inhibit responding to these relations in order to respond on the basis of categorical relatedness. Younger infants may have more difficulty guiding their attention to the categorical distinction and hence require more support from the task context to make that distinction more salient.

The object-examining and sequential-touching tasks clearly differ in how much they guide infants’ attention to the relevant aspect of the task. In the object-examining task, infants are presented with each object from one category on successive trials, and category membership is what remains constant across successive trials. As a result, the relation among those objects is salient, and thus this task may focus infants’ attention on what is relevant. It should be noted that some experiments using familiarization-dishabituation procedures also have found that presenting infants with contrasting items from the two categories during familiarization serves to guide their attention to contrasts between categories of simplified, artificial stimuli (Quinn, 1987; Younger, 1985). In some contexts, with some stimuli, presenting items from two categories during familiarization may facilitate infants’ comparison of those exemplars, and their differentiation of the categories. Even in these previous experiments, however, the relevant distinction can only be recognized by considering the exemplars presented during successive trials over the course of familiarization. That is, in all familiarization procedures, infants must examine each exemplar or pair of exemplars and note what remains constant across successive trials. This aspect of these procedures may serve to guide infants’ attention to the relevant categorical relation. The sequential-touching task, in contrast, provides little external guidance to focus infants’ attention on the
relevant relation. Infants are simply presented with eight objects randomly arranged on a tray; the categorical relation among the objects is not presented but must be discovered by surveying the entire array of objects present.

Why would older infants require less support to guide their attention than would younger infants? They may have skills that help them attend to category membership and thus allow them to discover the relations among the objects more quickly than younger infants. For example, more advanced language skills may help older infants recognize categorical relatedness, although the exact relation between language and categorization in sequential-touching tasks is unclear. For example, Gopnik and Meltzoff (1992) found that 18-month-old infants with larger vocabularies of object names engaged in more categorical behavior in sequential-touching tasks, whereas Mandler et al. (1991) found no relation between language and sequential touching. Because language skills and vocabularies increase between 10 and 16 months, however, developmental changes in language skills may have contributed to the developmental change in categorical responding in the present investigation.

It is impossible to establish from these experiments whether reducing the information-processing load or guiding infants' attention to the relevant distinction alone explains the developmental differences observed. The object-examining task is simpler both because objects are presented one at a time and because all the objects from one category are presented before any of the objects from the other category are presented. Future studies can tease these factors apart somewhat, although it is likely that any effort to guide infants' attention to the relevant distinction will also result in lowering the information-processing demand.

What implications do these results have for the study of infant categorization? Traditionally, assumptions have been made about the kinds of categories infants of different ages "have" based on their performance on tasks such as those employed in these experiments. These results suggest, however, that one cannot draw conclusions about the categories infants of different ages "have" independent of the task in which categorization is assessed. From a general standpoint, these results raise a fundamental issue in the study of cognitive development, namely the relation between competence and performance. This distinction does not seem to be informative. In particular, performance should not be viewed as masking underlying competence. Rather, understanding how features of tasks influence infants' ability to use their skills will contribute to our understanding of the development of those skills. As has been argued with respect to other domains of development (e.g., Plumert, 1994; Rogoff, 1990), we believe that a fruitful approach to studying infant categorization is to determine how and why developmental changes occur in infants' ability to apply their categorization skills to increasingly complex situations. In short, categorization skills should become more flexible with development. Future research that addresses these changes in flexibility may help to shift the focus from what categories infants of different ages "have" to how and why categorization skills change with development.

REFERENCES

Oakes, Plumert, Lansink, and Merryman

development of contextual categories. Cognitive
Mandler, J.M., & McDonough, L. (1993). Concept forma-
Oakes, L.M. (1994). Development of infants’ use of contin-
uity cues in their perception of causality. Developmental Psychology, 30, 869–879.
Oakes, L.M. (1995, March). The role of perceptual similar-
ity in infants’ differentiation of land and sea ani-
mal. Presented at the biennial meeting of the
Society for Research in Child Development, Indianapolis.
In C. Rovee Collier & L.P. Lipsitt (Eds.), Advances in
Infancy Research, Vol. 9 (pp. 1–54). Norwood, NJ:
Ablex.
examining: Habituation and categorization. Cognitive
Development, 6, 377–392.
Oakes, L.M., & Tellinghuisen, D.J. (1994). Examining in
Quinn, P.C. (1987). The categorical representation of visual
pattern information by young infants. Cognition, 27,
145–179.
Oxford University Press.
Developmental Psychology, 16, 391–396.
manipulative exploration. Child Development, 57,
105–114.
with objects: Basic cognitive processes and individ-
ual differences. New Directions for Child
Ruff, H.A., Saltarelli, L.M., Capozzoli, M., & Dubiner, K.
(1992). The differentiation of activity in infants’
exploration of objects. Developmental Psychology,
28, 851–861.
approach to the development of cognition and
Younger, B.A. (1985). The segregation to items into cate-
gories by ten-month-old infants. Child Development,
56, 1574–1583.
categories. In G. Bower (Ed.), The psychology of
learning and motivation: Advances in research and

09 June 1995; Revised 24 April 1996