Development of Exclusivity in Perceptually Based Categories of Young Infants

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The exclusivity of perceptually defined categorical representations for natural animal categories in young infants was investigated. Previously, as well as in Experiment 1, evidence was obtained for a categorical representation for cats in 3- and 4-month-old infants that excluded dogs but included perceptually similar female lions after a number of different familiarization procedures. However, in Experiment 2 both dogs *and* female lions were found to be excluded when the initial familiarization with cats alone was followed by six pairings of familiar cats and novel lions intermingled with two added pairings of familiar cats. The present results indicate that a categorical representation can attain a high level of exclusivity during early infancy as a consequence of experience with exemplars of the contrasting categories that accents the perceptual similarities among members of a category and the perceptual differences among exemplars from different categories. © 1994 Academic Press, Inc.

In two recent series of experiments (Eimas & Quinn, 1994; Quinn, Eimas, & Rosenkrantz, 1993), we investigated the abilities of young infants to form categorical representations for realistic, pictorial exemplars of various species of animals. These experiments were also concerned with the exclusivity of these representations, that is, the extent to which they excluded exemplars from contrasting basic-level categories and with the role of perceptual similarity between exemplars of contrasting categories on estimates of exclusivity. The latter is particularly important given the necessarily perceptual nature of the information that must underlie these representations.

In the first experiments (Quinn et al., 1993), we found that infants, approximately 3 and 4 months of age, formed categorical representations for cats that excluded dogs and birds and for dogs that excluded birds and cats, although the latter occurred only when the variation among the exemplars of dogs was reduced to match that which existed among the cats. The second series of studies (Eimas & Quinn, 1994) found that infants of the same age formed categorical representations for horses that excluded cats, zebras, and giraffes and again for cats that now excluded horses and tigers but not female lions—that is, lions without the distinguishing feature of manes. Moreover, these categorical representations could not be attributed to failures to discriminate among members of a category, nor could they be attributed solely to perceptual preferences, although such preferences did exist in some instances, e.g., a large sample of tigers was preferred over an equally large sample of cats. The fact that dogs and cats were differentiated despite the absence of obvious features such as the stripes of the zebras or tigers or the exceptionally elongated necks of giraffes shows that the processes of categorization and differentiation can be tuned to rather subtle attributes of these animals, possibly overall body shape and particular body parts as well as facial configurations. Comparable findings with somewhat older infants were obtained in earlier experiments by Cohen and Caputo (1978), Colombo, O'Brien, Mitchell, Roberts, and Horowitz (1987), and Roberts (1988).

As well as providing evidence for perceptually based, categorical representations for exemplars of natural-kind categories at a quite early age, our experiments have indicated that the representations for young infants are notably exclusive. Interestingly and theoretically important, the categories of young infants resemble the manner in which more mature humans parse the world of mammals, although they undoubtedly do not include information about "the kind of thing it is" (Mandler, 1992) and thus should not be considered conceptual in nature. These findings also inform us that measures of exclusivity will depend on the similarity of the contrasting exemplars that are used during the test trials, trials that pair novel exemplars from the familiar category with novel exemplars from novel contrasting categories. Thus, had we used exemplars from

novel categories more similar to horses, such as donkeys or gazelles, the representation for horses might have included these animals just as the representation for cats included the highly similar exemplars of female lions.

Eimas and Quinn further investigated the inclusion of female lions in the categorical representation for cats. They found that by 6 to 7 months of age, the categorical representation for cats excluded female lions, although the data did not provide direct insights into how greater categorical exclusivity develops. In attempting to explain these findings, it was noted that the failure of younger infants to exclude lions from the categorical representation for cats may have been due to immaturity with respect to resolution acuity or spatial frequency and phase sensitivity or both (Banks & Salapatek, 1981; Dobson & Teller, 1978; Held, 1989). However, the fact that these infants were able to differentiate cats and dogs would seem to lessen the force of arguments of this nature. Given this, the issue for us became whether more exclusive representations for basic-level categories in young infants could be experimentally induced by altering the perceptual experience infants have with exemplars from the contrasting categories of concern by changing the familiarization procedure. Eimas and Quinn attempted to induce greater exclusivity by presenting varying numbers of exemplars of cats and lions together across the set of familiarization trials, a modification of the procedure Quinn (1987) had first introduced. Quinn had found that presenting exemplars from two categories enhanced the strength of the representation for geometric forms as evidenced by the likelihood that a categorical representation was formed. We believed at the time that the effects of this procedure might be further evidenced in enhanced exclusivity for the animal categories used in our experiments (see Homa & Chambliss, 1975, for comparable findings with adult observers). However, when we presented either 4 cats and 12 lions or the converse during familiarization the evidence again indicated that lions and cats had formed a single, global representation that excluded horses, a representation that we believed to be akin to the child-basic categories noted by Mervis (1987). Nevertheless, still believing that the greater exclusivity of categorical representations is at least in part a consequence of perceptual experience (cf. Gibson, 1969), we undertook the present experiments in an effort to understand the development of categorical exclusivity. Toward this goal, we further modified our familiarization procedure in a manner that we assumed would better enable the infant to perceive the similarities among the exemplars belonging to each category as well as the subtle perceptually given differences that exist between the exemplars of the two contrasting categories.

EXPERIMENT 1

Experiment 1 presented cats and lions during familiarization which, as we noted earlier, presumably allows the observer to discern the perceptual

attributes that are both similar and distinctive about each category and in this manner to form separate representations. We modified our earlier use of this procedure (Quinn, 1987; Quinn et al., 1993) by presenting infants with two familiarization periods. The first followed the typical familiarization procedure during which 6 pairs of 12 different cats were displayed. Immediately thereafter we presented the second familiarization period which consisted of 6 familiar cat–novel lion pairs. In effect, we sought to teach infants about one category before introducing members of the contrasting category that would allow direct comparison between exemplars of the two categories. Two preference tests followed immediately after the second familiarization. All subjects were given the critical novel cat–novel lion pairing—the test trials that measured categorical exclusivity in our experiments. Half of the subjects were presented with a novel cat–novel dog comparison, whereas the other half were presented with a novel lion–novel dog pairing. The latter comparisons provide evidence that categorization occurred, by showing that at least one other species was excluded from either a global category that included both cats and lions or two separate categories, one for cats and one for lions. Whether or not a single global representation was formed is known by the outcome of the former novelty preference test.

The predictions for Experiment 1 are as follows (see also Eimas & Quinn, Experiment 6, 1994). If infants form representations approximating adult-basic level categories for cats and lions that exclude lions and cats, respectively, as well as dogs (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976), the expectation is for a preference for the novel lions over the familiar cats to emerge during the second set of familiarization trials. Furthermore, on test trials, a preference for lions over novel cats as well as for dogs over novel cats and novel lions should be observed. The expected preference for lions over cats to emerge during familiarization and on the test trials is based on the assumption that when there are more cats than lions experienced during familiarization, the categorical representation for cats will be more familiar than that for lions and thus the novel lions in being relatively less familiar should be preferred over the novel cats. Alternatively, if infants form only a child-basic category inclusive of both cats and lions (Mervis, 1987), but exclusive of dogs, then one would not expect to observe a preference to emerge for the novel lions over the familiar cats during the course of the second familiarization period. One would also not expect to see a preference for the novel lion over the novel cat on the test trials. However, a preference for the novel dog when paired with either a novel cat or a novel lion should occur.

Method

Subjects. The subjects were 32 3- and 4-month-old infants. Sixteen of the infants were 3 months of age and 16 were 4 months old, and 14 infants were males and 18 were females. An additional 21 subjects participated

in the study, but were excluded from the data analysis for fussing (n = 13), failure to compare stimuli during a preference test (n = 6), and experimenter error (n = 2). Preliminary analyses were performed for looking times during familiarization and for percentages of novelty preferences during the test trials as a function of age in each experiment. In no case did the 3-month-old infants differ from infants 4 months of age.

Stimuli. The stimuli were 54 colored photographs of cats, dogs, and female lions (18 exemplars per category). The pictures of cats and dogs were cut from Simon and Schuster's Guide to Cats (Siegal, 1983) and Simon and Schuster's Guide to Dogs (Schuler, 1980). The pictures of female lions were cut from a variety of nature books depicting the animals in their natural habitat. Pictures from all categories were selected to represent a variety of shapes, colors, stances and orientations of each type of animal. Each picture contained a single animal that was either sitting, standing or running and that had been cut away from its background, centered, and mounted onto a white 17.7 by 17.7-cm posterboard for presentation. The pictures were chosen so as to be as nearly the same size as possible in order to eliminate size per se as a possible basis for categorization. As a consequence, infants were required to use attributes such as body shape and facial configuration, which we believe to be more nearly those that perceptually define animal categories than does size.

Apparatus. Infants were tested by means of a portable visual preference apparatus, adapted from that used by Fagan (1970). This apparatus is essentially an enclosed viewing box with a hinged, gray display stage (85 cm long and 29 cm high) that contains two compartments to hold two 17.7 by 17.7 cm posterboards. The posterboards were illuminated by a 60 Hz fluorescent lamp shielded from the infant's view. The center-to-center distance between the two compartments was 30.5 cm. A .625-cm peephole located midway between the stimulus compartments permitted observation and recording of the infant's visual fixations.

Procedure. The infants were tested individually. They were brought to the laboratory by a parent and placed in a reclining position on a seated parent's lap. An experimenter wheeled the apparatus over the infant, keeping the infant's head centered with respect to the middle of the display stage. At this point, with the display stage open, the infant could see only the experimenter's face. As soon as the infant was properly aligned and apparently at ease, a trial was begun. The experimenter loaded the stimuli from a nearby table into the stimulus compartments, elicited the infant's attention and closed the stage, thereby exposing the stimuli to the infant. The center of the display stage was approximately 30.5 cm above the infant while the stimuli were being viewed. During a trial, an experimenter observed the infant through the peephole and recorded fixations to the left and right stimuli using a 605 XE Accusplit stopwatch held in each hand. Interobserver reliability of this procedure is high (see for example,

Cohen & Strauss, 1979; Haaf, Brewster, de Saint Victor & Smith, 1989), with estimates in our laboratory ranging from .88 to .93 (Bomba, 1984; Quinn, 1994; see also Eimas & Miller, 1992, for equally high estimates of reliability in our laboratory using video images of infant faces). Between trials, the experimenter opened the stage, recorded the looking time data, changed the stimuli, when necessary, recentered the infant's gaze and closed the stage. With the exception of the perceptual preference experiment noted on page 17, two experimenters were used to record fixations, one during familiarization trials and another during test trials. The experimenters were trained research assistants who were naive to the hypotheses of the studies and the experimental condition of a particular infant (i.e., the stimulus information that the infant had been shown during familiarization).

Each infant was first familiarized with 12 cats, randomly selected and different for each infant, presented during six 15-s trials (two different cats per trial). Each infant was then given a second familiarization period consisting of six 15-s trials, each of which paired one of the familiar cats with a different novel lion. The familiar cats and novel lions were again randomly selected and different for each infant. The left–right positioning of the cats and lions over the six trials was balanced within each infant. The infants then participated in two novel-category preference tests, the order of which was counterbalanced across infants. All infants received a novel lion vs novel cat preference test. For half of the infants, the other test paired a novel cat with a novel dog; for the other half of the infants, a novel dog was presented with a novel lion. All test stimuli were randomly selected and different for each infant. Each novel category preference test consisted of two 10-s trials with the same stimuli being presented on each of the two trials. The only difference across trials was that the left–right positioning of the single exemplar from each of the two categories, counterbalanced across infants on the first trial, was reversed on the second trial.

Results and Discussion

Familiarization trials I: Cat–cat pairs. The infants did not show a reliable decrement in looking time during the initial familiarization with cats from the first three trials ($M = 8.02$ s, $SD = 3.24$) to the last three trials ($M = 7.52$ s, $SD = 3.28$; $t(31) = 1.57$, $p > .10$, one-tailed). This failure to find evidence of habituation is consistent with our earlier reports that also found no habituation to the photographs of different exemplars of animals shown during familiarization in some, but not all experiments (Eimas & Quinn, 1994; Quinn et al., 1993). The source of this lack of habituation is, we believe, the presentation of many quite varied and discriminably different stimuli that held the infants' attention throughout the familiarization period. More important, however, given the existence

	Pairs of test-trial stimuli		
	Cat/dog	Lion/dog	Cat/lion
Preference	64.34[a]	60.16[a]	55.08[b]
SD	22.03	21.03	21.08
N	16	16	32
t (vs chance)	2.60**	1.93*	1.36

[a] Preference for Dog.
[b] Preference for Lion.
* $p < .05$, one-tailed.
** $p < .025$, one-tailed.

of evidence for systematic novelty preferences during test trials in each of our experiments, the failure to habituate can in no way be construed as indicating a lack of processing.

Familiarization trials II: Familiar cat–novel lion pairs. A lion category preference score was calculated for each infant by dividing the summed looking times to the novel lions over the six trials by the summed looking time to both categories over the six trials. The score was then converted to a percentage and averaged across infants and yielded a mean lion category preference of 52.84% ($SD = 11.62$; $t(31) = 1.38$, $p > .05$, one-tailed). This suggests that the new lions were still not perceived to be sufficiently different from the familiar cats to elicit a reliable novelty preference.

Preference test trials. Mean novel category preference scores are shown in Table 1. Dogs were preferred to cats and lions, but, as was true in the experiments of Eimas & Quinn (1994), lions were not preferred to cats. The convergent results from the second familiarization and novelty-preference test trials lead to the conclusion that lions were not distinguished from cats, but rather had again become part of a global representation with cats that excluded dogs—evidence for a perceptually determined child-basic category (Mervis, 1987). That infants had in fact formed a categorical representation that included cats and lions is further supported by our earlier findings that infants can distinguish individual exemplars within the cat category and that infants do not have preferences to observe dogs to cats (Quinn et al. 1993).

EXPERIMENT 2

In Experiment 2, our further attempt to demonstrate the differentiation of cats and lions at 3 to 4 months of age was predicated on the assumption that the categorical representation for cats presumably established during

the first familiarization period of Experiment 2 had not been strongly enough established or strongly enough evoked during the second familiarization period. As a consequence, the cats and lions were not differentiated during the second familiarization sequence of trials. To remedy this presumed source of our failure, we replicated Experiment 2 with one procedural difference: we added two trials that paired only familiar cats during the second familiarization period. This was done in order to remind infants of the initial representation for cats and perhaps further narrow the criteria for this representation and in this manner to underscore the similarities among cats and their differences with lions. Reinstatement procedures or reminders have been used effectively by other investigators studying the mental representations of young infants (e.g., Baillargeon, 1993; Rovee-Collier & Hayne, 1987).

Method

Subjects. Thirty-two infants, 25 3-month-olds and 7 4-month-olds, served as subjects. Fifteen of the infants were males, and 17 were females. Six additional infants were tested but not included in the data analysis because of fussiness ($n = 4$) and failure to look at both stimuli on test trials ($n = 2$).

Stimuli and apparatus. The pictures of cats, dogs and lions and apparatus were those used in Experiment 1.

Procedure. All procedural details of Experiment 1 were repeated in Experiment 2 with the addition that two familiar cat-familiar cat trials were added to the six familiar cat–novel lion trials of the second familiarization. The cat–cat trials occurred on Trials 3 and 7 of the second set of eight familiarization trials. The familiar cats for the second set of familiarization trials were randomly selected from the set of cats presented during the first familiarization period and were thus different for each infant.

Results and Discussion

Familiarization trials I: Cat–cat pairs. As in Experiment 1, there was no significant difference between looking times for the first three trials ($M = 9.99$ s, $SD = 2.60$) and last three trials ($M = 9.50$ s, $SD = 2.90$; $t(31) = .82$, $p > .10$, one-tailed). Once again, the multidimensional variation among the pictorial exemplars of domestic cats was sufficient to maintain infant attention throughout the first familiarization.

Familiarization trials II: Familiar cat–novel lion pairs. To determine if a preference for cats emerged during the second familiarization, only data from cat–lion trials were analyzed. Looking time on cat–cat trials was not analyzed; the trials themselves served an important reminding function, but the data obtained on them would not be informative as to whether lions were being differentiated from cats. Analysis of the first two cat-

TABLE 2
MEAN NOVEL-CATEGORY PREFERENCE SCORES (PERCENT) FOR EXPERIMENT 2

	Pairs of test-trial stimuli		
	Cat/dog	Lion/dog	Cat/lion
Preference	61.93[a]	54.21[a]	62.73[b]
SD	18.51	19.25	17.49
N	16	16	32
t (vs chance)	2.58*	.86	4.12*

[a] Preference for Dog.
[b] Preference for Lion.
* $p < .025$, one-tailed.

lion trials (the trials before the first cat–cat presentation) showed as ex-
pected a mean preference score of 47.68% which was not significant (SD
= 21.04, $p > .10$, one-tailed). However, analysis of the last four cat–
lion trials (the trials after the first cat–cat pairing (Trials 4, 5, 6, and 8)
revealed that lions were preferred over cats ($M = 58.08\%$, $SD = 18.70$;
$t(31) = 2.44$, $p < .025$, one-tailed). The results of the final four lion–
cat pairings thus provided our first evidence that lions had begun to be
excluded from a categorical representation of cats, an observation that
our modification of the familiarization procedure was effective—a con-
clusion receiving additional support from the test-trial data.

Preference test trials. Table 2 shows that the mean novel category pref-
erences for dogs over cats and, more importantly, for lions over cats were
reliable. These findings suggest that 3- to 4-month-old infants had for the
first time formed a categorical representation for cats that excluded both
dogs and lions. Apparently, the addition of the cat–cat trials during the
second familiarization was effective in reminding infants of the common-
alities among cats or in making the differences between cats and lions
more readily detectable or both.

Also of interest in Table 2 is the observation that dogs were not pre-
ferred to lions. Had infants formed a second categorical representation
for lions (in addition to the one formed for cats), then dogs should have
been preferred. That this was not the case suggests that lions were dif-
ferentiated from cats as individual instances and not as a separate category.
In other words, the infants had succeeded in excluding lions from the
representation developed for cats, but they had not succeeded in orga-
nizing the lion exemplars into a distinct categorical representation. As a
consequence, novel lion–novel dog pairings elicited no reliable preference
for dogs—all test trial exemplars of dogs and lions were equally novel
individual experiences. We consider why lions were not categorized at
the end of Experiment 4.

The results of Experiment 2 clearly point to a role of perceptual experience in the development of greater categorical exclusivity, at least for categories based on sensory properties. Given this, our original intention was to extend these findings by showing that a categorical representation for lions that we presumed to initially include cats could be altered to exclude cats by means of the familiarization procedure used in Experiment 2. We began with an experiment to show that after familiarization with exemplars of lions alone, a global representation for lions and cats that excluded dogs would be formed. Sixteen 3- and 4-month-old infants (6 females and 10 males; 11 3-month-olds and 5 4-month-olds) were first familiarized with 12 instances of lions, two different exemplars on each of 6 trials, and then presented two preference tests, one pairing a novel lion with a novel dog and the other a different novel lion with a novel cat. The mean novelty preference for dogs was 57.92% (SD = 16.21; $t(15)$ = 1.95, $p < .05$, one-tailed), as expected. However to our surprise, the mean preference score for cats was 60.44% ($t(15)$ = 2.53, $p < .01$, one-tailed). Thus, the categorical representation for lions already excluded cats and dogs—a consequence, we suspect, of the reduced variability among the pictures of lions that resulted in a more narrowly defined, i.e., more exclusive, representation being established (Quinn et al., 1993). Support for less variability among the exemplars of lions is found in the reliable reduction in looking times during familiarization across the first three trials (M = 9.80 s, SD = 3.29) and last three trials (M = 8.53 s, SD = 3.61) ($t(15)$ = 2.26, $p < .025$, one-tailed). Of course, it is possible that the evidence for a categorical representation for lions could be a function of the inability of infants to discriminate among the exemplars of lions—the novel lion presented on the test trials being perceived simply as the familiar exemplar and not a different member of a familiar category—or to a spontaneous preference for dogs. Given the results of Eimas and Quinn (1994) there is presumably no a priori preference for cats over lions or conversely. We tested for these possibilities in two control experiments, Experiments 3 and 4.

EXPERIMENT 3

Experiment 3 tested whether infants were able to discriminate the various exemplars of lions.

Method

Subjects. The subjects were 16 3- and 4-month-old infants. There were 12 males and 4 females and 12 infants were 3 months of age and 4 infants were 4 months old. Two additional infants were dropped from the experiment, one for being fussy and the other for failing to look at both test-trial stimuli.

Stimuli and apparatus. These were the same as those used in Experiment 2.

Procedure. Each infant was presented with a different, randomly selected pair of lions, one of which was arbitrarily designated the familiar stimulus and the other the novel stimulus. The familiar stimulus was duplicated and shown in each compartment of the display panel for 6 15-s trials. There were then two 10-s test trials during which the familiar and novel lions were displayed with their left–right positions counterbalanced across trials.

Results

During familiarization there was a reliable decrement in looking times from the first three trials ($M = 9.27$ s, $SD = 3.66$) to the last three trials ($M = 8.23$ s, $SD = 3.51$; $t(15) = 2.21$, $p < .025$, one-tailed). On the test trials, infants reliably preferred the novel lion, thereby showing that the individual lions could be discriminated ($M = 63.73\%$, $SD = 18.81$; $t(15) = 2.92$, $p < .01$, one-tailed) and that the categorization of lions was not due to a failure to discriminate the exemplars of lions.

EXPERIMENT 4

In Experiment 4, we sought evidence for an a priori preference for dogs over lions.

Method

Subjects. The subjects were again 16 infants, 11 3-month-old and 5 4-month-old infants. Six of the infants were males and 11 were females.

Stimuli and apparatus. These were the same as those used in Experiment 2.

Procedure. Each infant was presented with a different set of 8 randomly chosen pairs of dogs and lions, one pair of which was displayed over each of 8 15-s trials. For a rationalization of this procedure the reader is referred to Eimas and Quinn (1994).

Results and Discussion

The looking times to dogs were summed over the eight trials for each infant, divided by the total looking time to lions and dogs, and converted to percentages. The mean preference for dogs was 51.31% ($SD = 9.45$; $t(15) = 0.55$, $p > .20$). There was thus no spontaneous preference and given that the lions were discriminably different, it is reasonable to believe that the infants did in fact form a categorical representation for lions that excluded both dogs and cats.

In light of the results of Experiments 3 and 4, we return now to consider why lions were not categorized in Experiment 2. We believe the answer lies again in the greater variability among the exemplars of cats compared

with the exemplars of lions. Further evidence in favor of this hypothesis comes from a replication of Experiment 2 with the single difference being that lions served as the target category, that is, as the familiar category whose exclusivity was measured. We found that the representation for lions excluded cats and dogs ($M > 62.00\%$ and $p < .025$, one-tailed, in both cases), just as the representation for cats in Experiment 2 excluded lions and dogs. Moreover and importantly the representation for cats excluded dogs ($M = 61.88\%$ and $p < .025$, one-tailed). In other words, categorical representations for both lions and cats were formed. Given that there was lower variability among the lion exemplars than among the pictures of cats, the representation for lions during the initial familiarization period could have been more firmly established and perhaps more narrowly defined than that for cats in Experiment 2. Consequently, fewer resources might have been expended on the continued categorization of lions as opposed to cats during the second familiarization period. As a further consequence, greater resources could then have been available for the categorization of cats following familiarization with lions than for the categorization of lions following familiarization with cats (see Quinn et al., 1993, for evidence that exemplar variability is related to the probability of forming a categorical representation).

GENERAL DISCUSSION

In the present experiments, we found that altering the familiarization procedure prior to tests of categorization and the exclusivity of a categorical representation of cats produced a more finely tuned category, that is, a category with greater exclusivity. In earlier research, Eimas and Quinn (1994) and Quinn et al. (1993) found that young infants were able to form a categorical representation for cats that excluded dogs among other mammals but not perceptually similar female lions (and see Experiment 1). However, a categorical representation for cats that excluded dogs and lions was evidenced when the familiarization procedure was modified by first presenting 12 exemplars of cats, which (presumably) established a categorical representation for cats. These trials were then followed by six trials during which cats and lions were presented together along with two trials when cat–cat pairs were displayed. The latter trials presumably made the differences between cats and lions more apparent, by reminding infants of the representation for cats and the common attributes that underlie this representation and perhaps by further narrowing the representation.

What we find particularly interesting and important about this demonstration is that the capacities for making fine distinctions among highly similar natural kinds exist in young infants, but that such distinctions will not be made in the absence of appropriate experience. Moreover, the appropriate experience would appear to require enhancing the likelihood

that the similarities among like things and the differences between members of different categories will be observed and encoded. The additions to the familiarization procedure, adapted from the use of familiarization trials that presented contrasting exemplars on each trial (Quinn, 1987), were designed to accomplish just these purposes. It would seem then that the young infant's ability to parse the world of things and events is potentially a very rich one. Of course, this partitioning of the environment must undoubtedly be based on perceptible properties. Nevertheless, it is worth noting that these properties provide sufficient information to make it unnecessary for the transition from perceptually based to conceptually based representations (e.g., Karmiloff-Smith, 1992; Mandler, 1992) to require a reorganization of category boundaries, at least in a goodly number of instances. It does of course require the acquisition of new knowledge—knowledge that may in some instances be perceptually instantiated (Eimas, 1994; Quinn & Eimas, in preparation; and see Jones & Smith, 1993, for a discussion of perceptual knowledge in children's conceptual structures).

Although our experiments clearly support a strong role of perceptual experience in the development of categorical representations with relatively exclusive extensions (cf. Gibson, 1969), they do not inform us about the exclusivity of the earliest categorical representations. Is it the case that the original categorical representations of infants have broad extensions, being in effect child basic as opposed to adult basic in nature (cf. Mervis, 1987)? Or if categorization is guided by certain rather narrow, developmentally early a priori perceptual preferences, which is possible given the data of Eimas and Quinn (1994), might some very early categorical representations be nearly as exclusive as the representations of adults? What this problem requires is systematic investigation into the processes of categorization by perceptually naive infants during the first few weeks of life.

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