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WHAT DO INFANTS KNOW ABOUT CATS, DOGS, AND PEOPLE? DEVELOPMENT OF A “LIKE-PEOPLE” REPRESENTATION FOR NONHUMAN ANIMALS

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Infancy is an important time window for learning how knowledge is acquired. During the first months of life, infants experience objects from various classes, but at different rates of presentation. For instance, infants are likely to encounter other humans more frequently than nonhuman animals. This aspect of infants' early experience allows investigators to examine whether the category representations that infants form for humans versus nonhuman animals differ in terms of their exclusivity and structure. Researchers can also inquire about the perceptual information and type of processing (i.e., bottom-up vs. top-down) used to categorize humans and nonhuman animals. The present chapter reviews convergent evidence from looking time, computational, and brain-imaging methods indicating that the contrast between how infants respond to humans versus nonhuman animals

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exemplifies an expert–novice difference in the early development of category representations. This difference suggests that infants may respond to non-human animals in a human-centric manner and use a “like-people” foundation for a commonsense biology. An implication is that persons, even very early in development, may form strong attachments with nonhuman animals because humans perceive nonhuman animals to be like other humans.

THE MENTAL PROCESS OF CATEGORIZATION

The central cognitive process at issue in the chapter is that of *categorization*, which refers to the recognition of different entities as members of the same category based on some internal representation of the category (Murphy, 2002). Categorization is considered to be a critical cognitive ability, with some arguing that it is the most fundamental activity to be carried out by the nervous system (Edelman, 1987) and the most foundational of all cognitive processes (Thelen & Smith, 1994). This is because a system of mental representation lacking in category representation would be dominated by unrelated instance information, and individuals would have to learn to respond anew to each novel object encountered. That is, without categories, each new entity encountered in the world would be unrelated to entities previously encountered. It is via categorization processes that memory storage emerges as organized, retrieval of information becomes efficient, and individuals become capable of responding with familiarity to an indefinitely large number of exemplars from multiple categories, a majority of which will not have been previously experienced.

HISTORICAL VIEWS ON THE DEVELOPMENTAL ORIGINS OF CATEGORIZATION

Because of the importance of categorization as a mental process that supports everyday cognitive functioning, there has been interest in understanding how it begins and is manifested during early development. Different theoretical accounts have been offered. An associative learning view is that categories are formed through pairings of environmental encounters and verbal labels (Hull, 1920). By this view, a young child sees a dog and hears it labeled as such. Over time, as the experience is repeated, the child will arrive at a meaning for the concept of “dogs.” An anthropological view is that the world has little or no natural order: The child must learn through instruction to impose order on natural disorder (Leach, 1964).

Although there is little doubt that some of our skill at dividing the world into categories is derived from language and formal instruction, with

both mechanisms still the subject of contemporary inquiry (e.g., Csibra & Gergely, 2009; Dean, Kendal, Schapiro, Thierry, & Laland, 2012; Rakison & Lupyan, 2008), the question arises as to whether something even more fundamental might underlie our ability to categorize, especially in the initial months of life, when the contributions of language and instruction toward concept formation may be minimal (but see Ferry, Hespos, & Waxman, 2010). In response to this question, Rosch (1978) argued that the world is structured along lines of natural discontinuity, such that categories are marked by bundles of correlated attributes. For example, birds tend to have feathers, two legs, and make chirping sounds, whereas dogs tend to have fur, four legs, and make barking sounds. By this view, an organism that can detect such correlations and compile them into separate representations is capable of categorization, and if that is the case, then at least the initial start-up of categorization may begin without the benefit of language and instruction. It therefore becomes important to understand the categorization abilities of infants, as it may be from these abilities that the more complex categories of children and adults are derived.

A METHOD TO STUDY CATEGORIZATION IN YOUNG INFANTS

To study categorization in young infants (approximately 3–7 months of age), researchers have adapted a looking time methodology based on novelty preference (Fantz, 1964). The basic idea is that when it comes to generic objects, infants will look longer at the novel relative to the familiar. In studies of categorization, infants are familiarized with instances from a common category (e.g., different instances of cats). Then, during a novel category preference test, two new instances are presented. One is a novel instance from the familiarized category (a cat not previously seen), and the other is a novel instance from a novel category (e.g., a bird or dog). If the infant generalizes responsiveness to new instances of the familiarized category (i.e., looks for about the same amount of time to the new cat relative to the cats shown during familiarization) and responds differentially to novel instances from the novel category (i.e., displays a visual preference for a novel bird or dog), then it may be concluded that the infants have formed a category representation for the class of familiarized cat exemplars that includes novel instances from the familiarized category (i.e., novel cats) and excludes novel instances from the novel category (i.e., novel birds or dogs). This conclusion is also contingent on the results of control conditions demonstrating that infants can discriminate the instances from the familiarized category and that the preference for the novel category exemplars did not arise simply from an *a priori* preference.

2 CATEGORIZATION OF NONHUMAN ANIMALS BY INFANTS

Experimental Evidence

Given that some of the earliest words in a child's expressive vocabulary include *kitty*, *dog*, *bird*, and *horse* (Gentner, 1982; Gleason, 2005; Nelson, 1973), it seemed a natural step to investigate how young infants represent nonhuman animal categories (Eimas & Quinn, 1994; Quinn & Eimas, 1998; Quinn, Eimas, & Rosenkrantz, 1993). Infants were presented with a dozen images of cats or horses during familiarization. Those infants familiarized with cats were administered novel category preference tests pairing novel cat images with novel images of birds, dogs, horses, and people, whereas those infants familiarized with horses were administered novel category preference tests pairing novel horse images with novel images of cats, giraffes, zebras, and people.

Examples of the categories can be seen in Figure 1.1. The images from the nonhuman animal categories included different breeds, coloring, and stances, and the images of humans included both males and females in standing, running, or walking poses. Moreover, it can be seen that size differences between the categories were minimized. Had size not been removed as a cue, and infants differentiated between the categories, then the studies would

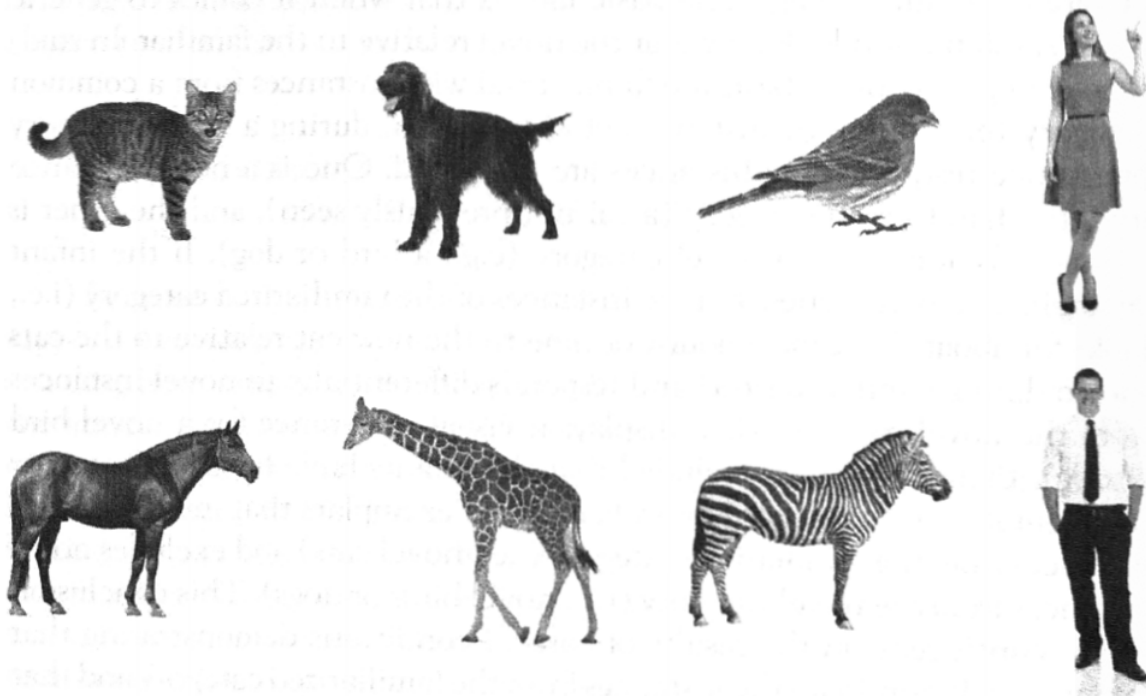


Figure 1.1. Examples of the nonhuman animal and human images presented in the studies investigating infants' categorization of nonhuman animals.

have been vulnerable to the critique that only simple size discrimination had been demonstrated. It is also important to note that each category consisted of 18 different images. Such large stimulus sets allowed each infant to be familiarized and tested with randomly selected images from the target and contrast categories.

The findings were that infants familiarized with cats generalized responsiveness to novel cats and displayed novel category preferences for birds, dogs, horses, and people. In addition, infants familiarized with horses generalized responsiveness to novel horses and displayed novel category preferences for cats, giraffes, zebras, and people. Control studies showed that the results of the novel category preference tests could not be attributed to within-category discrimination failure (which would have rendered the various instances of the familiarized category indistinguishable from one another, thus making the novel category preference test more like a simple discrimination test) or to a priori preferences for the contrast categories. These outcomes indicate that infants can form category representations for nonhuman animal categories that include novel instances of those categories but exclude members of contrasting nonhuman animal categories as well as instances of humans (for corroborating results, see also Mareschal, Powell, & Volein, 2003; Oakes & Ribar, 2005; Younger & Fearing, 1999).

Why Is Categorization by Infants Significant?

The results of the studies investigating categorization of nonhuman animals by infants are significant because they suggest that infants have the ability to divide the world of objects into perceptual category representations that later come to have conceptual significance for children and adults. As such, category development may reflect enrichment of category representations initially formed through perceptual experience (Madole & Oakes, 1999; Quinn & Eimas, 1997; Rakison & Poulin-Dubois, 2001). More concretely, the evidence indicates that infants are not representing the world as an undifferentiated bunch of grapes. Rather, when presented with realistic, pictorial instances of the categories, infants form distinct representations of, for example, cats and dogs. These representations may serve as placeholders for the acquisition of the more nonobvious, essentialist attributes that occurs beyond infancy. That is, children learn and adults know that cats have cat DNA and give birth to kittens, whereas dogs have dog DNA and give birth to puppies (Gelman, 2003; Keil, 1989). It may be the process of incorporating these more abstract attributes into the category representations of infants that provides a pathway to mature concepts. Indeed, it's difficult to envision how one could go from the undifferentiated bunch of grapes starting point to the mature concept end point without the perceptual category

representations of infants serving as a facilitating intermediary. It should also be acknowledged that what is being attributed to infant performance is not that infants are learning long-term memory-based concepts of cats and dogs with which they leave the lab. The claim is that infants are demonstrating perceptual parsing skills in the laboratory that can presumably be deployed when infants encounter real cats and dogs in the natural environment.

A Role for Part Information

What is the perceptual information that infants use to form category representations for nonhuman animals? In some cases, such as when horses are contrasted with zebras, distinctive body markings (e.g., the stripes of the zebras) may provide the basis for the category partitioning. However, in other cases, such as the contrasts between cats, dogs, and horses, the diagnostic information is not obvious, given that each species possesses a head, a body, four legs, fur, and a tail. To investigate the perceptual information that infants use to categorize cats versus dogs, the categorization experiment contrasting cats and dogs was repeated. However, in this instance, only information from the heads (bodies occluded) or bodies (heads occluded) was presented during familiarization and the novel category preference test (Quinn & Eimas, 1996). Infants displayed a novel category preference in the head-only, but not the body-only, condition, suggesting that the head is used to partition the categories. This conclusion was bolstered by an additional experimental outcome from a procedure in which infants were familiarized with cat and dog images and then tested with hybrid images, that is, dog head on cat body and cat head on dog body (Spencer, Quinn, Johnson, & Karmiloff-Smith, 1997). The novel category preference was found to follow the direction of the novel category head. Both results suggest that the category representations of infants for nonhuman animals are in some instances based on part information (see Rakison & Butterworth, 1998, for further evidence on the importance of parts as a basis for category formation by infants).

A Summary Representation

A further question concerns the nature of the representations that infants form for nonhuman animal categories. Are infants simply storing individual instances of the category in accord with an exemplar-based representation (Nosofsky, 2011), or are they extracting just the summary information about the category in accord with more of a prototype representation (Minda & Smith, 2011)? A prototype is the central value extracted from a series of varying exemplars (e.g., Homa, Cross, Cornell, Goldman, & Schwartz, 1973; Posner & Keele, 1968). To investigate this issue, the familiarization portion of

the categorization experiment in which infants were presented with a dozen images of cats or horses was repeated. However, in this instance, the ensuing preference test contrasted a novel image from the familiarized category with one of the images presented during familiarization (randomly selected for each infant). If infants are representing the individual instances of category, then they should display a preference for the novel instance of the category. If, however, they are representing only summary information, then one would not expect a preference between the novel and familiarized exemplars. The outcome was no preference toward the novel over the familiarized (i.e., a null preference), which is in accord with the idea that the category representations of infants for nonhuman animals are based on summary information, perhaps in the form of individual prototypes corresponding to each category (e.g., Bomba & Siqueland, 1983; Quinn, 1987). This finding suggests that infants are representing "cat" rather than individual cats in the case of cats as the familiarized category. Although caution should be exercised in terms of drawing conclusions on the basis of no preference between instances, the results take on additional significance when contrasted with the different finding observed when humans are the familiarized category (to be discussed subsequently).

A Role for Online Learning Taking Place During Category Familiarization

Another question concerning the category representations formed by infants for nonhuman animals is whether those representations are formed online during the course of the experimental familiarization procedure or whether the experimental procedure is tapping into a representation that existed prior to arrival at the laboratory. One source of evidence relevant to this question comes from computational learning systems that are trained with measurements of the surface attributes of the cat and dog images, the same images that were presented to infants in the laboratory (e.g., Mareschal, French, & Quinn, 2000). Such learning systems were able to simulate infant performance in their category-learning behavior. This result suggests that the category learning can be based on bottom-up processing of the image statistics, which in turn is consistent with the idea that the category representations of infants for nonhuman animal categories are formed online during the course of the experimental familiarization procedure. This conclusion is also consistent with the observation that at least some of the infant participants in the categorization studies did not have cats or dogs as pets at home and were not likely to have directly experienced the target category of horses or the contrast categories of giraffes or zebras prior to participation in the studies. A possible facilitative influence of a home pet such as a cat or dog on categorization performance will be discussed in a subsequent section.

A second piece of evidence comes from measurement of event-related potentials (ERPs) in infants in an ERP analogue of the behavioral categorization task (Quinn, Westerlund, & Nelson, 2006). Infants were presented with 18 cat images for 500 ms per image during the first half of familiarization, another 18 images during the second half of familiarization, then 20 new cat images intermixed with 20 dog images. If infants are learning the cat images during familiarization, then the response to the second set of cats should differ from the response to the first set of cats because it will reflect a learned category structure. The response to the learned category structure should then generalize to the novel cats, but not to the novel dogs. The response to the novel dogs should look more like the response to the initial set of cats, reflecting in both instances initial experience with exemplars of a category.

In studies of simple recognition memory in infants using ERP methods, a late slow-wave component that peaks between 1,000 and 1,500 ms post-stimulus is associated with recognition of familiarity and detection of novelty (de Haan & Nelson, 1997). In particular, if the wave returns to baseline, then that is associated with recognition of familiarity, whereas if the wave deflects away from baseline in a negative direction (a component called the *negative slow wave*), that is associated with detection of novelty. For the late slow-wave activity recorded over left occipital-parietal scalp, responses to the initial set of familiarized cats and novel dogs deflected away from baseline as a negative slow wave, reflecting recognition of their novelty. In contrast, responses to the second set of familiarized cats and the novel cats returned to baseline, reflecting recognition of familiarity. The ERP results are thus consistent with the computational results in suggesting that the cat and dog images are learned online during the course of experience with the images.

CATEGORIZATION OF HUMANS BY INFANTS

Experimental Evidence

Given positive evidence of categorization of nonhuman animals by infants and mindful of the perceptual differences between nonhuman animals and humans, one might expect that it would be straightforward to demonstrate that infants would form a category representation of humans inclusive of novel humans, but exclusive of nonhuman animals. To this end, infants were familiarized with a dozen images of humans and then administered novel category preference tests in which novel humans were paired with cats, horses, fish, and even cars (Quinn & Eimas, 1998). Surprisingly,

the infants generalized responsiveness not only to the novel humans, but also to the cats, horses, and fish, although they additionally displayed a novel category preference for the cars. It is important to note that control studies showed that infants did not display a spontaneous preference for humans over nonhuman animals, thus ruling out an a priori preference as a possible basis for the generalized responsiveness to the nonhuman animal contrast categories. The infants thus seemed to form a broadly inclusive representation for humans that included novel humans as well as nonhuman animals but excluded cars. Pauen (2000) also reported evidence for a broadly inclusive representation of humans by infants that includes non-human animals.

What Is the Basis for the Asymmetry?

Why would infants include nonhuman animals in their representation for humans but exclude contrasting nonhuman animal categories and humans from their representation of nonhuman animals? That is, why would infants include cats, horses, and fish in their representation of humans, but exclude birds, dogs, horses, and humans from their representation of cats, and exclude cats, zebras, giraffes, and humans from their representation of horses? A consideration is that in contrast to learning about the nonhuman animal images online during the course of an experiment, even the youngest infants in the studies at issue have acquired several months of experience with humans prior to participation in the studies. This consideration leads to the suggestion that infants may be at a more advanced stage of processing images of humans relative to images of nonhuman animals, which in turn gives rise to the proposal that what infants know about nonhuman animals may be likened to what novices know about generic object categories, whereas what infants know about humans may be likened to what experts know about objects in their domain of expertise.

To evaluate the proposal further, prior studies have pointed to at least three advantages that experts display over novices when perceiving objects within their domain of expertise. First, experts are better at recognizing commonalities among objects within their domain of expertise (Murphy & Wright, 1984). Notably, this characteristic of expertise is already evident in infant responding to the equivalence of humans, cats, horses, and fish. It could be that infants are recognizing the abstract resemblance of a head, attached to an elongated body, with skeletal appendages across all four categories. The recognition of such a resemblance may in turn be the basis for the human representation being an attractor for nonhuman animals. Second, experts tend to recognize objects within their domain of expertise at a subordinate level. That is, instead of recognizing a feathered animal at the generic

level of bird as a novice would, an expert would recognize the object as a "sparrow" or "white-crowned sparrow" (Gauthier & Tarr, 1997; Tanaka & Taylor, 1991). Third, experts tend to recognize objects within their domain of expertise as configural wholes rather than on the basis of individual parts (Busey & Vanderkolk, 2005; Gauthier & Tarr, 2002). The next two sections consider whether there is evidence that infants represent humans at the subordinate level and as organized wholes.

An Exemplar-Based Representation

As was asked about infant representation of nonhuman animal categories, one can inquire about the structure of the representation infants use to form a category for humans (Quinn & Eimas, 1998). The data indicate that infants represent the human category at the level of specific exemplars. In particular, when familiarized with a dozen humans and tested with one of the familiar humans (randomly selected) and a novel human, infants prefer the novel human. This result stands in contrast to the null result that was observed when infants were administered this same type of familiarization procedure and preference test, but with cats or horses as stimuli. The findings with the human stimuli are consistent with the idea that infants recognize humans at an expert, subordinate level.

A Role for the Whole

As indicated earlier, when infants form category representations for nonhuman animals that exclude contrasting nonhuman animal categories (i.e., a representation for cats that excludes dogs), they do so on the basis of perceptual part information (i.e., the head). However, when the whole stimulus versus head only (body occluded) versus body only (head occluded) categorization study is repeated with cats and humans (instead of cats and dogs), the major finding is that it's only in the whole stimulus condition that cats are included in the human representation (Quinn, 2004). Moreover, a follow-up study showed that the inclusion of the cats into the representation for humans occurs only when the whole stimulus images are upright, suggesting a role for configural processing in the formation of a representation for humans that includes nonhuman animals (Quinn, Lee, Pascalis, & Slater, 2007). Taken together, these studies indicate that infants include nonhuman animals in their representation for humans based on holistic-configural stimulus information, which is in accord with the idea that expert-like processing underlies the recognition of humans by infants.

A Contribution From Previously Acquired Knowledge

As noted, computational and ERP evidence suggest that infant learning of nonhuman animals takes place primarily via online learning. By contrast, there is computational evidence suggesting that infant responding to human images is based on learning about humans that occurred prior to arrival at the laboratory (Mermillod, French, Quinn, & Mareschal, 2004). For example, if the same neural network that simulated infant learning of cat and dog images learns about humans and nonhuman animals just from the bottom-up information available in the stimulus images, the network does not produce the categorization asymmetry observed in the infant's looking time behavior in the laboratory. However, if the network is provided with a long-term memory that was trained with images of humans, then the network does produce the asymmetry (i.e., a representation for humans that includes nonhuman animals and representations for nonhuman animals that exclude humans). This result suggests that prior knowledge about humans contributes to the formation of a category representation for humans that includes nonhuman animals.

Further support for the idea that how infants respond to humans in the laboratory is based on prior knowledge comes from studies on how infants respond to social category attributes of humans, namely, the gender and race of human faces (Quinn et al., 2013). In particular, processing advantages are observed for the categories that infants experience more frequently on a day-to-day basis. For example, infants raised by female primary caregivers represent female faces as individual exemplars but represent male faces as a summary structure (Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002). In addition, infants come to display superior recognition abilities for faces from within one's own racial group (Kelly et al., 2007, 2009).

SUMMARY

The evidence reviewed has documented differences in the way that infants represent nonhuman animals versus humans. Specifically, infants represent nonhuman animal categories as exclusive of both humans and contrasting nonhuman animal categories, on the basis of part information, with a summary representation and because of learning taking place at the laboratory within the experimental task. In contrast, infants represent humans as inclusive of nonhuman animals, on the basis of holistic-configural information, with an exemplar representation, and by recruiting from a preexisting knowledge base about humans.

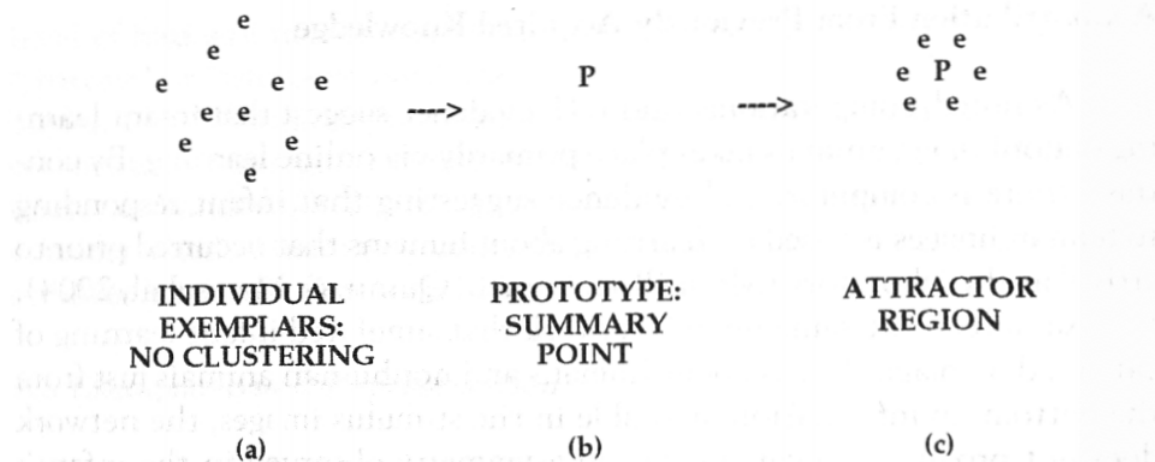


Figure 1.2. Schematic depiction of the course of early knowledge acquisition.

An Accounting of the Differences

The differences in how infants represent humans versus nonhuman animals may be quantitative in nature and reflect different levels of knowledge that infants have about humans versus nonhuman animals. Figure 1.2 provides a schematic illustration depicting a possible course of early knowledge acquisition in which infants start out experiencing individual exemplars from multiple categories. With sufficient experience and armed with inherent abilities to compute within-category similarity and between-category dissimilarity, infants begin to form structured representations for these categories based on summary-level prototypes. The expectation is that such representations would be formed for a variety of generic object categories, including those for nonhuman animals. It is this type of representation that reflects the way a novice represents generic object category information. More generally, the argument is that core processes extracting the similarity structure of the environment may largely account for the representation of such categories.

With additional experience that comes in the form of large numbers of exemplars, or rich or lengthy interaction with a smaller number of exemplars, the summary representation is supplemented with information about individual instances, and it is in this process that the representation comes to take on an expert nature and acquires its attractor or magnet-like properties. More broadly, the claims are that differences in the frequency of exposure to different classes are needed to account for how infants represent humans, and what comes first may play an important role in structuring the perceptual field. The significance of such attractor representations for the larger course of cognitive development comes in their potential for organizing large portions of experience. That is, the inclusion

of nonhuman animals into the representation of humans may be an important step in the development of a broad, domain-level representation of animals in general. By this view, humans may be the glue that provides the coherence for the concept of animal.

Further Thoughts on the Longer Term Developmental Significance of the Infant's Representation for Humans

The incorporation of nonhuman animals into a representation by infants may remind some readers of the findings of Carey (1985), who reported that children reason about nonhuman animals on the basis of their similarity to a human prototype. Moreover, Inagaki and Hatano (1999, 2006), while discussing the Carey findings and related results of their own, attributed the outcomes to the more substantial knowledge that children have about humans relative to nonhuman animals. The argument here is that the seeds of the human-based inference or person analogy system of reasoning in children may be planted very early in development and may be rooted in infants' differential experience with humans versus nonhuman animals.

Does This Mean Humans Are Special?

The thesis advanced in the present chapter should not be construed as a "humans are special" argument. For example, there was nothing special about the human category that was stored in the long-term memory component of the computational network described earlier (Mermillod et al., 2004). This observation leads to the prediction that any category to which infants or children are exposed repeatedly could serve as an attractor for categories perceived to have some commonalities. In support of this idea is the finding that children who have experience raising goldfish use goldfish as well as humans as a basis for their projections about other animals in children's inductive reasoning tasks (Inagaki, 1990).

If humans are not special and pets such as goldfish can provide organizing information acquired about other animals, then one may ask whether infants with a cat or dog at home display expert-like processing advantages for the corresponding categories. The evidence on this question has been mixed, with initial reports suggesting no effect but subsequent studies that used more of an individual differences approach suggesting that there may in fact be an effect. Consistent with the argument advanced earlier in the chapter that learning about cats and dogs in the laboratory is based predominantly on online learning processes, first reports were that infants presented with a cat or dog category-learning task and with a cat or dog at home (that

was a match with the cat or dog category in the task) did not show advantages in preferential responding to a novel contrast category at either the basic or subordinate level (Quinn, 2004, 2010). These findings should perhaps not be viewed as surprising given that the infants experienced only a single exemplar of the category (the cat or dog pet) and because the richness, frequency, and duration of an infant's encounters with a pet would not be expected to match that experienced with humans. Moreover, anecdotal reports from parents who express concern over infants falling victim to the bite of a pet dog or scratch of a pet cat and who take steps to control and even limit infant-pet interactions are consistent with this expectation. An additional consideration when interpreting the null outcomes is that they may reflect to some extent a ceiling on novel category preferences. Such preferences tend to range between chance responding, at 50%, to above-chance novel category preference scores, in the range from 60% to 65%. Given that infants without pets already categorize nonhuman animal images at above-chance levels, that does not leave much room for a facilitative effect of a home pet to be measured on top of the already above-chance performance achieved without a home pet.

Other observations are consistent with the idea that a home pet can facilitate infant categorization performance, and some subsequent studies have provided support for these observations. In particular, single exemplars have been shown to have facilitative effects on category representation and induction tasks in the case of the caregiver's influence on the gender category in infancy (Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002) and the pet goldfish's influence on nonhuman animal categories in childhood (Inagaki, 1990). Moreover, Kovack-Lesh, Horst, and Oakes (2008) reported that experience with pets facilitated infants' categorization of cats and dogs. Notably, the effect was found only among a subset of the infants living in those households (i.e., those who actively compared the exemplars presented during familiarization) and was independent of whether the category learned during the laboratory familiarization session matched with the category of pet present in the household, although a follow-up study suggested that the effect is stronger when the cat or dog category learned in the laboratory matches with the type of pet at home (Kovack-Lesh, Oakes, & McMurray, 2012).

It will be interesting to determine in future work whether additional expert processing advantages (i.e., configural processing, attractor effects) accrue for infants being reared with a cat or dog in their household. Computational evidence suggests that at least in the case of attractor effects, the answer will be yes, as Rogers and McClelland (2004) reported that neural networks trained on dogs generalize broadly from dogs to goats and robins, although not to trees. One possible caveat on the prediction

is that the networks were trained on multiple dogs (not just single exemplars). It could be that such category learning is in part what serves to tune perceptual systems to features that will be useful to learning subsequently presented categories (Quinn & Tanaka, 2007) and gives rise to this type of expertise effect.

CONCLUSION

One may ask how the account advanced in this chapter connects with the broader themes presented in the volume as a whole. One theme of emphasis concerns social neuroscience, and recent evidence has begun to identify possible neural correlates that may be associated with the inclusion of nonhuman animals into a category representation of humans by infants (Marinović, Hoehl, & Pauen, 2014). Another theme of emphasis concerns the mechanisms by which humans develop companion relationships with nonhuman animals such as cats and dogs. The present chapter suggests that such relationships may develop in part because nonhuman animals are perceived to be like humans. It has been argued that infants and young children may compute similarity in relation to internal reference points to guide their responding in various domains of development. For example, infants may rely on a “like-me” representation when imitating the behavior of others (Meltzoff, 2007) and also rely on a “like-caregiver” representation when looking at the faces of others (Quinn et al., 2010). The results reviewed here suggest that infants and young children may use a “like-people” representation when developing their common-sense notions of animals and the biological world.

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The Social Neuroscience of Human–Animal Interaction

EDITED BY

Lisa S. Freund, Sandra McCune, Layla Esposito,

Nancy R. Gee, and Peggy McCardle

AMERICAN PSYCHOLOGICAL ASSOCIATION

WASHINGTON, D C

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