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INDUCTIONS, GENERALIZATIONS, AND EXTENSIONS:  
THE DUBIOUS ROLES OF SIMILARITY AND LANGUAGE IN THE  
DEVELOPMENT OF MEANING

by

Rachel Marsh

A dissertation submitted to the Graduate Faculty in  
Psychology in partial fulfillment of the requirements for the degree  
of the Doctor of Philosophy, The City University of New York

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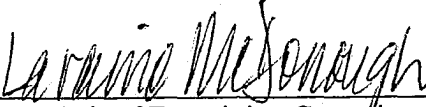
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This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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Abstract

Inductions, Generalizations, and Extensions:  
The Dubious Roles of Similarity and Language  
in the Development of Meaning

by

Rachel Marsh

Advisor: Professor Laraine McDonough

The goal of the current experiments was to investigate the relationship between conceptual development and language acquisition by assessing the roles of similarity, language, and function in the generalizations and extensions made by young infants and preschoolers. In Experiments 1 and 2 the inductive generalization technique as created by Mandler and McDonough (1993; 1996; 1998; 2000; McDonough & Mandler, 1998) was employed to study the inferences that 14-, 19-, and 24-month-old infants have made about the animal and vehicle domains. Atypical (e.g., an alligator and a shoveler) rather than prototypical (e.g., a dog and a car) exemplars of animals and vehicles were used to assess the roles that perceptual similarity (Experiment 1) and language (Experiment 2) play in infants' categorization abilities. The results of both experiments were consistent in that only the 24-month-olds attended to the perceptual similarity of the exemplars, generalizing more to the target exemplars (those of the same basic-level category as the exemplars used for modeling the activities). It is concluded that the generalizations of younger infants are not facilitated by language and that only older infants (24-month-olds) use either their knowledge of basic-level concepts or their knowledge of the

heuristic that items of the same shape usually have the same label to attend to perceptual similarity. The role of language in conceptual development was addressed further in Experiment 3 in which toddlers' extensions of novel words and functional facts were compared in order to explore the language-specificity or domain-generality of some of the proposed constraints in language acquisition. Results indicated that young children extend such facts as systematically as they extend novel words. It is concluded that when the functions of artifacts are made apparent, children derive meaning (semantic rather than episodic knowledge) through the use of domain-general processes that are not specific to language.

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## Chapter 1: Introduction

The objective of my research to date has been to investigate early concept formation in infancy and the manner in which language acquisition may or may not influence early concepts throughout development to the preschool years. Although research on early conceptual development has proliferated in recent years, our understanding of the infant mind is still quite limited and what we know only begins to answer the multitude of questions we still have. For several years, research on cognitive development stemmed from Piaget's theory that posited that infants in the sensorimotor period (i.e., before two years of age) are not capable of representation. However, through the work of many other researchers (e.g., Baillargeon, 1987; Meltzoff & Moore, 1977; Spelke, 1991; Mandler and McDonough, 1993; 1996; 1998; 2000), we have come to realize that this position is incorrect. Such research continues to suggest that Piaget likely underestimated the conceptual abilities of young infants. In general, infants are not limited to perceptual processes. For example, with their work on categorization, Mandler and McDonough (Mandler et al., 1991; Mandler & McDonough, 1993; 1996; 1998; 2000; McDonough & Mandler, 1998) have shown us that perceptual categories are not necessarily the first to be conceptualized developmentally. Category formation is not, as proposed by Rosch and her colleagues (1976), based purely on motor movements and perceptual similarity. Although similarity is a useful heuristic, the construct itself is based on shaky grounds, particularly in light of the developmental research on this topic showing that similarity changes with increased conceptual knowledge and language acquisition (Abecassis et al., 2001; Kemler-Nelson et al, 1995; 2000a; 2000b; Smith et

al., 2001). This questionable role of similarity in conceptual development is the first issue that I have focused on throughout my work.

The second focal issue has concerned the questionable role of language in category formation as well as the questionable influence of language on thought. According to Waxman and Markow (1995), words or labels constrain infants' generalizations and inductions by focusing their attention on the commonalities among objects, thus language facilitates the establishment of object categories, particularly at the superordinate levels. However, categorization at the global level has been found with young infants without the benefit of labels (Mandler & McDonough, 1993) and, as shown by Nazzi and Gopnik (2001), the effect of labels does not induce the formation of categories but may instead highlight the concept or categories already available to infants. Yet, it has not yet been made clear the degree to which learning concepts in general and/or language specifically influences basic-level categorization skills. Therefore, I have addressed this controversial topic by examining the effects of labels on the inductive generalizations of infants and toddlers.

My interest in the influence of language on conceptual development is what brought me to the next issues addressed in my research. First, the specific commonalities that young children focus on in naming and categorization, whether they are perceptual (e.g., overall shape; Landau, Smith, & Jones, 1988; Smith, Jones, & Landau, 1996) or more conceptual (e.g., function; Kemler Nelson et al., 1995; 2000a; 2000b), and second, the nature of the processes that are invoked during language acquisition. In regard to this latter issue, I have explored a current controversy in the literature concerning the language-specificity (Waxman & Booth, 2000; Behrend, Scofield, & Kleinknecht, 2001)

or the domain generality (Markson & Bloom, 1997) of some of the proposed constraints and biases in language acquisition.

## **Chapter 2: Induction and Similarity**

Our traditional views on early inferences and categorization in infancy and early childhood tend not to distinguish what something looks like from what kind of thing an object is. That is, most researchers agree that formation of early categories must be based on perceptual similarity because other relevant knowledge and understanding of objects is lacking in early infancy (Eimas & Quinn, 1994; Keil, 1991). Although similarity is a useful heuristic for older children and adults when faced with puzzling situations (e.g. Carey, 1985; Keil, 1989), it is not unprincipled or unchanging throughout development thus unlikely to be exclusively responsible for early categorization. Categorization of basic-level categories, defined as being based on perceptual similarity, has been demonstrated in 3-month-old infants using a preferential looking technique (e.g., Eimas & Quinn, 1994). It is therefore curious that older infants (e.g., 14- and 20-month-olds) do not also use this available cue but categorize according to kind (Mandler & McDonough, 1996; 1998).

At some point in development, infants form concepts about the world and these concepts, in turn, influence their perceptions of similarity in the same way that conceptual knowledge influences the similarity judgments of adults (Mandler & McDonough, 1996). For instance, if given three objects: a whole egg, a golf ball, and a fried egg, and asked to choose the two that are most “similar,” most of us would choose the two eggs in spite of the fact that they don’t look alike simply because the two eggs are the same kind of thing. Although the whole egg and the golf ball look most similar, our

knowledge of both objects can influence our conception of similarity (Keil, 1989; McDonough, 2002). After all, one would not seriously place an egg on a golf tee and proceed to hit it down the fairway. Our notions of similarity are not fixed because similarity matrixes are not consistently defined. If one considers overall shapes, a whole egg and a golf ball look alike and at some point in development an infant might treat them as belonging to the same category.

Evidence that notions of similarity change with development comes from experiments conducted by Landau, Smith, and Jones (1988; Smith, Jones, & Landau, 1996; 2002). They have shown that the shape bias, a dimension of perceptual similarity, is weighted more heavily and markedly from early childhood to adulthood. Shape is a cue that is not only most predictive of basic-level categories, but has been used in the definition of them as well (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). The data from Landau et al. (1988; Smith, Jones, & Landau, 1996; 2002) suggest that it is not until basic-level terms are acquired that shape becomes a salient cue. Prior to language acquisition, the use of the shape bias to define similarity is not as prevalent as previously thought.

At around the same time that shape becomes more salient and basic-level terms are learned, concepts about basic-level categories are also beginning to be formed (Mandler & McDonough, 2000). Prior to the formation of basic-level concepts, infants as young as 7 and 9 months of age have already begun to conceptualize animals and vehicles as different kinds of things, basing their categorization on conceptual differences as well as perceptual ones (Mandler & McDonough, 1993; 1996). Not only do they show an appreciation for the common relation among dogs, fish, and birds (that they are all

animals), but they also generalize the common properties that bind such a domain together (all animals drink). As demonstrated in experiments in which an inductive generalization technique is used, infants generalize such properties broadly across the respective domains and also tend to restrict their generalizations to the correct domain (Mandler & McDonough, 1996; 1998; 2000). For example, when shown a dog being put to bed, infants will put other animals to bed, but not vehicles, and when shown a car being keyed, they will key other vehicles, but not animals. Even more surprising, results show that infants will generalize across these broad domains to appropriate exemplars that they have never seen before, such as aardvarks and forklifts (Mandler & McDonough, 1996).

These results contradict the commonly held view that infants do not have concepts at the “superordinate” level, that they have only formed basic-level categories on the basis of perceptual similarity alone (e.g., Eimas & Quinn, 1994; Keil, 1991; Mervis & Rosch, 1981). Furthermore, the fact that the infants in Mandler and McDonough (1996) were reluctant to cross domain boundaries in their imitations even when the actions on inappropriate exemplars were modeled for them (e.g. giving a car a drink), implies that their generalizations are powerful ones. Infants are not like parrots in that they are not willing to imitate that which they do not deem appropriate.

It is important to note that different views of categorization in development (the traditional view that perceptually based basic-level categories are formed first (e.g., Eimas & Quinn, 1994; Keil, 1991; Mervis & Rosch, 1981) versus the view that more conceptual categories are formed first (e.g., Mandler & McDonough, 1996; 1998; 2000)), stem from the results of research involving different tasks and infants of different ages.

Given the changes that occur in the information processing abilities of infants as they develop, it is no wonder why the tasks employed with older infants would also change, becoming more complex. For example, Eimas and Quinn (1994) used a habituation-dishabituation paradigm to show that 3-month-olds, when shown 2-D pictures of horses, form a perceptual, basic-level category that distinguishes them from dogs and tigers. Many researchers looking at very early infant abilities have used variants of this procedure because it is appropriate to their developmental level in that it compensates for their limited motor skills (e.g., Diamond, 1985; Spelke & Newport, 1998). With slightly older infants (7-to-11-month-olds), other researchers have used object examination and sequential touching tasks with 3-D objects in order to measure infant sensitivity to category distinctions (Mandler & McDonough, 1993; Oakes, Madole, & Cohen, 1991; Mandler & Bauer, 1988). These researchers have demonstrated that infants, before their first year of age, overlook perceptual variations thus suggesting that they categorize conceptually, on the basis of animal and vehicle domains. Mandler & McDonough's (1996; 1998; 2000) inductive generalization procedure, more complex in that it involves the imitation of properties modeled on 3-D objects, has been used with 1-to-2-year-old children. In addition to measuring the boundaries of children's categories, this procedure measures the extent to which children extend properties of category members to one another. That is, it measures infants' conceptual understanding. The results of these experiments have shown that even infants as young as 9-months categorize objects in terms of what kinds of things they are, at the superordinate level first (McDonough & Mandler, 1998).

In their previous experiments using the inductive generalization procedure, Mandler and McDonough used a dog for modeling animal properties and a car for modeling vehicle properties. These exemplars, dogs and cars, are both highly typical of animals and vehicles. The question remained whether infants would continue to generalize in the same manner if they see actions modeled by a less typical member of a domain. Although the answer to this question is unknown, research by Bauer, Dow, and Hertsgaard (1995) showed that prototypicality can play a role in the categorization abilities of infants as young as 13- and 16-months. Prototypical exemplars are those that have the greatest number of attributes in common with other members of the category to which they belong, and the fewest number of attributes in common with members of contrasting categories (Rosch & Mervis, 1975). It follows that categories composed of such prototypical exemplars should provide greater within-category similarity and clearer between-category contrast, and thus should facilitate differentiation. Whereas these prototypes are perceptually based in regard to the basic level, they are more conceptually based at the superordinate level in that choosing them involves some understanding of the world. For example, a German Shepard is recognized as a prototypical dog because of its specific perceptual features. However, as adults we know that a dog is a prototypical animal due to our understanding of and experience in the world. After all, dogs are among the most common animals that we see in everyday life.

Bauer et al. (1995) thus varied the prototypicality of the exemplars that comprised the object sets in their sequential touching tasks in order to see if prototypicality effects operate in parallel at both the superordinate and basic levels. At the superordinate level, a categorization task contrasting prototypical animals (e.g., a pig, cat, dog, and cow) and

vehicles (e.g., a school bus, motorcycle, pick-up truck, and sedan) was compared to a task contrasting nonprototypical animals (e.g., an alligator, snail, rhinoceros, and ostrich) and vehicles (e.g., a wooden canoe, armored tank, battleship, and space shuttle). At the basic level, Bauer and her colleagues contrasted, for example, prototypical dogs (e.g., a German Shepherd, collie, and Labrador retriever) with prototypical fish (e.g., a bass, trout, and salmon) and nonprototypical dogs (e.g., a bulldog, Chihuahua, and Spitz) with nonprototypical fish (e.g., an eel, sunfish, and nurse shark).

Infants (13- to 28-months) behaved systematically toward categories of prototypical exemplars at an earlier age than toward categories of nonprototypical exemplars. Furthermore, the gap between categorization of the prototypical and nonprototypical exemplars narrowed first at the superordinate level of contrast and later at the basic level of contrast. With nonprototypical exemplars, whereas both of the older age groups of children in this study (24- and 28-months) performed systematically on the global-level sets, only the 28-month-olds did so on the basic-level sets. Therefore, Bauer et al (1995) concluded that prototypicality has a pronounced effect on categorization throughout the second year of life.

Carey (1985) demonstrated that the generalizations of older children (4- and 10-year-olds) and adults are influenced by similarity and typicality factors. The children in her study were willing to project or generalize novel properties to other items only when they construed them as being similar to the exemplar. For example, on being told that an X has “omentum” inside it, children were more likely to project the property of “omentum” to items similar to X and more typical of the domain to which X is a member. In other words, they made their judgments by comparing each item to the exemplar on

which they were taught the property. Interestingly, these children demonstrated asymmetries in their judgments. While they generalized quite broadly when the exemplar was more prototypical of the animal domain (e.g. a dog), their generalizations were much more constrained when the exemplar was less similar to the entire domain (e.g. a person). However, it could be argued that the children in Carey's study (1985) were less willing to generalize the property to other members of the person domain because people constitute a more coherent category. It is a more salient and significant category in terms of their every day experiences. Nonetheless, such asymmetries in generalization, which would reflect similarity and/or typicality effects, have not yet been systematically explored in younger infants except in the domain of language (e.g., Meints, Plunkett, & Harris, 1999).

Using a preferential looking task to examine language comprehension, Meints et al. (1999) tested infants ages 12, 18, and 24 months, for typicality effects and found that infants do not embrace the naming of atypical exemplars until their second year of life. When the targets in their experiment were named, the 12-month-olds displayed an increase in looking for the typical but not the atypical targets and the 24-month-olds displayed an increase for both. Consistent with Bauer et al (1995), Meints et al (1999) have also demonstrated the pronounced effect that typicality can have on categorization throughout the second year of life. Interestingly, Meints et al (1999) showed that infants, like the older children in Carey's (1985) study, also demonstrate asymmetries in their judgments. That is, infants younger than two years are willing to connect names to typical examples of objects and animals, but are unwilling to connect names to the atypical. At 2-years of age, they connect the names to both.

In Experiment 1, I looked at inductive generalization in infancy, replicating the study conducted by Mandler and McDonough (1998) with an important twist. Mandler & McDonough modeled actions using prototypical animals (e.g. a dog), demonstrating that infants generalize from what they know to that which is unfamiliar to them (e.g. an aardvark). Infants' willingness to generalize activities seen on a dog to an aardvark suggests that they have construed the modeling event along the lines of "I saw an animal drinking." If, however, an infant is shown an action or property with an unfamiliar item, will they construe the situation in the same way? Will they still construe the modeled event as "animal drinking" and imitate it using the appropriate exemplars? Therefore, we modeled actions with atypical rather than typical members of a domain (e.g., an alligator rather than a dog, a shovel rather than a car). Differential treatment of the generalizations or unwillingness to generalize appropriately in response to this change would imply that infants show asymmetries in their categorization abilities (as well as in their language comprehension, Meints et al., 1999). Most importantly, we wanted to see what role, if any, perceptual similarity would play in infants' inductive generalizations when they were shown actions modeled by atypical rather than typical members of a domain. Therefore, the infants were given both perceptually similar exemplars and perceptually dissimilar distractor objects to use in their generalizations. For example, when shown an alligator drinking, they could choose to imitate the event with either another alligator (an exemplar from the same basic-level category) or a cheetah (an exemplar from a different basic-level category).

### Chapter 3: The influence of language on thought

The linkage between linguistic and conceptual organization in development has been the focus of research by Waxman and her colleagues (Balaban & Waxman, 1997; Waxman & Gelman, 1986; Waxman & Markow, 1995). According to Waxman and Markow (1995), words or labels constrain infants' generalizations and inductions by focusing their attention on the commonalities among objects. In so doing, labels facilitate the establishment of object categories, particularly at the superordinate levels. Although the effect of language on basic-level categorization has also been reported (Balaban & Waxman, 1997), the evidence for its facilitative effect on superordinate categorization is deemed stronger because, as implied by the traditional view of categorization in infancy (e.g., Eimas & Quinn, 1994; Keil, 1991), basic-level categorization appears earliest in infancy thus it should not require additional cues such as language. Similarity alone should suffice. Using a novelty preference paradigm, a task used to assess how infants categorize various objects, researchers have found that the introduction of labels facilitated infants' categorization of both the superordinate (Waxman & Markow, 1995) and basic-level (Balaban & Waxman, 1997) object sets.

In their later studies, 9-month-olds were familiarized to a series of pictured objects from the same basic-level category (e.g. slides of rabbits). For those in the word condition, the slides were presented in conjunction with the appropriate label (e.g. "rabbit"). Those not in the word condition heard a tone in conjunction with each slide. At test, all of the infants viewed two slides, one depicting a new member of the familiar category (e.g., another rabbit) and the other depicting a member of the novel category (e.g., a pig). Balaban and Waxman (1997) reasoned that if infants form object categories

in this task, they should reveal a novelty-preference at test. According to their data, the infants in the word condition showed a greater preference for novelty (e.g., attended more to the pig) than those in the tone condition. Therefore, Balaban & Waxman (1997) concluded that labels, although presumably novel to the 9-month-olds in their study, make the members of the same basic-level category more salient to the infants. This increased saliency resulting from labeling is what, according to Waxman and her colleagues, facilitates categorization.

However, previous researchers have employed preferential-looking paradigms to test language comprehension making opposite predictions (Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987; Naigles, 1990; Choi, McDonough, Bowerman, & Mandler, 1999). The child looks at scenes while listening to verbal input and comprehension is measured by comparing looking time to the scenes that do and do not match the verbal input. In these studies the children are said to have demonstrated comprehension or learning by looking longer at the matching screen than at the non-matching screen. That is, on hearing a label, children look longer at the display that matches the label. In contrast, Balaban and Waxman (1997) claimed that the infants in their study demonstrated an appreciation of a label (or recognition) by looking at the non-matching (novel) rather than matching slide-upon hearing one.

Waxman and her colleagues (e.g., Waxman et al., 1986; 1995; Balaban & Waxman, 1997) argue that labels facilitate categorization, particularly at the superordinate levels. However, we know that categorization of superordinate/global categories is found with young infants without the benefit of labels (albeit with a few more familiarization trials, Mandler & McDonough, 1993) and as shown by Nazzi and

Gopnik (2001), the effects of labels do not induce the formation of categories but may instead highlight the categories or concepts already available to infants. Therefore, we conducted Experiment 2 to test the claim that labels facilitate categorization (e.g., Waxman et al., 1986; 1995; Balaban & Waxman, 1997) by adding labels to our inductive generalization procedure (e.g., “the alligator is thirsty... have a drink alligator!”). We hypothesized that if the children in Experiment 2 generalized differently (i.e., to members of the same basic-level category more often) than those in Experiment 1, the difference would be due to the effect of labeling.

Interestingly, Booth and Waxman (2002) have very recently conducted two experiments demonstrating a much subtler effect of labels on categorization. These researchers showed young infants novel category exemplars along with a demonstrated function, a novel name, or no cue at all. When asked to “find another one,” infants at both ages (14- and 18-months) were more likely to select the category match when they were given a hint regarding the core meaning of the object (e.g., shown its function). Furthermore, the novel names only facilitated the categorization abilities of the 14-month-olds when they were presented along with such hints about function. In light of these recent findings, Booth and Waxman (2002) now explain that unlike object functions, names bear an arbitrary relation to the objects that they denote. As a result, a name cannot provide a core meaning directly for young infants and cannot, in and of itself, facilitate categorization. This explanation clearly runs contrary to Waxman’s earlier claims regarding the facilitative effect of labels (e.g., Waxman et al., 1986; 1995; Balaban & Waxman, 1997).

One possible reason for this inconsistency among Waxman's findings is the fact that the objects used in this latter study (e.g., Booth & Waxman, 2002) were novel whereas those used in the former studies were familiar to most infants (e.g., rabbits, pigs in Waxman & Balaban, 1997). Booth and Waxman (2002) suggest that such differences in the familiarity and meaningfulness of the stimuli may have been responsible for the smaller effect of the labels in their study. Infants may already have some core meaning associated with the familiar objects used in the previous studies (e.g., Balaban & Waxman, 1997), perhaps in the form of domain membership or underlying causal structure. In contrast, Booth and Waxman (2002) used novel objects for which infants could have no knowledge of any such core meaning. For young infants (14 months of age), labeling only facilitates categorization when accompanied by cues regarding the core meaning of novel objects (e.g., demonstrated function). These researchers go on to explain that by 18 months of age, once they are beginning to acquire more extensive lexicons, infants may begin to understand that labels or names typically refer to commonalities among objects even when the core meanings of those categories are not obvious. This is consistent with recent evidence demonstrating that by their second birthday, infants use names to categorize and to guide their inductive inferences regarding the non-obvious properties of objects (Nazzi & Gopnik, 2001; Welder & Graham, 2001).

Nazzi and Gopnick (2001) used an object manipulation task to assess infants' ability to map a novel label to an object and then use the label to form new object categories. In other words, their goal was to determine whether infants would pair together unfamiliar objects that receive the same name. Nazzi and Gopnick (2001)

exposed all the infants in their study (16- and 24-months) to both visual and naming trials (two blocks of three different trials, six trials in total). The object sets for the visual trials consisted of a pair of identical objects and a third that differed perceptually, whereas those used for the naming trials consisted of three very distinct objects (differing in shape, color, and texture), two of which received the same name. Therefore, the objects in the naming condition could only be categorized on the dimension of naming. The experimenter spoke to the infant during the presentation of each object, saying either “look at this one” for the visual trials or “look at this ‘tib’” for the naming trials. At test, the experimenter held up one object of the visual or named pair and asked the infant to give him “the object that goes with this one.”

Nazzi and Gopnick (2001) found that whereas the 20-month-olds used naming information to categorize the objects, the 16-month-olds did not. The younger infants showed above chance performance when exposed to visual information, but only chance performance when given naming information, indicating that they used the visual but not the naming information to categorize the objects. Nazzi and Gopnick (2001) interpreted their results in light of correlation analyses that showed that name-based categorization is related to productive vocabulary size. That is, older children, with larger productive vocabularies, are more likely to categorize based on names. This is an important point that will be discussed in the following chapter in which some research on naming and categorization in young children is reviewed.

#### **Chapter 4: Word extensions: Perceptual vs. Conceptual Biases**

As adults, labels highlight categories that share properties with the labeled object thus on hearing a label we tend to focus on the commonalities among objects. The

specific commonalities that young children focus on in naming and categorization, whether they are perceptual (e.g., overall shape; Landau, Smith, & Jones, 1988; Smith, Jones, & Landau, 1996) or more conceptual (e.g., function; Kemler Nelson et al.; 1995; 2000a; 2000b) is a major issue debated in the literature on lexical categorization.

Although we know that concepts permeate percepts, when this happens in development is still unclear. According to Landau et al. (1988) and Smith (1996), labels or names recruit attention to salient perceptual properties, particularly overall shape. Labeling or naming considered as nothing more than a “dumb attentional mechanism” in young children, driven by automatic associations. These researchers found that when similarities in function and in appearances were pitted against one another, children 3-years and younger generalized names based on whatever aspects of appearance were made perceptually salient, regardless of whether properties of the test objects were functionally relevant or not. Lexical categorization, even for 5-year-olds, was guided by the property of shape. Furthermore, when the function of the objects was clearly demonstrated (e.g., Landau, Smith, and Jones; 1998) these researchers found that 2-year-olds continued to extend word meanings on the basis of shape even when a function, such as a sponge soaking up water, was demonstrated and objects sharing that function (but not sharing shape) with the standard objects were available. Smith and her colleagues (Landau et al., 1988; 1998; Smith, 1996) claim that young children are immune to functional information, the use of which points to conceptual knowledge because it cannot be inferred from perceptual appearance alone. Instead, children’s use of names is “attentionally encapsulated,” driven by attention to perceptually salient properties, particularly overall shape, and automatic associations (Smith, 1996).

This view that perceptual appearances, specifically a “shape bias,” guides young children’s lexical categorization runs counter to claims made by Kemler Nelson and her colleagues (1995; 2000a; 2000b) who have demonstrated that young children do in fact use knowledge of function in lexical categorization. Although they will use perceptual information in naming, the perceptual properties that they attend to are conceptually mediated. Kemler Nelson and her colleagues (1995; 2000a; 2000b) stress the relationship between the structure and the function of artifacts, explaining how the appearances of artifacts tend to be highly correlated with their intended functions. This leads to the distinction between intended function (that intended by the object’s designer) and current functions, those that can be dependent on particular features of the artifact. For example, we know that a broken chair that is missing a leg is still a chair because we are aware of its intended function. Although its current function has changed in that it will no longer afford sitting on, the fact that it is missing a leg would not lead us to call it by another name. It has therefore been argued that intended function (the function intended by the object’s designer), rather than current function, is closer to the core of mature artifact categories (Bloom, 2000; Kemler Nelson, 2000a).

Adults will infer category membership on the basis of function rather than appearance when the two are pitted against one another. For example, Keil (1989) presented adults with pictures of common artifacts (e.g., tools such as screwdrivers and hammers) that, in one case, the item looked very much like the conventional artifact but provided a different function and, in another case, it looked different but functioned in the conventional way. Although adults considered the latter to be members of the artifact

category (e.g., tools), they treated those that provided different functions as non-members.

Developmental research by Kemler Nelson, Morris, and Herron (2001) examined how children between 4- and 10-years of age lexically categorize objects that have different intentional origins. The researchers had the children name modified instances of familiar categories, half of which were damaged so that the accident prevented them from functioning as intended (e.g., a torn envelope). Other objects were “intentionally dysfunctional” in that structural features that appeared to be elements of design prevented them from carrying out the category-typical function (e.g., an object that looks like a safety pin but is not). Kemler Nelson et al. (2001) found that even 4-year-olds were more likely to extend the familiar category name to the damaged objects than the intentionally dysfunctional objects, suggesting that even young children use the conceptual criterion of intended rather than current function as the basis for categorizing artifacts.

When the intended function of an object is difficult to infer, the only thing left to go by is the current function, that which can be derived from the object’s appearance. It is in this way that appearances play a role in categorization. Appearances matter to the extent that they can help in evaluating whether the current functions were the intended ones (Kemler Nelson, 2000a). It has also been demonstrated that young children tend to expect objects similar in overall appearances to have the same functional properties (Baldwin, Markman, & Melartin, 1993). Even early on, when they are first beginning to acquire basic-level terms, they are quite sensitive to the relationship between structure and function in the context of naming. They will frequently hear a name for an object whose function is easily understood and whose appearance is related in compelling and

understandable ways to its function (e.g., a toothbrush or a dishwasher or a notebook).

Kemler Nelson et al. (2000b) explain how this relationship between structure and function may provoke young children to link names with functions and, at the same time, make sense of the relationships between the names, functions, and appearances of objects.

It is the contention of these researchers that children will attend more to function than appearances in lexical categorization tasks when the relationship between the structure and the demonstrated function of an object is compelling, easily perceived, and easily understood (Kemler Nelson et al., 2000a). Kemler Nelson et al. (2000a) conducted a study for which they designed novel artifacts to be used as stimuli. Each of the artifact sets contained a standard that was designed with a particular function in mind and two test objects that were used to evaluate the basis for categorization (i.e. similar appearance versus similar function). Within the test pairs, a functional object was only moderately similar-looking to its standard but functioned like it and a dysfunctional object was more similar-looking to the standard but could not provide the designated function. For example, the “becket” was designed to dispense balls one at a time when several of them are loaded into its vertical tube. The test set that went with this standard consisted of a functional object that looked rather different but maintained the same function and a dysfunctional object that looked similar but could not be loaded with balls and did not have a hole in its vertical tube for dispensing them. Kemler Nelson et al. (2000a) examined the data to see if 4-year-olds’ tendency to use functional information as a basis for name generalization depended on whether or not the demonstrated function was plausibly linked to the function intended by the object’s designer. They created two

experimental conditions: the plausible-function condition in which the functions of the standard objects were demonstrated with the functions for which they were intentionally designed, and the implausible-function condition for which new functions were created for the same objects. These functions were “implausible” in that they provided less compelling causal accounts of aspects of the objects appearances. For example, when the “becket” was described and demonstrated for the children in the implausible-function condition, they were told, “a toy snake can wriggle in it,” and then shown a toy snake being inserted into its vertical tube. Kemler Nelson et al. (2000a) obtained adult ratings of these stimuli in order to ensure that the functions designated plausible were more compelling as explanations of the designers intentions than those designated implausible.

After the standard objects were labeled for the children and their functions were described and demonstrated relative to the condition (plausible or implausible), the functional and dysfunctional test objects were presented one at a time. For both conditions, the functional objects provided the same function (plausible or implausible) as the standard and the dysfunctional objects did not. For example, in the plausible function condition a dysfunctional “becket” could not be loaded with balls (the function for which it was originally intended) and in the implausible condition a snake could not be inserted into its tube. After placing the two test objects (one functional and one dysfunctional) in front of the child, the experimenter elicited a test response by saying, for example, “one of these is a ‘becket’ and the other is not. Can you tell me which one is a becket?” Recall that Kemler Nelson et al. (2000a) were specifically asking whether young children shown plausible functions, relative to those shown implausible ones,

would be more willing to use the demonstrated functions as a basis for name generalization.

The results of this experiment showed an influence of intentional considerations on children's lexical categorization of artifacts. Whereas the children for whom the implausible functions were demonstrated made functional and dysfunctional choices equally often, those for whom the plausible functions were demonstrated extended the name to the functional test objects more often. According to Kemler Nelson et al. (2000a), their results point to the role of the compellingness of the structure/function relation as being critical. Categorization by function is more likely to occur when the object's appearance helps to make sense of the object's intended function. When the demonstrated functions that were not convincing accounts of why the objects had the perceptual properties that they did (e.g., the implausible-function condition), the young children in this study were less likely to privilege functional information over shape or overall appearance as a basis for generalizing an artifact name.

Kemler Nelson et al. (2000a) also demonstrated that categorization by function is more likely to occur when children are not pressed to respond impulsively. When they manipulated response tempo they found that the children who generated names slowly and deliberately named objects based on function (e.g., chose the functional rather than dysfunctional test object more often). However, children who generated names rapidly and unreflectively generalized names based on appearance rather than function. Kemler Nelson and her colleagues (2000a; 2000b) thus proposed that function-based naming entails conceptual processing and conceptual processes. When compared with perceptual processes, conceptual processes are much slower. Furthermore, they also suggested that

this result is compatible with their suggestion that children's lexical categorization is more mindful and adult-like with conceptual underpinnings. In contrast to Smith and her colleagues (1996; Landau et al., 1988) who have suggested that young children may be influenced by functional information, but only in a reflex-like, non-conceptual way (i.e., encapsulated processes), Kemler Nelson and her colleagues (1995; 2000a; 2000b) argue for continuity between how children and adults name and categorize artifacts.

Apparently, when given time to reflect on the situation, labeling or naming in children is not a "dumb attentional mechanism."

However, in a more recent paper, Smith et al. (2001) slightly modified this position. Although they still claim that children will extend new names for unfamiliar objects based on perceptual appearances, they now clarify that it is the experience of learning names (the "on-the-job training"), rather than the names themselves that focuses children's attention to shape. These researchers carried out a longitudinal study in which toddlers at 17-months of age were taught specific names of things in artificial categories that were organized by shape. After weeks of training, they first tested the children's mapping of names to three novel objects that each differed from a given exemplar either in shape, color, or texture. To see if the toddlers knew that the novel names spanned a whole category of similarly shaped things, the researchers used the same mapping task but used four completely novel lexical categories. The names, exemplars, and test objects were all novel for this test and, again, one test object matched the exemplar in shape only, one in color only, and one in texture only. Finally, Smith et al. (2001) assessed whether learning to attend to shape in the context of naming resulted in accelerated object name acquisition in general. As indicated by parental reports, the data suggested that teaching

the children names for four artificial categories, each well organized by shape, accelerated the learning of object names outside of the laboratory. That is, Smith et al.'s (2001) data suggested that overall vocabulary growth is correlated with learning the heuristic that shape correlates with object labels. As you will see, this later finding is more in line with the results of our studies using the inductive generalization procedure (Experiments 1 and 2).

Although Smith and her colleagues seem to have modified their earlier stance regarding the role of labels, now putting the emphasis on the learning of the labels rather than the labels themselves, they continue to report that children focus on perceptual rather than conceptual commonalities when naming and categorizing artifacts (2001). In other words, these researchers shun the possibility that children may be searching for meaning when they extend names. Kemler-Nelson and her colleagues, however, acknowledge the conceptual curiosity of young children, arguing that they actively search for meaning. When acquiring words, children attend to conceptual (e.g., functional) rather than perceptual commonalities. Interestingly, Kemler-Nelson has systematically shown us what Katherine Nelson (1974) has been telling us all along, that semantic knowledge has its roots in the function of objects and how objects are used in everyday events. That is, children's linguistic concepts derive from their understanding of what one can do with an object and what that object can do.

Although there has been much speculation that children's inductions about artifacts differ from those about natural kind categories, I'd first like to go over some research on the latter before I return to a discussion of the former. As will be made evident, children seem to rely on essential information (psychological essentialism views

will be discussed below) when making inductions about both. Whereas for natural categories this information has to do with the genetic and biological properties of living entities (Gelman & Markman, 1986, 1987; Gelman & Wellman, 1991), for artifacts the essential information has to do with their intended functions (Bloom, 2000; Kemler Nelson et al., 2001).

#### **4.1: Natural Kind Categories**

Everyday thought is theory-like in the sense that we make use of unobservable, causal-explanatory constructs in order to explain the everyday events that we see (Gelman, Coley, & Gottfried, 1994). For example, we refer to gravitational forces in order to explain why dropping a rock from some height will cause it to propel downwards. Similarly, we refer to genetic dispositions and innate potential in order to explain properties of living things. Both gravity and genes are unobservable but explanatory constructs. Such constructs or “theories” lead us to classify together or categorize entities that share the same theory-relevant properties. For example, adults tend to classify plants and animals together into a category of living things because we believe that both grow, need water, and reproduce. Furthermore, we tend not to classify together things that look the same but differ in theory-relevant properties (i.e., we exclude whales from the category of fish because of underlying differences such as breathing ability and blood temperature.) The unobservable property of the intended functions of artifacts (as shown by Kemler Nelson and her colleagues, 1995; 2000a; 2000b) works in a similar way in that it is also an explanatory construct that we can use to classify together things that share the same function, in spite of differences in perceptual appearances. According to Kemler Nelson et al. (1995), the central role of intended

function in artifact categories is akin to the central role of genetic and biological properties shared among entities within categories of living things.

Much research has been conducted on children's theory-like beliefs about natural kinds with results that are discussed in line with what Medin termed "psychological essentialism" (Medin & Ortony, 1989). Gelman, Medin, and their colleagues (Diesendruck, Gelman, & Lebowitz, 1998; Gelman, 1998, Gelman, Coley, & Gottfried, 1994; Gelman & Markman, 1986, 1987; Gelman & Wellman, 1991; Medin & Ortony, 1989) claim that people, adults and children, have a belief that certain categories, especially natural kinds, have some essential non-obvious properties that determine what a category is. Keil (1989) and Gelman and Wellman (1991) showed that children believe that the identity of an animal changes only if its internal, and presumably essential, properties are changed. Keil (1989) told kindergartners, second, and fourth graders a story about a raccoon that underwent a transformation that made it look like a skunk (e.g., had its fur shaved and dyed). He found that children in the second grade (8-year-olds) insisted that the animal was still a raccoon. Gelman and Wellman (1991) presented 4- and 5-year-olds with transformations that involved the removal of insides (e.g., the stuff inside an animal such as bones and blood) or the removal of outsides (e.g., the animal's fur). They then asked the children if the item would still be the same and still be able to function after the transformation. Gelman and Wellman (1991) found that, as predicted, most of these children said that the identity and functioning of an item would change if its insides were removed. This was not so for the outsides, even when the removal sharply changed the object's appearance. Both of these studies demonstrate that children realize

that the features most critical or essential to an object's identity may be internal and non-obvious, reflecting underlying properties.

Other evidence for essentialist beliefs in children comes from induction studies in which category membership is pitted against perceptual similarity (Carey, 1985; Gelman & Markman, 1986; 1987). These studies demonstrate that children do not rely solely on perceptual similarity for drawing inferences, but rather on underlying essential properties. For example, Carey (1985) showed groups of children (ages 4- to 10-years) a mechanical monkey that could move its arms and bang cymbals together. She then asked the children whether they thought the monkey could breathe, eat, and have baby monkeys. In spite of the perceptual similarity between this monkey and real monkeys, all but one of the 4-year-olds denied that it possessed these animate properties. Having differentiated living things from non-living things, the children were unwilling to generalize essential properties of the former to the latter (see Massey & Gelman, 1988 for more evidence with younger children). The essentialist assumption, like a theory, leads to the expectation of non-obvious similarities among category members (unobservable but essential properties) and unlimited inductive potential (Gelman et al., 1994). Although experimental evidence for an essentialist world-view is most abundant in the biological domain, Gelman et al. (1994) maintain that preschool children seem to have or make it in a variety of other domains as well. That is, children assume that events and features are caused and tend to search for internal or inherent (but unobservable) causal mechanisms. In the domain of artifacts, the causal mechanisms that children search and rely on when making inductions about category membership are the functions of the objects in question.

## 4.2: Intended Function

Artifacts (e.g., human-made entities such as chairs and clocks) seem to be categorized on the basis of the creator's intent, according to their intended functions. Before speculating as to how young children learn the names for such categories, we should first look at the nature of adults' understanding. Chairs and clocks come in a range of different sizes: there are beanbag chairs, basket chairs, chairs for dolls; there are grandfather clocks, digital clocks, and clocks shaped like coke bottles. What makes these things all chairs and clocks does not reduce to facts about their appearance (Bloom, 2000). However, the current functions of such artifacts are not necessarily what defines them as chairs and clocks either. Although chairs are things that we sit on and clocks are things that tell time, one could also sit on a desk or the floor as well and some people can tell time by looking at the position of the sun in the sky. Furthermore, we would still call a broken chair that is missing a leg a chair and a broken clock a clock even though it can no longer tell the time. A chair is something that was built with the intention that people sit in it and a clock is something that was built with the intention that it tells the time. Therefore, it is safe to say that intended function is a much better cue to artifact-kind membership than current function. In fact, in studies in which intended function and current function are pitted against each other, intended function wins out (Hall, 1994; Keil, 1989; Rips, 1989). Bloom (2000) points out that such a theory based on intended function is also able to account for our intuitions that a floor is not a chair and the sun in the sky is not a clock, but a broken chair and a broken clock remain a chair and a clock respectively.

Researchers who have asked whether children have this same essentialist understanding of the intended function of artifacts have done so by exploring how children extend artifact names. As described above, Kemler Nelson and her colleagues (2001) maintain that children, like adults, use the conceptual criterion of intended rather than current function as the basis for categorizing and naming objects. Bloom and Gelman (2000) have also shown us that preschoolers are more likely to provide names for human-made artifacts that they believe to have been intentionally rather than accidentally created. These researchers showed young children (e.g., 2- to 6-year-olds) and adults a series of simple objects (e.g., a knife, a toy, and a painting) that were either described as purposefully created or created by accident. The experimenter then simply asked the participants what the objects were (e.g., 'what is it?'). Consistent with their hypothesis, even the 3-year-olds were more likely to provide artifact names (e.g., 'it's a knife') when they believed the objects were intentionally created and material-based names (e.g., 'it's plastic') when they believed the objects were accidentally created. Gelman and Bloom (2000) concluded that intuitions about intention play a very important role in artifact naming.

Also bearing on this issue, Paul Bloom and his colleagues have conducted a series of experiments looking at how children name pictorial representations (Bloom & Markson, 1998). They have demonstrated that young children are more willing to name pictures that are drawn intentionally (either by themselves or by the experimenter). In one study with 4- and 5-year-olds, two objects (e.g., a fork and a spoon) were placed in front of the child, one to the left and one to the right. The experimenter looked intently at one of the objects (e.g., the fork) and appeared to draw a picture of it. However, the

picture was actually pre-drawn to look equally like both of the objects. The picture was then placed between the two objects and the child was asked what it was of.

Interestingly, over 90 percent of the time, the children's answers depended on what they thought the experimenter was intending to draw. That is, if she had been looking at the spoon while drawing it, the children called the picture a spoon and if she had been looking at the fork, they called it a fork. However, in a control condition, in which the children did not watch the experimenter draw the picture, the children responded randomly when asked to name it. In another experiment, the experimenter asked 3- and 4-year-olds to draw pictures of a balloon and a lollipop on two separate sheets of paper. After a pause in which the child and experimenter engaged in another activity, the experimenter rediscovered the drawings and asked the child to name them. Note that like most drawings created by young children, they did not look much like balloons or lollipops. However, when asked to name the drawings, the children did so on the basis of what they had intended to represent. Furthermore, the responses were not subtle. A child would insist, for example, that one was a balloon and rigorously correct the experimenter if she called it a lollipop even though the picture looked equally like either object.

According to Bloom (2000), how children name pictures has implications for a theory of naming in general. Although his findings are inconsistent with the brute-shape proposal that children are limited to extending names on the basis of shape (e.g., Landau, Smith, & Jones, 1988; Smith, Jones, & Landau, 1996), shape is a good cue to what a pictorial representation should be called because it is a cue to the intent of the artifact's creator. Therefore, in regard to the discrepancies between Smith's findings and those of Kemler Nelson, Bloom (2000) proposes "a change in perspective - moving away from

putting shape and function against each other and instead exploring the extent to which they serve as cues to underlying intent” (p. 166). This proposal, that children infer intent when naming artifacts is consistent with Gelman’s (1994; 1986, 1987; 1991) assertion that children are little essentialists, seeking to understand the properties of objects in terms of the deeper, essential aspects of their nature. In the domain of human-made artifacts, these essential aspects are their intended functions. That is, children name and categorize objects on the basis of their intended functions.

To summarize, there are many issues that have been discussed thus far and all continue to be highly debatable topics in the literature. First, to be addressed in Experiment 1, is the highly questionable role of similarity in the inductive generalizations of infants. Second, to be addressed in Experiment 2, is the theoretical relationship between concepts and words. That is, I assess the role of labeling in infants’ categorization abilities, how it changes (or remains the same) up to the second year of age (Waxman et al., 1986; 1993; 1995; Balaban & Waxman, 1997; Welder & Graham, 2001). Third is whether or not the categories underlying children’s names for things are perceptual or whether, like adults, they have conceptual underpinnings. In other words, how do children infer meaning from the words that they are exposed to in reference to objects in the world around them? Lastly, I have pointed out that perhaps children are essentialists searching for causal mechanisms that, in the domain of artifacts, pertain to the intended functions of such human-made objects. However, in spite of these ongoing debates, it is well agreed that young children are amazingly efficient word learners (Carey, 1982; Au & Markman, 1987).

### **Chapter 5: Constraints or biases in language acquisition**

Language learning is an induction problem. Children must be able to figure out the goals and intentions of those speaking to them, the appropriate aspects of the environment that are being referred to, and then be able to generalize what they have learned to new situations. To explain how it is that young children are such efficient word learners in spite of this problem, researchers have proposed that children are equipped with certain assumptions, biases, or constraints that allow them to infer the meaning of words fairly quickly (Quine, 1977; Markman & Hutchinson, 1984; Woodward & Markman, 1988). That is, children can fast map, they assume that labels refer to whole objects as well as to taxonomies, and they use strategies such as mutual exclusivity and the principle of contrast to sort out the words that they are learning. Both fast mapping and the taxonomic assumption are described in the following paragraphs. Mutual exclusivity refers to the child's tendency to assume that an object has only one name (Markman, 1990) and the principle of contrast refers to the child's assumption that every name has only one meaning (Clark, 1983). An in depth description of these latter two strategies is unnecessary for the purposes of the current research and as such will not be discussed further.

It is important to note that these proposed constraints are based on the supposition that young children who are learning language begin with a rich conceptual structure (Woodward & Markman, 1988). That is, even young infants already have a rich repertoire of cognitive accomplishments prior to learning language. The emphasis on the amount of learning that takes place prior to or near the onset of language acquisition posits a rather intriguing puzzle: Are the processes used for early cognitive

accomplishments available to assist children in acquiring their first language (i.e., a domain general account)? At some point, one must presume that general cognition contributes meaning (semantics) to the lexicon. However, if there are language-specific learning mechanisms, then how should we parse the processes that are domain specific from those that are domain general? The two constraints or processes that have been recently raised in the context of the domain-specificity v. domain-generality arguments are: the ability to ‘fast-map’ a new word to its appropriate referent/domain and the ‘taxonomic assumption’ which allows appropriate extensions of the new word, particularly if that word is a noun.

Fast mapping refers to the ability to infer the meaning of a novel word after minimal, or even a single, exposure to it. Fast mapping was originally examined in the context of lexical contrast (e.g., “bring me the chromium one, not the blue one”; Carey, 1982; Au & Markman, 1987; Heibeck & Markman, 1987; Markson & Bloom, 1997). Carey & Bartlett (1978) taught children (3- and 4-year-olds) a novel word and then tested their ability to map that word to its referent. In a pretest, most children labeled an olive-colored chip “green.” Carey and Bartlett (1978) then presented it to the children in the context of a lexical contrast (e.g., “Bring me the chromium one, not the blue one”). The children in their study successfully mapped the word “chromium” to the olive-colored chip. Children and adults alike assume that the two terms, “blue” and “chromium,” refer to the same kind of attribute, in this case color.

Fast mapping in children has been frequently studied in terms of children’s use of semantic context (Au & Markman, 1987; Heibeck & Markman, 1987; Goodman, McDonough, & Brown, 1998). The data reported by Heibeck and Markman (1987)

suggest that preschool children also use other, non-linguistic cues that are available in the semantic context to infer the meaning of a novel word (e.g., “bring me the chromium one, not the other one”.) In order to determine the meaning of this new word, the children must have made the assumption that the contrast was based on the one salient feature that was available in the semantic context (e.g., color). In fast mapping, children may be able to rapidly eliminate many potential candidates for the meaning of a novel word by attending to the salient property on which objects can be contrasted. The salient property is the non-linguistic cue that is available in the semantic context (e.g., color).

Recent research has focused on the domain-specificity (specific to language) or domain-generality of the fast-mapping process in preschool children. According to Markson and Bloom (1997), the fast-mapping process is not specific to word learning. The children in their study (3- and 4-year-olds) successfully learned both novel words (e.g. “koba”) and novel facts (e.g. “My uncle gave me this”) that they were taught for unfamiliar objects. They were able to fast-map both and retain these mappings over time. This is not particularly surprising since we know that 2-year-olds and even 11-month-olds are fully capable of engaging in one aspect of episodic memory, the ability to recall a novel action after lengthy delays (Bauer & Dow, 1994; McDonough, 1991).

Markson and Bloom (1997) only examined the children’s recognition memory for the words and facts. They did not test the extendibility of the labels to other objects or properties of objects in their study (Markman & Hutchinson, 1984). In the field of language acquisition, a common way to ask children how they have interpreted the meaning of a novel word is to see how they will extend a newly acquired word to other exemplars (Markman & Hutchinson, 1984; Golinkoff et al, 1994). That is, if a child is

given a new word and a referent for it, we can see what other referents they are willing to call by that name.

Markman and Hutchinson (1984) proposed that when young children learn a new label for an object, they tend to think that the label denotes a category or a particular kind of thing. This is what Markman & Hutchinson (1984) have termed the taxonomic assumption. Young children tend to extend novel words to taxonomically-related items rather than those that are related in some other way (i.e., thematically). Markman & Hutchinson (1984) presented 2- to 5-year-old children with a target picture (e.g., a cow), a taxonomic choice (e.g., a pig), and a thematic choice (e.g., some milk). When the cow was labeled with a novel word (e.g., "dax"), the children tended to choose the taxonomically related item more often. That is, they extended the label to the taxonomic item (the pig), showing that they believe the label to refer to a particular category (e.g., animals). According to Markman and Hutchinson (1984), the labels constrained the children's choices in terms of making taxonomic choices, implying that labels facilitate categorization (but see Nelson, 1988).

More recent research has shown that even younger children (1- and 2-year-olds) can make taxonomic choices in the absence of a word or label as long as they are given explicit instructions (Bauer & Mandler, 1989). The data collected by Bauer and Mandler (1989) demonstrated that labels do not constrain infants' categorization because the labels in their study did not teach the infants any more than did the instructions of the task. For example, when the toddlers were given a toothbrush, another toothbrush (taxonomic relation) and some toothpaste (thematic relation) along with the instruction to "find another on just like this one," they demonstrated a significant preference for the

taxonomic relation. Bauer and Mandler (1989) thus concluded that the infants must have come to the task already having some knowledge about taxonomic and thematic relations. Of relevance to the present discussion is the fact that the task employed in both of these studies (e.g., Markman & Hutchinson, 1984; Bauer & Mandler, 1989) allows us to interpret how infants and children construe the meaning of novel words. That is, we see how they are willing to extend those words. Therefore, in order to interpret how children younger than 2-years of age construe the meaning of facts, we should see how they are willing to extend them as well. If evidence against a dedicated system for word learning in children exists, as Markson and Bloom (1997) have suggested, then it should show that children extend novel words and novel facts in the same way.

Both Waxman and Booth (2000) and Behrend, Scofield, & Kleinknecht (2001) compared novel words and facts on this dimension of extendibility. Waxman and Booth (2000) expanded Markson and Bloom's (1997) paradigm by adding extension trials following a brief exposure to either a novel word ("This is a koba") or a novel fact ("My uncle gave this to me"). Using both free-choice and forced-choice tasks, they found that the preschoolers in their study (4-year-olds) nearly always extended a novel word to members of a target category but rarely extended it to members of a contrasting category. However, no such systematicity was found for facts. That is, the preschoolers extended the novel facts at chance levels to both target and non-target category members. Although children are willing to extend both a novel word and a novel fact beyond the designated individual, their patterns of extensions in this study differed dramatically between the two domains (words and facts). Waxman and Booth (2000) argued that there might be principles guiding the acquisition of words that are not invoked in the

acquisition of facts. They take issue with Markson and Bloom's argument for a domain-general account of word learning.

Behrend et al (2001) have also argued that children use language-specific rather than domain-general word-learning mechanisms. They reported two studies in which they employed a modified version of Markson and Bloom's original paradigm attempting to investigate limitations of the aforementioned earlier studies. Specifically, they wanted to test children younger than 3 years of age and they wanted to assess extension patterns under more natural linguistic circumstances. Objects are frequently tagged with both a name and a fact in a single sentence frame, leaving the child to infer the meaning of both pieces of information and use them to guide their future extensions. However, both Markson and Bloom (1997) and Waxman and Booth (2000) tagged novel objects with either a novel name or a novel fact, but never both. Therefore, when Behrend et al (2001) tested extensions, they introduced a target object with both a novel word and a novel fact simultaneously (e.g., "My uncle gave me this koba). They then asked the children a name extension question (e.g., "Are there any other kobas here or not?") and a fact extension question (e.g., "Are there any other things my uncle gave me here or not?") in a counterbalanced order.

According to Behrend et al (2001), the results of their study supported their hypothesis that children as young as 2 and a half-years extend novel words more frequently and consistently than they extend novel facts. However, looking at their data on the fact extension trials, the picture does not seem so clear. The data suggest that children are unsure how to interpret facts. They either did not extend a fact to any additional exemplars (41%), perhaps thinking that the fact was episodic and not

generalizable, or they made the opposite assumption, extending it to all four exemplars (36%). The children's confusion could have been due to the arbitrary nature of the facts used in their study. Facts such as "My uncle gave me this," and "My cat stepped on this," for example, are arbitrary because they can be applied to most anything. Nothing about these facts define or give essential information about the particular objects in question.

The purpose of testing children's extensions is to see how they have interpreted or how they have inferred meaning from the words or facts in question. How would adults infer the meaning of something so arbitrary? One suspects that, depending on the fact, adults would treat it as episodic by not extending it to any other items. The fact that your uncle gave you an item (e.g., an L-shaped metal bracket as in Behrend et al (2001)) would not lead you to infer that your uncle gives you all items that are from the same category as that item (e.g., brackets). However, it is apparent why both Behrend et al. (2001) and Waxman and Booth (2000) chose to test such arbitrary facts in their studies. They were attempting to demonstrate the domain specificity of word learning by comparing the extendibility of words and facts. Words are also arbitrary. We presume that infants first perceive words as meaningless sounds of speech. In early infancy, phonemes are distinguished and tend to be those that are found in the exposed language (Kuhl, 2000; Werker, 1989). However, although phonemes and words get distinguished and recognized, it is still unclear how they interact with early concepts. That is, what gives words meaning and from where does that meaning arise?

According to Nelson (1985; 1988), because words are not meaningful in and of themselves, meaning must be derived from context. Before learning words, children construct concepts about the familiar things in their world. These concepts are formed

through experience with objects in conventional situations. From these experiences, interacting with the world of people and things and trying to make sense of it, the child forms representations of events and concepts of objects. The words that the child hears within a variety of contexts (e.g., interacting with parents, siblings, and other adults) have conventional meanings in the parent language. Children are introduced to these meanings in situations or contexts where their use is appropriate and their reference is transparent (Nelson, 1988). Therefore, the meaning that is attached to words arises from experienced events (context) or, more specifically, representations of those events. Those representations are then generalized to other events, and the words that refer to the people and objects within them are then generalized as well. Nelson (1985) explains how at first (before 2-years), language terms, when they are understood or used, are confined to certain activity contexts and embedded as part of these contexts. Sometime in the first half of the second year, children begin to differentiate event representations into their parts in that they begin to conceptualize entities in terms of their functional roles, no longer tied to specific events or contexts. It is at this point and in this way that children start to generalize words, using them to refer to objects in the world. By this account, words are initially arbitrary in that they alone do not convey meaning to the young child. Yet, with development, meaning comes to be “based in a conceptual system that derives from the child’s representation of experienced events” (Nelson, 1985, p. 122).

Therefore, it is clear why researchers have compared children’s fast mapping of words with facts such as “it fell in the sink” or “my uncle gave it to me” in their studies (e.g., Markson & Bloom, 1997, Waxman & Booth, 2000, Behrend et al., 2001). Both words, especially novel words (e.g., *dax*), and facts such as these are similar in that both

are arbitrary. Both could refer to anything or nothing at all. Neither the words nor the arbitrary facts used in these studies conveyed any information about function or conventional use. It is quite possible that the language-specific account of word learning (e.g., Waxman & Booth, 2000. Behrend et al., 2001) would not have been supported if the facts that the researchers had used had been less arbitrary and more defining of the items in their object sets (an issue that will be further discussed in the next section.) Nonetheless, both Behrend et al. (2001) and Waxman and Booth (2000) have shown that when children are given a novel word or label in reference to an unfamiliar object, they will systematically extend it to other objects of the same or similar shape. The results of both these studies were similar even though the ages widely differed (Waxman & Booth tested 4 year olds; Behrend et al. tested 4 years olds as well as a younger group of 2 year olds with no age differences reported).

During the process of language development, the words that children hear spoken everyday within their language communities are spoken intentionally. There are many varieties of intentional utterances. Many of these are informative (e.g., “this does not belong in your nose”) in that they are spoken to children with the intention of teaching something. However, other utterances are not informative and spoken intentionally for other purposes. For example, some utterances are intentionally playful (e.g., “peek a boo!”) and others are intentionally spoken to invoke joint attention or sharing (e.g., “look at the alligator!”). Because they are exposed to such utterances quite often, young children learn that utterances are intentional and that the words within these utterances must have meaning (Woodward, Sommerville, & Guajardo, 2001). Therefore, upon hearing a novel word, the child may assume that the word is meaningful even though he

or she may not know what the meaning is. The child then needs to infer what the meaning is based on the context in which it is used (Nelson, 1988). If told that an object is a “koba” and then asked if any other “kobas” are present within a given object array, how would a preschool child respond? That is, what strategy would he or she use to infer the meaning of the novel word and then what strategy would he or she use to extend that meaning? The finding that toddlers tend to extend words to similarly shaped items does not tell us about their cognitive abilities or meaning per se (see Nelson, 1974). Recall that Smith and her colleagues (Landau et al., 1988; 1998, Smith et al. 1996) maintain that labels recruit attention to salient perceptual properties (e.g., overall shape) and that labeling or naming in young children is nothing more than a “dumb attentional mechanism” driven by automatic associations.

In contrast, Kemler Nelson and her colleagues (1995; 2000a; 2000b) maintain that young children use conceptual knowledge when naming artifacts. They demonstrated that preschoolers extend novel names on the basis of demonstrated function, especially when the function appears to be originally intended by the object’s designer. According to Gelman and her colleagues (1986; 1987; 1991; 1994; 1998), children have essentialist beliefs. They will search for meaning in the form of causal explanations and they will categorize based on the assumption that category members share some unobservable but essential properties. In the domain of artifacts, these essential properties pertain to the functions that the objects belonging to a certain artifact category can all perform (Kemler Nelson et al., 1995; 2000a; 2000b). Therefore, when young children hear a novel word (e.g., “koba”) in reference to an object, they may infer the meaning of the word by searching for the essential properties of that object (e.g., function). They might then

extend that word to other objects in an array that share those properties. The same should be true of facts. Young children should also extend facts on the basis of function, but only if those facts demonstrate something about the function of the objects that they refer to.

Recall that according to the data collected by Behrend et al. (2001) and Waxman and Booth (2000), children extend novel words more frequently and more systematically than they extend novel facts. These researchers interpreted this data to mean that young children use language-specific rather than domain-general word-learning mechanisms. However, the facts used in this study were arbitrary in that they could presumably refer to anything or nothing at all (e.g., "it fell in the sink"). More importantly, the facts did not disclose any information about the intended functions of the artifacts that were used in either study. Kemler Nelson and her colleagues (1995; 2000a; 2000b) have repeatedly demonstrated that preschool children (4-year-olds) tend to extend novel words on the basis of intended function when those words are presented in reference to novel artifacts. Therefore, in Experiment 3 I examine how preschool children extend novel facts and novel words for artifacts. However, unlike Behrend et al (2001) and Waxman and Booth (2000), I use facts that disclose information about the intended function of the artifacts in question. I propose that preschoolers would extend such facts just as systematically as they extend novel words.

### **Chapter 6: Experiment 1**

This Experiment was concerned with inductive generalization in infancy, replicating the study conducted by Mandler and McDonough (1998) with an important twist. We modeled actions with atypical rather than typical members of a domain.

Mandler and McDonough (1998) showed infants an activity modeled on a particular exemplar (e.g., a dog drinking from a cup) and then gave the infants other exemplars (e.g., a rabbit & a car or a bird & an airplane) along with the prop (e.g., a cup) to test their imitation of the activity. Results show infants will generalize to dissimilar items (i.e., from a dog to a bird) as often as they will to similar items (i.e., a dog to a rabbit). In another experiment, infants generalized the same activities to unusual exemplars (e.g., an anteater) as well (Mandler & McDonough, 1996). Such results suggest that neither perceptual similarity nor typicality factors influence early generalizations. One possible reason for this is that the modeling exemplars used in these experiments were very familiar to the infants (e.g., a dog or a car) and highly typical of the animal and vehicle domains. Research by Bauer et al. (1995) showed that the typicality of exemplars plays a significant role in the categorization abilities of infants as young as 13- and 16-months. As previously discussed, the infants in this experiment demonstrated basic-level but not superordinate level categorization when unusual exemplars were used, showing that when infants are unfamiliar with the items to be categorized, they rely on similarity cues that can be used easily for sorting basic-level categories.

The goal of the present experiment was to find out when in development and under what conditions similarity plays a role in infants' generalizations. As a starting point, we reasoned that young infants might use similarity to guide their generalizations if such unusual or atypical items (e.g., an alligator) are used for modeling as well as testing the properties under investigation. Therefore, rather than showing the infants an activity modeled on an exemplar that is a typical member of a domain (e.g., a dog drinking from a cup), we modeled with an atypical member (e.g., an alligator drinking from a cup). We

then gave them other exemplars, one belonging to the same basic-level category as the exemplar used for modeling (e.g., another alligator) and the other belonging to a different basic-level category (e.g., a cheetah) along with a prop (e.g., a cup) to test their imitation of the activity. We hypothesized that the infants' generalizations will be more conservative than in previous studies (e.g., Mandler & McDonough, 1996; 1998; 2000), a finding that would reflect their lack of experience with such items. That is, infants may prefer to generalize activities to members of the same basic-level category (i.e., another alligator but not a cheetah). The atypical nature of the items might lead them to attend more to the perceptual similarity between the target exemplars and the exemplars used for modeling.

## Method

### *Participants*

Thirty-six infants of three different age groups participated in this experiment. Twelve were seen when they were 14 months (mean = 14 months, 15 days; range = 14 months, 3 days to 15 months, 9 days), twelve when they were 19 months (mean = 19 months, 13 days; range = 19 months, 4 days to 20 months, 18 days), and twelve when they were 24 months of age (mean = 24 months, 10 days; range = 23 months, 17 days to 25 months, 3 days). Half of the infants, 6 from each age group, were recruited from an existing pool of volunteer parents who had responded to advertisements in local newspapers in San Diego, California. Most (75%) were white (not of Hispanic origin), some (15%) were Philipino, and some (10%) were Latin American. These infants were tested in a laboratory at the University of California, San Diego. The remaining infants were recruited from a pool of volunteer parents who had responded to flyers left at day

care centers and pediatricians' offices in the Brooklyn, New York area. These infants were tested by a different experimenter than those tested in San Diego, California. Most (67%) of these infants were white (not of Hispanic decent) and 4 were of Black/African American decent. They were tested in a laboratory at Brooklyn College and a small toy was given to the infants for their participation.

### *Properties tested*

Each infant was tested on four properties: two appropriate to animals and two appropriate to vehicles. The animal properties were drinking from a cup and sleeping. These were modeled by putting a little cup to the face of a small replica of an animal and by putting a small replica of an animal in a little bed. The vehicle properties were giving a child a ride and using a key on a vehicle. The first of these was modeled by placing a doll who was in a seated position on top of a replica of a vehicle and scooting it. The second was modeled by touching a key to the side of a vehicle. These four properties and the props used for their modeling were taken from Mandler and McDonough (1996) in their study of inductive generalization in infancy. However, the modeling and test exemplars that were used differed in that they were not prototypical animals or vehicles. Table 1 lists these exemplars along with the properties tested, the props used for modeling the actions, and the vocalizations that accompanied the modeling.

All of the exemplars were small replicas of animals and vehicles. The animal properties were modeled with an alligator and a light brown camel and the vehicle properties were modeled with a shoveler and a fire truck. The order of presentation and the model exemplars used within each domain was counter-balanced among the subjects. These four exemplars were used only for modeling the properties and were not given to

the infants. Instead, infants were tested using other animals and vehicles (the test exemplars). Each pair of test exemplars consisted of one that was a member of the same basic-level category and one that was a member of a contrasting basic-level category as the exemplar that was used for modeling. For example, for the animal property modeled with an alligator, the test animals were a smaller alligator (target) and a cheetah (distractor.) Table 6.1 lists these test exemplars, the targets and distractors corresponding to the four exemplars that were used for modeling.

### *Procedure*

Infants were invited into a laboratory set up as a playroom. After a brief introductory period to the lab they were seated in the parent's lap across the table from the experimenter. Parents were asked not to assist their infants in any way throughout the session. Two warm-up tasks, designed to accustom the infants to the imitation procedure, were administered prior to the generalization task. Both were exercises in hammering an object. In the first task, one pipe was fitted into another and a plastic hammer was used to pound them tightly together with the accompanying vocalization "bam, bam, bam, all fixed!" In the second warm-up, the experimenter put two large Lego pieces together and hammered them with the same vocalization. Infants were encouraged to imitate both actions and were praised for doing so. Infants' demonstrations of the animal and vehicle test properties were evaluated twice during the session, once before the properties were modeled (baseline) and again after they were modeled (generalization.)

*Baseline.* Before the properties were modeled, infants were given both test exemplars (target and distractor) and the prop used to demonstrate the target action. The amount of time allotted for baseline was determined by the infants. If an infant ignored

any of the three objects, the experimenter would point it out and say “Look, did you see this one?” After the infants were finished exploring each of the objects, the experimenter took them away. The prop was left on the table and the test exemplars were placed out of sight. The experimenter then brought out the modeling exemplar (e.g. an alligator) and demonstrated the target action with the prop (e.g. a cup) three times with the appropriate vocalization (e.g. “sip, sip, umm, good.”) The experimenter then removed the alligator from the table so that it could no longer be seen.

*Generalization test.* The test exemplars were brought back and simultaneously placed to the right and left of the infant. The target exemplar belonging to the same basic level category was placed equally often to the subject’s right and left throughout the session. The experimenter then handed the prop to the infant while repeating the vocalization (“sip, sip, umm, good.”) and waited until the infants no longer responded to the objects before removing them from the table. This procedure continued throughout the session until each infant had been tested on both animal and vehicle properties.

Table 6.1

Exemplars, actions, props and vocalizations

Exemplar for modeling action	Actions, props and vocalizations	Test exemplars	
		Same basic level category (target)	Contrasting basic level category (distractor)
Alligator	Drinking from a cup “sip, sip, umm, good”	Small alligator	Cheetah
Light Camel	Putting in a bed and patting “night night”	Dark camel	Zebra
Yellow Shoveler	Giving a seated child a ride “go for a ride, wheee”	Green shoveler	Garbage truck
Fire truck	Starting with a key “vroom, vroom”	Small fire truck	Pick-up truck

*Scoring.* Each session was videotaped for later coding. Infants were coded for performance (or nonperformance) of the properties and the exemplar they used for doing so. If an infant used both test exemplars to demonstrate the properties, the coder noted which was chosen first. Two coders were trained on data from previous Mandler and McDonough (2000) experiments until at least 95% agreement with previous coders was obtained. Then coders coded every participant. The actions turned out to be unambiguous: agreement between the two coders was 100%. Coders were blind to the hypotheses of the experiment, but not to the acts that were modeled (they were obvious given the props that were being used).

### Results

Table 6.2 shows for each age group the mean number of times the target or distractor exemplar was chosen first during baseline and after the action was modeled (i.e., at generalization). The scores could range from 0 to 4. (The percentages of target and distractor responses do not add to 100% because no participant performed an action for every event). Although the baseline data is reported first, it is important to note that the primary interest in this experiment is the generalization data - the extent to which infants generalized from the modeled behavior to the target versus distractor exemplars.

*Baseline Analyses.* Preliminary analyses had showed that infants at all three ages demonstrated significantly more of the activities at generalization than at baseline (14 months: generalization  $M = 3.25$ , baseline  $M = 1.75$ ; 19 months: generalization  $M = 3.33$ , baseline  $M = 1.75$ ; 24 months: generalization  $M = 3.14$ , baseline  $M = 2.05$ ).

We then carried out analyses of object salience to assure that target or distractor preference at generalization was not due to a priori salience of either test exemplar as

shown at baseline. Using chi-square tests, we examined the number of children who first chose each of the exemplars (target and distractor) within each object set at baseline. Preferences for the exemplars were evenly distributed with no significant differences among the four sets. Overall, object salience could not account for exemplar preference at generalization.

*Generalization analyses.* Given that the properties were appropriate to both exemplars, sometimes the infants generalized to one test exemplar and sometimes they generalized to both test exemplars. For our first set of analyses, the infant's first choices for demonstrating the actions were analyzed in a mixed-design analysis of variance (ANOVA). The between-subjects factor was Age (14-, 19-, 24-months) and the within-subjects factors were Domain (animal, vehicle) and Exemplar (target, distractor). The dependent variable was the number of actions demonstrated by each subject.

There was a main effect for Exemplar,  $F(1,33) = 11.89; p < .01$ , which was qualified by an three-way interaction involving Domain and Age,  $F(2,33) = 4.47; p < .05$ . In order to determine the locus of the interaction, follow-up one-way ANOVAs were conducted on each age group. As depicted in Figure 6.2, the results showed that the 14-month olds tended to generalize the activities to both exemplars,  $F(1,11) = .103; p > .05$ , equally often within both domains,  $F(1,11) = .000; p > .05$ . However, both the 19- and 24-month olds tended to restrict their generalizations to the test item from the same basic-level category (target) as the modeling exemplar, 19 months:  $F(1,11) = 8.57; p = .01$  and 24 months:  $F(1,11) = 7.62; p < .05$ . A closer examination of the data in Figure 6.2 shows that the 19-month olds tended to show a more pronounced preference for the target over the distractor items in the animal than in the vehicle domain (Animal target:  $M =$

1.33,  $SD = .49$ ; Animal distractor:  $M = 0.17$ ,  $SD = .38$ ;  $t(11) = 5.63$ ;  $p = .00$  and Vehicle target:  $M = 1.00$ ,  $SD = .85$ ; Vehicle distractor:  $M = 0.75$ ,  $SD = .75$ ;  $t(11) = .56$ ;  $p = .58$ ).

This pattern contrasts with the 24-month-olds who showed a stronger preference for the target over the distractor items in the vehicle domain (Animal target  $M = 1.67$ , Animal distractor  $M = 0.92$ ;  $t(11) = .71$ ;  $p = .49$ , Vehicle target  $M = 1.58$ , Vehicle distractor  $M = 0.33$ ;  $t(11) = 3.36$ ;  $p = .01$ ).

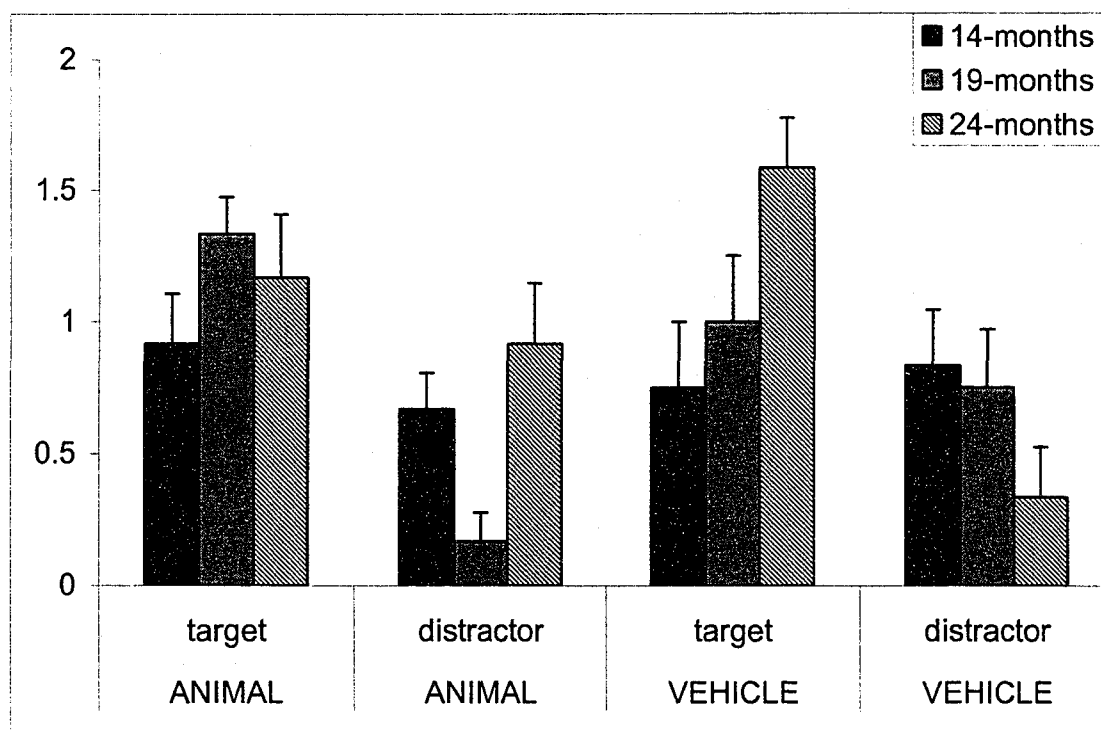
Table 6.2

Mean Number and Percentage of First Choices of Target and Distractor Exemplars in Baseline and Generalization

<i>Age in Months</i>	<i>Baseline</i>				<i>Generalization</i>			
	<i>Target</i>		<i>Distractor</i>		<i>Target</i>		<i>Distractor</i>	
	<i>M</i>	<i>%</i>	<i>M</i>	<i>%</i>	<i>M</i>	<i>%</i>	<i>M</i>	<i>%</i>
<i>Animals</i>								
14	0.75	38	0.25	13	0.92	46	0.67	33
19	0.33	17	0.67	33	1.33	67	0.17	8
24	0.75	38	0.50	25	1.17	58	0.92	46
<i>Vehicles</i>								
14	0.17	8	0.58	29	0.75	38	0.83	42
19	0.17	8	0.58	29	1.00	50	0.75	38
24	1.08	54	0.33	17	1.58	79	0.33	17

Figure 6.1

The mean number of actions (out of 2) performed by each age group with the target and distractor exemplars in the animal and vehicle domains.



For our second set of analyses, the infants' first and second choices combined were analyzed in a mixed-design analysis of variance (ANOVA). Again, there was a main effect for Exemplar,  $F(1,33) = 18.87$ ;  $p < .01$ , showing that significantly more actions were imitated with the target ( $M = 3.67$ ,  $SD = 1.63$ ) than the distractor ( $M = 2.47$ ,  $SD = 1.80$ ). However, no other effects or interactions reached significance. We then conducted conditional probabilities to examine how often infants went on to imitate an action again with the remaining item after their first choices had already been made. There seemed to be a developmental pattern or progression in the likelihood to first choose the target and then choose the distractor upon being given a second chance (23% of the 14-month-olds, 39% of the 19-month-olds, and 48% of the 24-month-olds).

However, due to the erratic behavior of the 19-month-olds, such a clear pattern was not apparent among the infants who chose the distractor first and the target second (50% of the 14-month olds, 15% of the 19-month-olds, and 57% of the 24-month-olds). It is possible that because infants of this age (19-months) are typically less cooperative, the experimenter may not have given them as much time to make their second choices.<sup>1</sup>

Finally, the data were examined to see if there were differences because of the change in location. We conducted an ANOVA with Age (14-,19-,24-months) and Location (UCSD, Brooklyn College) as the between factors and Exemplar (target, distractor) as the within factor. There was a main effect for Location,  $F(1,30) = 5.91$ ;  $p < .05$  (UCSD:  $M = 3.62$ , Brooklyn College:  $M = 2.91$ ); however, the pattern of results was the same for both. The infants tested in San Diego tended to perform more actions overall. One explanation for this difference is that the tester in San Diego had two years more experience working with infants than the tester in Brooklyn College. Another explanation is that two different populations were tested. Nevertheless, the same pattern of results was observed for both groups.

### Discussion

In this experiment we employed the technique of generalized imitation that was created by Mandler and McDonough (1996, 1998) to explore the knowledge base that infants have about objects such as animals and vehicles. This technique takes advantage of the fact that when infants imitate they try to reproduce what they have observed.

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<sup>1</sup> One can analyze the time allotted by the experimenter in order to make sure that significant differences are not attributable to any inadvertent biasing. Such analyses have been conducted in previous experiments by Mandler and McDonough but differences were not found. McDonough reports (personal communication) that it is extremely difficult to get reliable data from 19-month-olds for all experimenters using interactive measures and that it is more likely that an increase in the number of participants will clarify this finding.

Because we do not give the infants the exact objects used for modeling but instead provide a range of other objects from which they can choose for their imitations, we can use their choices to assess how they have interpreted the modeled events. However, when more than one object is available, infants can imitate more than once. Their first choice is presumed to indicate the closest available approximation to what they have understood of the modeled event. Their second choice, if made, indicates that they consider the other object a possible substitute as well. Thus, this technique both assesses how infants have interpreted the event and provides information about how far they are willing to generalize the appropriateness of the modeled behavior.

Interestingly, the data that we collected did not support the traditional view that infant's first categories are based on perceptual similarity. Rather, we found that the older but not the younger infants were more constrained in their patterns of generalization when atypical exemplars were used for modeling the actions (see figure 6.2). The 19-month-olds and especially the 24-month-olds seemed to be using either perceptual similarity or their general (albeit non-specific) knowledge of basic-level categories to guide their generalizations much more so than the 14-month-olds. For example, when shown an alligator being given a drink, the 24-month-olds were less willing to generalize the action to a cheetah or to choose the cheetah first in their generalizations. They more frequently chose the more perceptually similar exemplar first, that belonging to the same basic-level category as the modeling exemplar. The 14-month-olds, however, were equally as willing to give the cheetah a drink as they were to give another alligator a drink. The pattern of first choices made among this younger age group did not point in one direction, suggesting that they construed the modeling event simply as "animal

drinking” or “keying a vehicle.” Perhaps 24-month-old toddlers restrict their generalizations to basic-level categories because they attend to the perceptual differences and, unlike the younger infants, they have figured out that perceptual differences are meaningful in some way even though they may not know what the specific meaning is. Also, it is quite possible that having had more experience in the world, two-year-olds know more about alligators and cheetahs than 14-month-olds.

Previous research with older children has shown that their inductions are more influenced by conceptual category than by perceptual similarity (e.g., Gelman & Markman, 1986). To review, data from the research conducted by Mandler and McDonough (1996, 1998, 2000) indicate that infant’s generalizations are not guided by perceptual similarity or by the features of objects that they have observed. Rather, their generalizations are guided by the concepts that they have formed. Even though infants use various physical features to tell animals such as dogs and cats apart (Eimas & Quinn, 1994), they do not rely on them to construe the meaning of an event or generalize from it (Mandler & McDonough, ). They do not restrict the associations that they make to basic-level classes. For example, the infants in Mandler and McDonough’s studies were as apt to choose a rabbit as a dog to demonstrate a property modeled on a dog even when the property modeled was appropriate for a dog but not for a rabbit (e.g., chewing a bone). An even more convincing illustration of this principle is the fact that the youngest infants in the present study were as apt to choose a cheetah as an alligator to demonstrate a property modeled on another alligator. Therefore, our present results imply that infants generalize very broadly at first and, with development they begin to attend to the perceptual features that can be used in their initial construal of the activities. The

findings of all these studies were surprising in that their results are inconsistent with the traditional view that the earliest inductive generalizations take place at the basic level (Keil, 1991), occurring solely on the basis of common features or physical similarity. Although the traditional view made good intuitive sense, it grossly underestimated the cognitive capabilities of infants and young children.

The older infants' use of perceptual similarity in Experiment 1 signifies their movement on the developmental trajectory towards adulthood. This idea that notions of similarity change with development coincides with the findings of Smith and her colleagues (Landau, Smith, & Jones, 1988; Samuelson & Smith, 1999) who demonstrated that infants weigh the shape bias, a dimension of perceptual similarity, more heavily as they get older. With age, infants and young children become more fluent in language and concurrently begin to form basic level concepts, both of which appear to play a role in similarity judgments.

### **Chapter 7: Experiment 2**

This study was conducted to test further the claim that labels facilitate categorization (e.g., Waxman et al., 1986; 1995; Balaban & Waxman, 1997) by adding labels to our inductive generalization procedure. Infants and young children aged 14- to 24-months were again shown everyday activities modeled with atypical objects (e.g., drinking with an alligator). They were then allowed to imitate the activity with either an item from the same basic-level category (e.g. another alligator) or a different basic-level category (e.g., a cheetah). This time, however, the experimenter labeled the modeling exemplar while demonstrating the property (e.g. "the alligator is thirsty... have a drink alligator!"). If Waxman is correct in her assertion that labels facilitate categorization, the

addition of labels to this procedure should induce the infants in our study to choose the more perceptually similar exemplar more often (e.g., the member of the same basic-level category.) However, if labels do not have a facilitative effect on categorization and do not effect infants' generalizations, the results of this study should be similar to those of Experiment 1. That is, only the 24-month-olds, having had more experience with the process of language acquisition, should be constrained in their generalizations.

Older infants are in the process of learning new words that refer to basic-level objects. Their vocabularies have reached and in many cases will have exceeded what is known as the "vocabulary burst." Once children have a lexicon that exceeds 50 words, they begin to rapidly acquire as many as 7 to 10 new words a day (Carey, 1978; Templin, 1957). Having had more experience with the process of language learning, the 24-month-olds should be more familiar with the heuristic that shape correlates with object labels (Smith et al., 2002). Their knowledge of such a heuristic might tune them into the conceptual differences between basic-level categories, thus making perceptual cues more salient. With increased attention to the perceptual characteristics of objects, specifically the similarities between the modeling exemplar and one of the test items, older infants may be more conservative in their generalizations, generalizing more to the target exemplar, that from the same basic-level category as the modeling exemplar. This may be the case even though they are presumably unfamiliar with the particular labels used in the present experiment (e.g., alligator or shoveler). However, according to Waxman's findings (Balaban & Waxman, 1997), one would predict that the labeling should induce categorization for all of the infants, including the youngest (14-month-olds).

## Method

### *Participants*

Twenty-four infants of three different age groups participated in this experiment. Eight were seen when they were 14 months (mean = 14 months, 8 days; range = 13 months, 24 days to 14 months, 25 days), eight when they were 19 months (mean = 19 months, 17 days; range = 19 months, 2 days to 20 months, 2 days), and eight when they were 24 months of age (mean = 24 months, 13 days; range = 23 months, 27 days to 24 months, 22 days). The infants were recruited from a pool of volunteer parents living in the Brooklyn, New York area who had responded to flyers sent to their homes. Most (79%) were white (not of Latin origin), 3 were of Black/African American decent, and 2 were Latin American. These infants were tested in a laboratory at Brooklyn College. A small toy was given to the infants for their participation.

### *Properties tested*

The properties tested and the stimuli used were the same as in Experiment 1.

### *Procedure*

As in Experiment 1, the two warm-up tasks, designed to accustom the infants to the imitation procedure, were administered prior to the generalization task. Again, infants' demonstrations of the animal and vehicle properties were evaluated twice during the session, once before the properties were modeled (baseline) and again after they were modeled (generalization.)

To systematically examine language in the context of Experiment 1, the experimenter added labeling while she modeled the properties. For example, on placing the alligator in a bed, the experimenter said "Look! [pointing and looking to the alligator to make sure that joint attention was established] Alligator! The alligator is sleepy!

Night, night alligator!” Once the modeling was completed for the third time, the infant had heard the label “alligator” nine times, sufficient exposure for fast mapping at this age (Woodward, Markman, & Fitzsimmons, 1994). After the test exemplars were given to the infant, the experimenter handed the prop (i.e., the bed) to the infants saying, “The alligator is sleepy.” As in Experiment 1, the experimenter waited until the infants no longer responded to the objects before removing them from the table. This procedure continued throughout the session until each infant had been tested on both animal and vehicle properties. Again, the infant’s imitation of the modeled activity, their first and second choices of exemplars, was coded from videotapes.

### Results

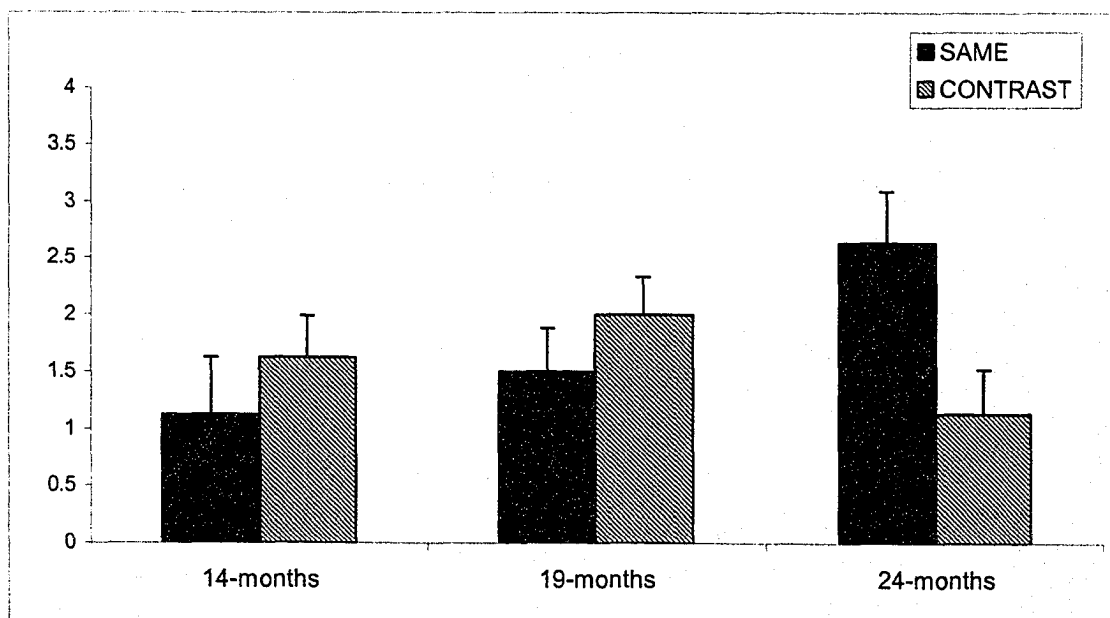
As in Experiment 1, preliminary analyses showed that infants at all three ages demonstrated significantly more of the activities at generalization than at baseline (14 months: generalization  $M = 2.75$ , baseline  $M = 1.00$ ; 19 months: generalization  $M = 3.50$ , baseline  $M = 1.38$ ; 24 months: generalization  $M = 3.63$ , baseline  $M = 2.13$ ). Because the primary interest in this experiment was again the extent to which the infants generalized from the modeled behavior to the target versus the distractor exemplars, we put more emphasis on our analyses of the generalization data.

*Generalization analyses.* For the first set of analyses, the infants’ first choices were entered into an analysis of variance (ANOVA) with Age (14-, 19-, 24-months) as the between-subjects factor and Domain (animal, vehicle) and Exemplar (target, distractor) as the within-subjects factors. The dependent variable was the number of actions demonstrated by each subject. Unlike Experiment 1, there were no significant effects involving Domain, showing that the infants in each age group tended to generalize

the activities equally often within both domains. However, there was a marginally significant interaction between Exemplar and Age ( $F(2,21) = 3.146; p = .06$ ). We therefore conducted one-way ANOVAs on each age group and as depicted in Figure 7.1, the results showed that, upon given a first choice, the 14- and 19-month-olds tended to generalize equally to both exemplars, 14-months:  $F(1,7) = .633; p > .05$  (target:  $M = 1.13, SD = .99$ ; distractor:  $M = 1.62, SD = 1.06$ ) and 19-months:  $F(1,7) = .583; p > .05$  (target:  $M = 1.5, SD = 1.06$ ; distractor:  $M = 2.0, SD = .93$ ). However, just as in Experiment 1, the 24-month-olds tended to restrict their generalizations to the test item from the same basic-level category (target) as the modeling exemplar,  $F(1,7) = 5.98; p < .05$  (target:  $M = 2.75; SD = 1.16$ ; distractor:  $M = .87, SD = 1.12$ ).

Figure 7.1

ANOVA: The mean number of actions (out of 4) performed by each age group with the target and distractor exemplars.

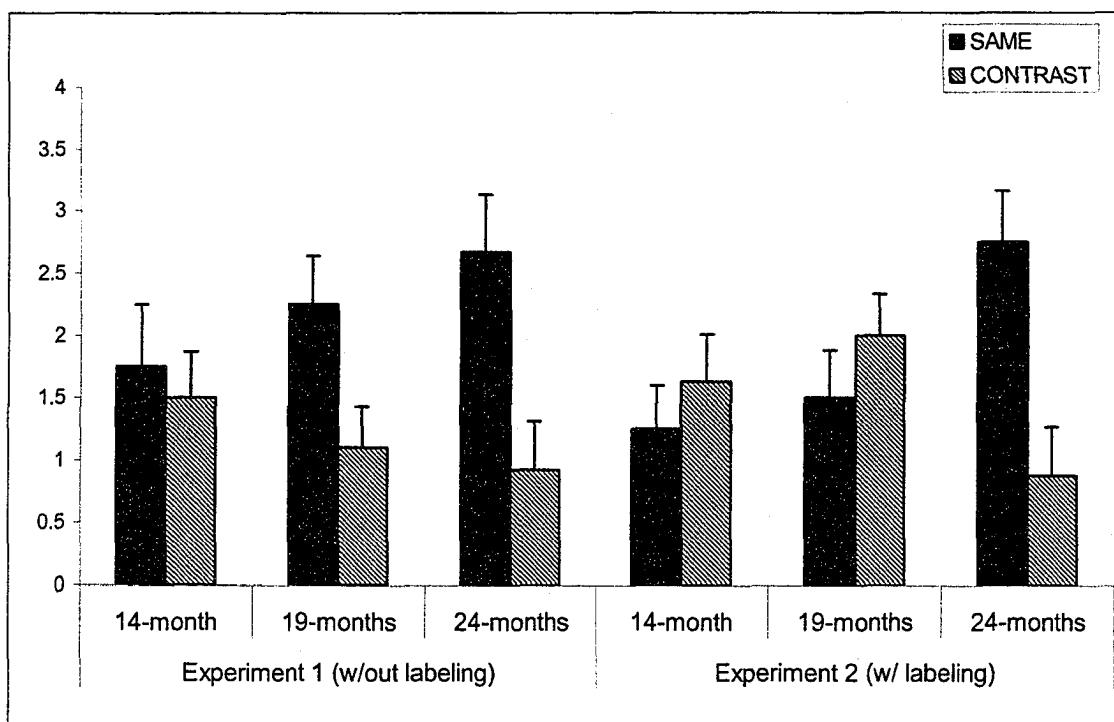


For our second set of analyses, the infants' first and second choices combined were analyzed in a mixed-design analysis of variance (ANOVA). Again, there was an interaction between Exemplar and Age,  $F(2,21) = 4.41$ ;  $p < .05$ , revealing the same pattern of results as our previous analysis of the infants' first choices. That is, even upon being given a second chance to choose an exemplar for their generalizations, both the 14- and 19-month-olds continued to choose the target and the distractor items equally as often (14-months: target:  $M = 1.5$ ,  $SD = .93$ ; distractor:  $M = 2.0$ ,  $SD = .75$  and 19-months: target:  $M = 2.88$ ,  $SD = .83$ ; distractor:  $M = 3.0$ ,  $SE = .92$ ). However, the 24-month-olds continued to choose the target items significantly more often  $F(1,7) = 6.30$ ;  $p < .05$  (target:  $M = 3.25$ ,  $SD = .88$ ; distractor:  $M = 2.25$ ,  $SD = 1.03$ ).

Our last set of analyses was conducted in order to compare the current results with those of Experiment 1 and to determine if there was an effect of labeling in the current experiment. The infants' first choices were analyzed in a mixed-design analysis of variance (ANOVA) with Age (14-, 19-, 24-months) and Labeling (E1: no labels, E2: labels) as the between-subjects factors and Exemplar (target, distractor) as the within-subjects factor. As can be seen in Figure 7.2, there was no main effect for Labeling,  $F(1,48) = .565$ ;  $p > .05$ , implying that the addition of labels in Experiment 2 did not change the infants' patterns of generalization. The remaining results mirror those above and do not qualify any previous interpretations of these data.

Figure 7.2

Comparison of generalization patterns in Experiment 1 and Experiment 2.



### Discussion

The results of this study show that labels only appear to influence the generalizations of older infants, a finding consistent with Nazzi and Gopnick (2001) who showed that labels do not begin to influence categorization until 20 months of age. Recall that the older infants in Experiment 1 (24-months) were the only group that seemed to be using perceptual similarity consistently in their generalizations. For example, after seeing the experimenter model the drinking activity with an alligator, they were more willing to choose an alligator than a dissimilar looking cheetah for their generalizations. Perhaps the 24-month-olds' reliance on perceptual similarity was due to the fact that they have had more experience learning and acquiring basic-level terms. It could be that the acquisition of such terms (the process of acquiring them) fosters the

acquisition of the later appearing basic level categories. The older, 24-month-olds are more accustomed than 19- and 14-month-olds to the language learning process thus are more attuned to the perceptual properties of objects (e.g., overall shape) that are usually generalizable to members of the same basic-level categories. The 24-month-olds in Experiment 1, those who did not hear labels accompanying the actions, showed the same pattern of results as the 24-month-olds in the current experiment, those who did hear labels. The youngest infants (the 14-month-olds) continued to generalize the actions to both exemplars equally often regardless of the added labels in the current experiment. That is, the addition of labels in the current experiment did not seem to influence or change the infants' patterns of inductive generalizations.

In light of other experiments that have shown that labeling influences generalization and categorization (e.g., Waxman and her colleagues, 1986; 1995; 1997), one must wonder why our experiment did not bear the same results. A likely explanation is that the older infants were mapping the labels onto concepts/categories that were already familiar to them. Mandler and McDonough (1993; 1996) have shown that infants as young as 7- and 9-months of age have already begun to conceptualize animals and vehicles as different kinds of things. However, at 14-months, these domains have yet to be conceptualized in terms of the many basic-level categories that are embedded within them. The 14-month-olds' pattern of generalizations suggested that they construed the alligator and the cheetah as perceptual variants of the same kind of thing (i.e., animals). Therefore, when the alligator was labeled, they reasonably inferred that the label should be extended to both of the items. This interpretation is consistent with Nazzi and Gopnick (2001), who suggested that the effects of labeling in young infants do not induce

the formation of categories, but instead highlight the categories and concepts already available to them. It is also consistent with the overgeneralization of basic-level terms that is found in the comprehension data with older children (McDonough, 2002). The results of the current experiment indicate that conceptualization in infancy requires more than just a label. The infants' patterns of inductive generalizations did not change when labels were added to the procedure. However, we tested infants' generalizations of familiar properties (e.g., drinking and sleeping) using unfamiliar objects (e.g., an alligator). Researchers who have demonstrated an effect of labeling on infants' generalization behavior (e.g., Welder & Graham, 2001) have done so using novel objects that possessed non-obvious, functional properties (e.g., a cloth-covered object that squeaked when squeezed). In such experiments, the labels may have a facilitative effect on categorization because they are all that the infants are given to go by.

### **Chapter 8: Experiment 3**

Young children's willingness to generalize novel labels based on function (e.g., Kemler Nelson et al., 1995; 2001a; 2001b), an aspect of conceptual knowledge, implies that they have inferred meaning from those labels. Specifically, they have interpreted the labels to denote object kind. Therefore, young children should be willing to infer meaning from novel facts and extend the meaning as well, but only if the facts that they are given also indicate something about object kind. Such facts should constitute the meaning of the objects that they refer to by themselves demonstrating function and causal relations. Kemler Nelson and her colleagues pointed out variables underlying function-based categorization and naming of artifacts in young children (2001a). One shown to be of utmost importance was whether or not the functions of the artifacts are plausible as

causal explanations of their physical structures. That is, children will only generalize names based on the function of objects when the functionally relevant attributes of those objects are obvious and unhidden. The same should be true of facts.

Children should be willing to generalize facts based on the functions of the objects that they refer to when those facts make the functionally relevant attributes apparent. Such facts should describe the functions of the objects. For example, one of the unfamiliar objects used by Behrend et al. (2001) was an L-shaped metal bracket. The children in this study (Experiment 2) were given a name and a fact in reference to this object (e.g., “My uncle gave me this Koba”) and were then asked the extension questions: “are there any other Kobas here?” or “are there any other things that my uncle gave me here?” It should not seem surprising that the children were confused about what to do with this piece of arbitrary information. We hypothesized that if the children had been told, for example, “this koba is used to hang pictures,” and then asked, “are there any other things that are used to hang pictures here,” they may have generalized the fact based on the function of the object. Therefore, the results would have been different. That is, the results of the name and fact extension trials would have coincided, demonstrating children’s willingness to extend both names and facts systematically to other members of the same category as the target object.

In order to make conclusions regarding the domain-specificity or domain-generalness of children’s extensions of novel words and novel facts, we needed to keep function in mind. In the present study we taught three- to four-year-olds both novel names and novel facts for unfamiliar objects within a single sentence frame. However, unlike Behrend et al (2001), the novel facts that we taught were not arbitrary. Rather,

they clearly described the function of the objects. The children were then presented with new arrays of objects that included the original training object, additional exemplars of that object, and distractors. From these arrays, children were asked to select exemplars of either the novel name or the novel fact.

## Method

### *Participants*

Twenty-four children participated in this study, twelve 3-year olds (5 females, 7 males) and twelve 4-year-olds (6 females, 6 males). The mean ages were 3 years, 4 months (range: 2 years, 8 months to 3 years, 7 months) and 4 years, 4 months (range: 4 years, 1 month to 4 years, 7 months). Children were recruited from the day-care center at Brooklyn College. Most were of Black/African American decent (71%), some (17%) were White (not of Hispanic origin), 2 were East Indian, and 1 child was Latin American. English was the primary language of all the children tested.

### *Materials*

*Training objects.* Four training objects were used for the name and fact training component of the experiment. Each of these objects was given a novel name along with a designated function that served as the novel fact. These training objects, their names, and designated functional facts are listed in Table 8.1.

Table 8.1

## Novel Training Objects and Novel Functional Facts (including novel words)

Novel Training Objects	Novel Functional Fact and Novel Word
1. Plastic hook	This koba is used to hang pictures.
2. Plastic funnel	This agnew is used to pour water.
3. Paint sponge	This daxon is used to paint things.
4. Cookie cutter	This jeter is used to make cookies.

*Test arrays.* Four test arrays were created for the four test trials of this experiment. Each included seven objects. Four of the novel objects (i.e., a training object and three additional exemplars) in each test array belonged to the same category and differed on the dimensions color, shape, and size (e.g., cookie cutters with unusual shapes, hooks) or color and size (e.g., funnels, paint sponges). The three remaining distractor objects in the test arrays belonged to different categories than the training object. They differed from the training object as well as from each other in terms of their individual appearances. For example, one test array included a hook as the training object, three additional hooks, and three distractor objects (e.g., a plastic toothbrush holder, a sponge, and a petri dish). A new set of distractors and exemplars was used for each trial.

*Procedure*

Children were tested individually in an isolated area within their day-care center. They were randomly assigned to either the word or the fact condition. Each child was asked to complete four experimental trials, one for each target object. Each trial consisted of three phases: baseline, name and fact training, and an extension test.

*Baseline.* For each trial, the experimenter first presented the six objects of a test array (excluding the training object) to the participant. The participants were encouraged to explore and manipulate the objects freely. The purpose of this component was to measure the saliency of both the exemplars and the distractors that made up each test array.

*Name and fact training.* Immediately following the baseline phase, the objects were removed from the table. The experimenter then picked up the appropriate training object and introduced it to the child with its designated name and functional fact. For example, she introduced the hook by saying, "See this? This is a *koba*. This *koba* is used to hang pictures. I can hang pictures with this *koba*." The experimenter then placed the training object to the side and proceeded to the next phase, the Extension test.

*Extension test.* The test array of objects was returned to the child (arranged randomly) with the target object positioned at the periphery. Depending on condition, the participant was then asked either the name extension question (e.g., "Are there any other *kobas* here? Can you show me another *koba* here or not?") or the fact extension question (e.g., "Are there any other things here that I can hang pictures with? Can I hang pictures with anything else here or not?") Children typically responded by pointing to or picking up their response choices. After a choice was made, the experimenter would move the item to the periphery of the array and repeat the question until the child said "no" or refused to make any more choices. Following the child's responses, the experimenter removed the test array from the table. She then replaced it with the next array and proceeded with the baseline phase of the next trial. Following completion of the last extension test, children were given a book and thanked for their participation.

## Results

*Baseline test.* Although previous studies did not make this comparison, we thought it important to compare the saliency of our test exemplars and distractor objects. An analysis of the children's first choices at baseline did not reveal any significant differences between the exemplar and distractor objects ( $p > .10$ , Exemplar = 38%; Distractor = 62%). An analysis of the children's first three choices at baseline did not reveal any significant differences either ( $p > .01$ , Exemplar = 43%; Distractor = 57%). This result indicates that the distractor objects were salient to the children and even slightly more salient than the exemplar objects. We concluded that our findings from the extension tests would not be compromised by the objects that we used.

*Extension test.* The primary dependent measure was the mean number of exemplar/distractor items chosen. A 2 (Age: 3-year-olds, 4-year-olds) X 2 (Extension Instructions: word vs. fact) X 2 Selection (exemplar vs. distractor) analysis of variance with the latter factor treated as a within-subjects factor was conducted on the mean number of objects chosen. This analysis revealed a main effect for Selection,  $F(1,20) = 400.28, p < .01$ . Children in both conditions were more likely to extend to the exemplars of the target category ( $M = 2.72, SD = 0.36$ ) than to the distractor objects ( $M = 0.36, SD = 0.56$ ). However, an interaction between Age and Selection ( $F(1,20) = 8.03, p = .01$ ) revealed that more distractor objects were chosen overall by the 3-year-olds ( $M = 0.60, SE = 0.20$ ) than the 4-year-olds ( $M = 0.13, SE = 0.04$ ),  $F(1,23) = 5.28, p < .05$ . However, both ages made a similar number of choices of exemplars ( $M = 2.63, SE = 0.11$  and  $M = 2.81, SE = 0.09$  respectively),  $F(1,23) = 1.72, p > .05$ .

The ANOVA also revealed a main effect for Extension Instructions ( $F(1,20) = 8.13, p = .01$ ) which was qualified by an interaction involving Age and Extension Instructions,  $F(1,20) = 7.01, p = .01$ . The results of the follow-up analyses examining the interaction indicate that while the 4-year-olds made a similar number of choices in the word ( $M = 1.46$ ) and fact conditions ( $M = 1.48; F(1,11) = .068, p > .05$ ), the 3-year-olds made significantly more choices overall in the fact ( $M = 1.90$ ) than in the word condition ( $M = 1.33; F(1,11) = 8.91, p = .01$ ). As can be seen in Table 8.2 and Figure 8.1, this finding was primarily due to the 3-year-olds choosing more distractors in the fact condition.

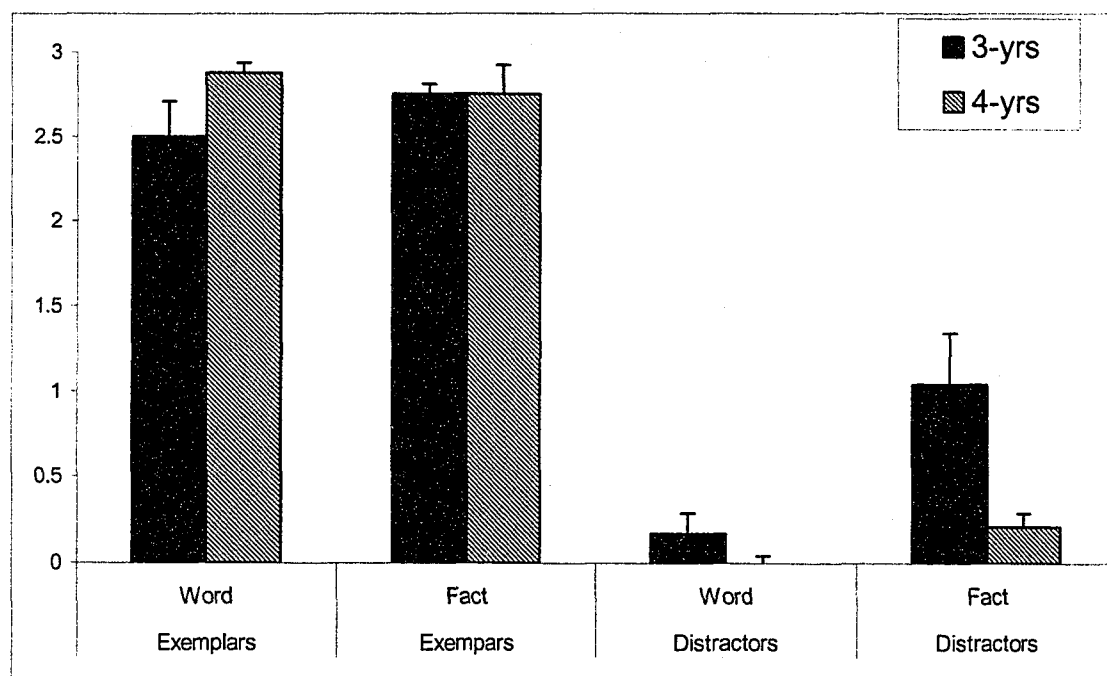
Table 8.2

Percentage of children, Mean Numbers, and Standard Deviations of Extensions to Exemplars and Distractors in Word and Fact Conditions as a Function of Age

Extension Type	Condition	Age		M	
		3-years	4-years		
Exemplars	Word	%	83%	96%	
		M	2.50	2.88	2.69
		SD	0.52	0.14	0.41
	Fact	%	92%	92%	
		M	2.75	2.75	2.75
		SD	0.16	0.42	0.36
Distractors	Word	%	6%	1%	
		M	0.17	0.00	0.10
		SD	0.30	0.10	0.23
	Fact	%	35%	7%	
		M	1.04	0.21	0.63
		SD	0.73	0.19	0.67

Figure 8.1

Mean number of word and fact extensions (out of 3) made by each age group to category exemplars and distractors.



In order to compare our findings with those of Behrend et al (2001), we also examined the percentages of children who extended the novel words and novel facts to additional exemplars. As can be seen in Table 8.3, almost all of the children in the current study extended the facts (92%) to all three of the appropriate exemplars. However, the children in the Behrend et al (2001) study extended the facts to either all of the appropriate exemplars (35%) or to none (41%).

Table 8.3

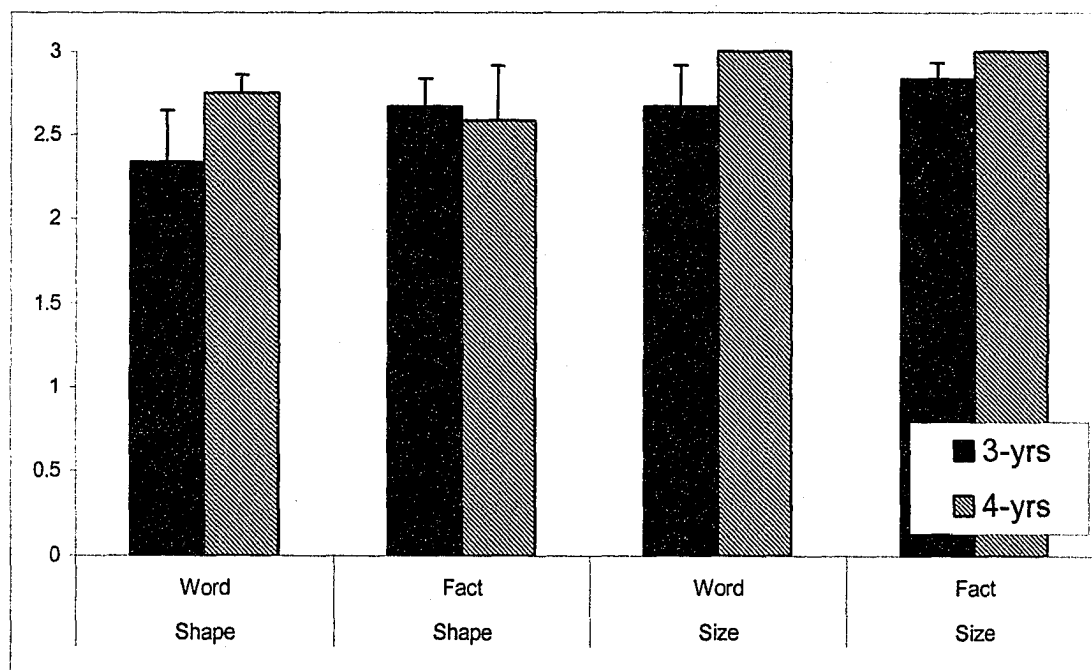
Percentage of Children who extended the Novel Words and Novel Facts to Additional Exemplars, Comparison Between Current Study and Behrend et al (2001)

		Number of Exemplars			
		0	1	2	3 or 4
Behrend et al	Word	7%	8%	7%	78%
Current study		0%	0%	17%	83%
Behrend et al	Fact	41%	17%	7%	35%
Current study		0%	0%	8%	92%

Finally, another analysis of the children's extensions to the category exemplars was conducted in order to determine if they were making their extensions on the basis of shape similarity. A 2(age group) X 2(condition: word or fact) ANOVA with exemplar dimension type (shape vs. size) as the within-subjects factor revealed only a marginal main effect for dimension type,  $F(1,20) = 4.14, p = .05$ , and no significant interactions. As can be seen in Figure 8.2, children in both age groups and in both conditions were nearly as likely to make extensions to category members that differed on the dimension of size ( $M = 2.88, SD = 0.34$ ) as they were to those that differed on the dimension of shape ( $M = 2.58, SD = 0.58$ ).

Figure 8.2

Mean number of word and fact extensions (out of 3) made by both age groups to exemplars that varied in shape and exemplars that varied in size.



### Discussion

The current findings demonstrate that the processes involved in word learning may not be as language-specific as other research has previously implied (Waxman & Booth, 2000; Behrend et al, 2001). Rather, the acquisition of novel words and novel facts in reference to unfamiliar objects both involve (a) establishing a mapping to a designated individual, and (b) extending that mapping to members of the same category as the target. Most importantly, these processes appear to be domain-general when the facts portray information about the function of the target objects. Unlike Behrend et al. (2001) who tested children's extensions of novel words to arbitrary facts, we used a similar procedure but replaced the arbitrary facts (e.g., "My uncle gave me this koba") with those that described the function of the objects (e.g., "I can hang pictures with this koba"). The

results showed that young children extend such novel facts just as systematically as they extend novel words. That is, the children extended the facts to as many category exemplars as they extended the novel words.

The only difference that we observed between the extensions of the children in the two conditions, those asked the name extension question versus those asked the fact extension question, had to do with the distractor objects. Interestingly, children's extensions to these objects were not analyzed in previous research (Behrend et al, 2001, Waxman & Booth, 2000). This could have been because the distractor objects used in these studies were not very salient to the children. In contrast, our baseline analyses revealed that the children in the current study immediately chose at least one distractor object upon first presentation of all the objects in a given array. That is, they could have made more extensions to the distractor objects than the children in previous studies because of the higher saliency of the objects themselves. Regardless, the differential treatment of these objects between the children in the word condition and those in the fact condition seemed to have been related to age. Only younger children in the study extended more facts than words to the distractor objects and this could easily have been due to their difficulty with the instructions of the task. As can be seen in the data, this difference is quite small.

Children's consideration of function in the current study is what distinguished our findings from those of other studies (Waxman & Booth, 2000; Behrend et al, 2001). We did not see differential extension of words and facts to other category exemplars because the facts in the current study described something about the function of the objects. According to Katherine Nelson (1974), children's linguistic concepts derive from their

understanding of what one can do with an object and what that object can do. This forms the functional core of the concept, whereas perceptual features are used only to identify later instances of the same kind of thing. More recently, Kemler Nelson and her colleagues (1995; 2000a; 2000b) have given us solid evidence that young children use their conceptual knowledge of function when naming artifacts. In contrast, Smith and her colleagues (Landau et al., 1988; 1998, Smith et al. 1996) maintain that labels recruit attention to salient perceptual properties (e.g., overall shape) and that labeling or naming in young children is nothing more than a “dumb attentional mechanism” driven by automatic associations.

In light of this controversy, we designed our stimuli in order to compare children’s extensions to category exemplars that differed either on the dimension of shape or on that of size. The fact that children extended to both types of exemplars almost equally implies that their ability to categorize objects goes beyond the realm of shape similarity. Although shape is salient to them in that they have learned that objects of similar shape are usually the same kind of thing, they are also aware that objects that differ in shape can share commonalities as well. The children’s concepts of the novel objects in the current experiment were based on the functional features of the objects. However, they may have extended the novel names to the new instances (exemplars) of the objects based on shared perceptual features. More relevant to the main hypothesis of the current study, these processes that guide children’s extensions seem to be domain-general when function is highlighted and made salient. The children extended the novel facts to category exemplars as systematically as they extended the novel, functional facts.

This implies that similar, if not the same, processes are invoked in the learning of both words and facts.

A major difference between the functional facts used in the current study and the arbitrary facts used in other studies (e.g., Behrend et al, 2001; Waxman & Booth, 2000) maps onto the difference between semantic and episodic memory. Arbitrary facts such as “My uncle gave me this koba” invoke episodic memory. Functional facts, however, provide the foundation for semantic memory because function gives meaning to objects and to their associated labels (Nelson, 1974; Kemler Nelson, 1995; 2000a; 2000b). It would therefore be erroneous to assume that the processes invoked by children when they are acquiring meaning about the world are specific to language. Regardless of whether that meaning comes in the form of words or functional facts, it is semantic memory, and one would hardly claim that semantic memory is domain-specific. It consists of our knowledge about the world, not all of which is encoded linguistically (e.g., Mandler, 1998; Piaget, 1967; Siegal, Varley, & Want, 2001).

According to Gelman and her colleagues (1986; 1987; 1991; 1994; 1998), children have essentialist beliefs. They will search for meaning in the form of causal explanations and they will categorize based on the assumption that category members share some unobservable but essential properties. In the domain of artifacts, these essential properties pertain to the functions that the objects belonging to a certain artifact category can all perform (Kemler Nelson et al., 1995; 2000a; 2000b). Therefore, as little essentialists, when young children hear a novel word (e.g., “koba”) in reference to an object, they may infer the meaning of the word by searching for the essential properties of that object (e.g., function). They might then extend that word to other objects in an

array that share those properties. The same is true of facts. Young children also extend facts on the basis of function, but only if those facts demonstrate something about the function of the objects that they refer to.

### **Chapter 9: General Discussion**

In Experiments 1 and 2 I employed the inductive generalization technique as created by Mandler and McDonough (1993; 1996; 1998; 2000; McDonough & Mandler, 1998) to study the inferences that 14-, 19-, and 24-month-old infants have made about the animal and vehicle domains. By using atypical rather than prototypical exemplars of animals and vehicles, I was able to assess the roles that perceptual similarity (Experiment 1) and language (Experiment 2) play in the categorization abilities of young infants. My interest in the role of language in conceptual development is what led me to the next issue that I addressed in Experiment 3: the nature of the processes evoked in language acquisition among toddlers. That is, in Experiment 3 I compared the way in which 3- and 4-year-olds extend novel words and novel facts in order to explore a current controversy in the literature concerning the language-specificity or domain generality of some of the proposed constraints and biases in language acquisition (Behrend et al, 2001, Markson & Bloom, 1997; Waxman & Booth, 2000). The following discussion will serve as a review of my findings from Experiments 1, 2, and 3, respectively.

The inductive generalization technique is a nonverbal technique that is used to ask preverbal infants about their categorical knowledge. Using little models of objects we demonstrate a property characteristic of a given class and then test whether infants will generalize the imitation of that property to other exemplars from the same class and/or those of a different class. This technique provides us with information about infant's

conceptual categories in that it tells us where the boundaries of a given class lie and the sorts of generalizations that infants are willing to make across these classes (Mandler & McDonough, 1996). Using prototypical models (e.g., a dog or a car) Mandler and McDonough have previously shown us that the perceptual categories resolved by 3-month-old infants (e.g., Eimas & Quinn, 1994) are not necessarily the first to be conceptualized developmentally. That is, through a series of experiments using this technique, these researchers have shown us that infants' generalizations do not rest on perceptual similarity when prototypical exemplars are used for modeling (Mandler & McDonough (1993; 1996; 1998; 2000)). The goal of Experiment 1 was to see if infants would generalize the same way (continue to overlook perceptual similarity) when atypical exemplars (e.g., an alligator or a shoveler) rather than prototypical exemplars (e.g., a dog or a car) were used for modeling.

Consistent with Mandler and McDonough (1993; 1996; 1998; 2000), the current data indicates that the earliest concepts about objects are rather global and that learning the details that distinguish basic-level concepts is a later achievement. Whereas the youngest infants in Experiment 1 (14-months) were equally as willing to generalize to both test exemplars, the older infants (24-months) were more constrained in their generalizations, choosing the exemplar from the same basic-level category as that used for modeling more often. That is, the results of Experiment 1 demonstrate that the developmental trend of conceptualization advancing downward from the global to the basic level (Mandler & McDonough, 2000) exists even when infants are making generalizations about objects with which they are presumably unfamiliar. This finding

lends further evidence to the point that early concepts are in fact dependent on some rudimentary meaning of objects rather than on their physical features alone.

It has been suggested that language acquisition may affect the course of conceptual differentiation during this developmental period (Gopnik & Meltzoff, 1992; Nazzi & Gopnik, 2001; Smith et al., 2001). However, the causal relation between language learning and conceptual differentiation is far from clear. Experiment 2 was conducted to address this issue and, more specifically, to test the claim made by Waxman and her colleagues (Waxman et al., 1986; 1995; Balaban & Waxman, 1997) that labels facilitate categorization. According to the current data, labeling does not necessarily induce infants to attend to perceptual similarity. Regardless of hearing a label in reference to the exemplars used for modeling (e.g., “the alligator is thirsty, have a drink alligator!”), the infants in Experiment 2 generalized in the same manner as those in Experiment 1. That is, it was still only the older group of infants in our study who used basic level categories to guide their generalizations. However, we used labels that are not necessarily familiar to infants (e.g., “alligator” and “shoveler”). Furthermore, we tested generalization in the context of domains with which the infants are already familiar (e.g. animals and vehicles). Mandler and McDonough (1996; 1998) have shown us that young infants are already aware that, for example, all animals drink and sleep. These are essential properties of all animals. Therefore, the labels used in the context of domains that infants are already familiar with may have nothing unique to contribute because infants already have the semantic knowledge necessary to make these inductions. However, the fact that the older infants in both Experiments 1 and 2 were more constrained in their generalizations than were the younger infants could have been due to

an indirect effect of language acquisition. Having had more experience with the process of language learning, 24-month-olds are perhaps more familiar with the heuristic that shape correlates with object labels (Smith et al., 2001). Their knowledge of such a heuristic might have tuned them into the conceptual differences between basic-level categories, thus making perceptual cues more salient. That is, the older infants may have been more conservative in their generalizations, generalizing more to the target exemplars, because they were using the heuristic thus attending more to the perceptual characteristics of objects, specifically the similarities between the modeling and the target exemplars.

However, as shown in Experiment 1 and by Mandler and McDonough (2000), 24-month-olds have begun to acquire basic-level concepts. They are beginning to attend to perceptual similarity even in the absence of labels or linguistic input. Therefore, we could say that a relationship between conceptual development and language acquisition seems to emerge around the second year of life. Furthermore, there seems to be a developmental progression leading up to this point. Initially, infants do not start out with a strong shape bias. As they are beginning to acquire basic-level concepts, they are also beginning to acquire language and use it to convey meaning. Through their experience using language to communicate about their concepts, they begin to learn the heuristic that similarly shaped items usually share the same label. It is at this point in development that they begin to use this heuristic when they are faced with new or puzzling situations. Therefore, it is highly possible that it is either language or concepts or both language and concepts that enable 24-month-olds to attend to perceptual similarity. For an overview of how Experiments 1 and 2 fit in with what is currently understood about the

developmental progression of cognitive and linguistic accomplishments up to 24-months of age, see Table 9.1.

Table 9.1

Cognitive and Linguistic Accomplishments in Development (three - to 24-months)

Age	Accomplishment	Citation
3-months	Basic-level categorization (perceptual)	Eimas & Quinn, 1994
7-months	Global categorization	Mandler & McDonough, 1993
9-months	Comprehension of intentional actions	Woodward et al., 2001
	Generalization of actions	McDonough & Mandler, 1998
13-months	Fast mapping	Woodward et al., 1994
19-to 24-months	Basic-level categorization (conceptual)	Mandler & McDonough, 2000 Marsh, Experiment 1
24-months	Shape-bias	Smith et al., 2001 Marsh, Experiments 1 & 2

Other researchers who have demonstrated an effect of labeling on infants' generalization behavior (e.g., Welder & Graham, 2001) have done so using novel objects that possessed non-obvious, unfamiliar properties (e.g., a cloth-covered object that squeaked when squeezed). When Welder and Graham (2001) labeled novel objects with familiar count nouns (e.g., "ball"), the infants performed as many target actions on the low similarity objects as they did on the high similarity objects. These results suggest that when the objects were treated like members of a familiar kind (i.e., given the same - familiar label), perceptual similarity did not influence infants' expectations about shared non-obvious properties. However, when the objects were labeled with novel nouns (e.g., "blint"), the infants did not overlook shape information. Just like the infants who were

not given labels in reference to the objects, the infants in the novel label condition performed significantly more target actions on the high similarity objects than on either the medium or the low similarity objects. It is interesting to note that Welder and Graham's (2001) findings are not entirely consistent with the claims made by Waxman and her colleagues (Balaban & Waxman, 1997; Waxman & Hall, 1993; Waxman & Markow, 1995). Recall that Welder and Graham maintain that infants recognize that familiar labels supply information about underlying object kind. According to the results of their experiments, infants as young as 16 months of age appreciate the conceptual information conveyed by familiar but not novel object labels. However, in Welder and Graham's (2001) experiments the information that the infants in the novel label condition attended to was the perceptual similarity among the objects. Although these researchers also suggest that there is continuity in lexical categorization across the infancy and preschool periods, their data does not allow them to make claims about underlying object kind.

It seems as though a label will only contribute to young infants' inductive inferences and generalizations to other category members when it is all that they have to go by. Therefore, the difference between the role of labels in our study and others (e.g., Welder and Graham's, 2001) is rather intuitive. Welder and Graham (2001) taught infants non-obvious properties of objects (e.g., squeaking when squeezed) and gave them either novel or familiar labels in reference to those objects. The infants overlooked perceptual similarity when they heard the familiar but not when they heard the novel labels. These unfamiliar properties, unlike those used in Experiments 1 and 2 (e.g., drinking and sleeping), are not general to domains with which infants are already familiar

(e.g., animals and vehicles). In order to generalize these non-obvious properties, the familiar labels could have been the only criteria that the infants in Welder and Graham's study had to go by. However, it is also likely that the infants were attending to the demonstrated functions of the objects when making their generalizations. Kemler Nelson and her colleagues have shown us that young children are willing to categorize objects and generalize labels on the basis of function, particularly when that function is demonstrated for them (e.g., Kemler Nelson et al., 2000a; 2000b). Children's consideration of function in such experiments implies that they have inferred the meaning of the category and the label that they learned.

Hypothesizing that function could be the link between linguistic and conceptual development, in Experiment 3 I employed a procedure similar to Waxman & Booth (2000) and Behrend et al. (2001) to test young children's extensions of novel words and facts to various artifacts. However, I replaced the arbitrary facts they used (e.g., "My uncle gave me this koba") with facts that described the function of the objects (e.g., "I can hang pictures with this koba"). The results showed that young children extend functional facts just as systematically as they extend novel words. That is, they extended the facts to as many category exemplars as they extended the novel words. These findings demonstrate that when information about the function of artifacts is made apparent, children employ the same processes when learning either words or facts that refer to them.

Language-specific processes, constraints, or assumptions were originally proposed to explain how young children are such efficient word learners in spite of the many challenges that exist for them. In the past, researchers have posited that these

processes are innate (e.g., Markman & Hutchinson, 1984) rather than a product of learning language itself. The two arguments that have been the focus of domain-specificity v. domain-generality views concern: (1) the ability to establish fast mapping of a word to a designated object and (2) the ability to extend that mapping to members of the same category as the target. Since agreement has previously been established regarding the domain-generality of the first argument (i.e., the fast-mapping process, Markson & Bloom, 1997; Behrend et al., 2001), the focus of the present experiment was on the second argument (i.e., the taxonomic assumption). Our results demonstrated that when function is highlighted, word learning and fact learning do not differ with regard to the dimension of extendibility.

In order to explore children's use of the shape bias in making their extensions (e.g., Landau et al., 1988; 1998, Smith et al., 1996), we designed our stimuli in order to compare children's extensions to category exemplars that differed either on the dimensions of size and color or on the dimensions of size, color and shape. The fact that children extended to both types of exemplars almost equally implies that their ability to categorize objects goes beyond the realm of shape similarity. Although shape is salient to them in that they have learned that objects of similar shape are usually the same kind of thing, they are also aware that objects that differ in shape can share commonalities as well. The children's concepts of the novel objects in the Experiment 3 were based on the functional features of the objects. It is likely that in the absence of information about function children would have made many more extensions to the exemplars that varied in size but shared the same shape. Without functional information, they would need to rely on the shape similarity (or perhaps shared features). As in the study conducted by

Behrend et al. (2001) in which arbitrary facts were used, the children lacked concepts of the novel objects. Recall that the participants in both the Behrend et al and the Waxman and Booth studies tended to be split in terms of their generalizations of the arbitrary facts. It is possible that some children who had learned that shape correlates with labels (as shown by Smith et al., 2001) may have also applied this learned heuristic (learned via domain general processes) to the extension of the arbitrary facts whereas other children either understood that the heuristic applies to labels only (and not facts) or they understood the arbitrary nature of the facts (and were perhaps more tuned into which events tend to be “episodic”) so they did not extend the facts at all.

To conclude in a somewhat speculative manner, the major difference between the functional facts used in Experiment 3 and the arbitrary facts used in other studies with this age group and older (e.g., Behrend et al, 2001; Waxman & Booth, 2000) maps onto differences between semantic and episodic memory. Facts such as “My uncle gave me this koba” invoke episodic memory. Whether or not children will come to expect that their uncle always gives them kobas is likely to depend on the desirability of a koba and the frequency with which their uncle provides them with other kobas and the provision that kobas are not offered to them by anyone else or by other means. In some cases, an uncle could become a “koba-giver” but these kinds of cases are likely to be rare. Functional facts, however, provide the foundation for semantic memory in that function gives meaning to objects and to their associated labels (Nelson, 1974; Kemler Nelson, 1995; 2000a; 2000b). It would therefore be erroneous to assume that the processes invoked by children when they are acquiring meaning about the world are specific to language. Regardless of whether meaning comes in the form of words or functional

facts, when we talk about semantic memory we are talking about meaning. It is not clear how one could claim that semantic memory is domain-specific. After all, our semantic memory consists of our knowledge about the world, which provides the symbol grounding our language needs. Yet not all of our knowledge is encoded linguistically (e.g., Mandler, 1998; Piaget, 1967; Siegal, Varley, & Want, 2001).

It is clear from the results of Experiments 1 and 2 that preverbal infants use their non-linguistic knowledge of global categories to make inductive generalizations. Upon seeing an alligator being given a drink, the 14-month-olds in both experiments understood the event as “animal drinking.” Although they were presumably unfamiliar with the particular animal used for modeling, they used their knowledge of the animal domain to infer that both exemplars were animals thus both should be given a drink. That the infants’ patterns of generalizations did not change in Experiment 2 when they were given labels for these unfamiliar items is further evidence that their knowledge of these superordinate level, animal and vehicle domains is not linguistically-based. The infants in Experiments 1 and 2 seemed to be using their domain-general knowledge of such domains to make their generalizations. It is domain-general rather than domain-specific knowledge (specific to language) because infants make the same generalizations regardless of the addition of linguistic input (e.g., Experiment 2). Although older children (e.g., preschoolers) are no longer preverbal and have begun to encode their concepts linguistically, it is my contention that they derive meaning from either the essential nature of natural categories or the function of artifact categories. That such meaning is ascertained regardless of whether the information is given in the form of

words or functional facts implies that the processes that young children use are not language-specific.

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