Infants' Generalization of Motion and Mental Properties to Animals and People.

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ABSTRACT

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It has recently been proposed that infants have formed conceptual categories, such as animate and inanimate objects, by the end of the first year (Mandler, 1992). How such global domains are represented remains to be determined. It has been argued that infants distinguish between animates and inanimates on the basis of the motion and mental characteristics of members of these two categories (Mandler, 1992; Rakison & Poulin-Dubois, 2001). In the present study, the inductive generalization paradigm was used to examine 16- and 20-month-olds' knowledge of the motion and mental capabilities of animate beings. Twenty-four 16-month-old infants and twenty-four 20-month-old infants participated in the study. The main objective of the present study was twofold: 1) to determine if infants can generalize motion and mental properties across category members, and 2) to examine the breadth of the animate category in young infants. The task included four trials, each of which consisted of a baseline and a generalization phase. The experimenter modelled two motion properties (jumping over a wall, moving up a set of stairs) and two mental properties (looking in a mirror, answering a phone) using a monkey doll. Test exemplars were toy replicas of animals and people. As expected, 16- and 20-month-old infants performed more actions during the generalization than during the baseline phase. Sixteen month-old infants chose the animal and person equally often to imitate both <u>motion</u> and <u>mental</u> properties, suggesting that infants have developed a concept of animates by that age. In contrast, 20- month-old infants chose the person significantly more often than the animal to imitate the <u>mental</u> properties, suggesting that by 20 months of age, infants reserve mental properties preferably to people.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Infants' Generalization of Motion and Mental

Properties to Animals and People.

Children possess quite remarkable cognitive abilities, including the ability to classify objects into broad categories. This is a remarkable accomplishment given the sheer diversity of objects in the environment. The nature of infants' earliest categorical distinctions is a central topic in the field of cognitive development. Some researchers have proposed that infants begin by forming basic-level categories that are easily distinguishable based on perceptual cues. Proponents of this view contend that such categories are based primarily on the physical similarity or degree of differentiation among objects (Mervis & Crisafi, 1982; Mervis & Rosch, 1981). That is, young infants' early perceptual categorization is considered to be based on similar shapes and features that objects share (Quinn & Eimas, 1996, 1998). Properties such as texture and shape presumably enable the infant to categorize at the basic level where objects within a category are relatively similar to one another, and fairly different from objects from another category. For instance, an example of a basic-level category that is easily differentiated from another basic-level category is that of dogs versus birds. Furthermore, researchers typically maintain that infants' early perceptual categories (of dogs and birds for instance) comprise the basis on which more abstract concepts are established. Quinn and Eimas, for instance, have argued that the formation of basic-level categories "is a necessary prerequisite for superordinate category formation" (Quinn & Eimas, 1996, p.15). It is believed that once infants have encountered individual objects from these basic-level categories, for instance a dog, they then continue to add information that is available through the perceptual system. Eventually, these categorical representations become conceptually-based and infants can generalize to dogs as a class. In other words, the assumption is that infants "first learn to identify what dogs look like and then to associate various behaviours and other properties with these perceptual categories" (Mandler, 2000, p.4). The claim is that with experience, infants learn to group these basic level categories of dogs, cats, birds etc. into a larger, more general category of animal, where within-category members are perceptually dissimilar.

The Conceptual View of Infant Categorization

Classifying objects into separate categories based on perceptual cues does not necessarily mean however that infants have "thereby formed any theory of what the objects being categorized *are* or that they can use this information for purposes of thought" (Mandler, 1992, p.588). One leading theory on early categorization is that infants form conceptual categories of objects, such as animals and vehicles, at an early age. According to this conceptual view of categorization, infants possess some understanding of superordinate categories that surpasses knowledge of purely perceptual similarities. More specifically, infants are said to "classify objects initially on the global level, referring primarily to conceptual knowledge of causal attributes" (Pauen, 2000, p.134). Essentially, proponents of this view argue that infants' early categorical distinctions are in effect conceptual in nature (Mandler, 1992, 2000). Hence, infants have acquired the ability to not only recognize what the objects are (perceptual knowledge), but have also acquired a meaning of what "kind of thing" the objects, such as animals or vehicles, are (conceptual knowledge). In contrast to the perceptual view of categorization which posits that infants first form basic-level categories before being able to categorize at a more global level, the conceptual view maintains that global categorization is an ability that develops first, followed later by a gradual differentiation of these more general, global categories. Accordingly, one of the purposes of conceptual categories "is to allow inductive generalizations across the exemplars of a class, a function that allows a wide range of knowledge to be acquired from a limited set of observations" (Mandler & McDonough, 1996, p.309). Given the significance of conceptual categories to infants' expanding capacity for knowledge, it is therefore imperative that we examine how infants arrive at this "new kind of understanding" (Mandler, 1992, p.588).

Infants' Categorization of Animate and Inanimate Objects

One way to address this perceptual versus conceptual question is by examining the animate-inanimate distinction in infancy. The development of the animate-inanimate distinction, which arises in early infancy, is one of the major achievements in cognitive development (Rakison & Poulin-Dubois, 2001). It is a fundamental cognitive ability that structures how humans divide their world. A great deal of research demonstrating that infants are capable of discriminating animate (e.g. animals) from inanimate objects (e.g., vehicles) comes from studies using the object-manipulation paradigm. In this task, an array of objects from two categories is simultaneously placed in front of the infant and the order in which the infant touches the objects is recorded. If infants understand the distinctions between the categories, it is reasoned that they would tend to sequentially touch objects that belong to the same category more frequently than would be expected by chance. Using this task, Mandler, Bauer, and McDonough (1991) presented infants with four animals (cow, turtle, seal, chicken) and four vehicles (ambulance, train engine, off-road vehicle, bus) and examined the order in which infants manipulated the objects. The results showed that by 18 months of age infants distinguish between the animal and vehicle domains. In a similar experiment, the authors used vastly perceptually dissimilar animal exemplars (elephant, rabbit, robin, shark) and vehicles (semi-cab, motorcycle, airliner, tugboat) with 20-month-old infants in order to see whether a greater degree of differentiation might affect infants' ability to categorize these items into broad domains. The authors replicated the findings of their previous experiment, providing further evidence that infants have developed global categories of animals and vehicles by 20 months of age. Additional support for this hypothesis is provided by a number of other studies. For instance, Mandler and McDonough (1993) and Rakison and Butterworth (1998a, 1998b) found comparable findings in even younger infants – infants as young as 9 and 14 months were found to distinguish animals and vehicles. As well, Oakes, Coppage, and Dingel (1997) found that 10-month-old infants' attention increased when they were presented with a truck after having been familiarized to animals. That is, by 10 month of age, infants were able to categorize animals and vehicles. While various studies have thus far indicated that between 10 and 20 months infants can categorize animals and vehicles, additional research on categorization also indicates that infants can distinguish animals from other artefacts. Using the object manipulation paradigm, Mandler, Bauer, and McDonough (1991) found that 22- to 24-month-old infants have formed global categories in three domains – plants, furniture and kitchen utensils – that are typically considered to be superordinate categories.

Researchers have also demonstrated that infants are capable of distinguishing people from inanimate objects. Ross (1980) used the habituation-dishabituation paradigm as a mean of assessing 12- to 24-month-old infants' category knowledge. Infants were presented with a series of individual exemplars from various categories and the amount of time infants looked at and touched each exemplar was recorded. If infants have attributed similar meaning to objects that comprise a category, then it is presumed that they would habituate (i.e., their looking time would progressively decrease) to repeated presentations of members of the same category. Moreover, since presentation of a novel stimulus leads to an increase in attention, then infants should presumably dishabituate when perceiving an out-of-category exemplar. Indeed, Ross found that infants habituated to people – indicating that they were able to recognize this category – and dishabituated when presented with an out-of-category exemplar. Infants understood that the novel out-of-category exemplar did not conform to the category they had been familiarized to. Similarly, Spelke, Phillips, and Woodward (1995) found that infants at 7 months reasoned differently about people and objects. In other words, infants understood that objects, but not people, require contact to move on their own. Taken together, these results suggest that infants have an understanding of people as different from objects.

Motion as the Basis for the Animate-Inanimate Distinction

One leading notion in the field of developmental research that has recently been proposed is that infants distinguish between animates and inanimates on the basis of the motion and mental characteristics of the members of these two categories (Mandler, 1992; Rakison & Poulin-Dubois, 2001). Premack (1990) argued that infants understand that animates engage in self-propelled motion whereas inanimates do not. According to Mandler (1992), infants make use of a specialized representational process (perceptual analysis) to recode perceptually available cues, such as self-motion, into more abstract, conceptual categories (image schemas). Infants' concepts of animate beings and inanimate objects are believed to develop from such schemas. In a detailed analysis of the development of the animate-inanimate distinction in infancy, Rakison and Poulin-Dubois (2001) presented a more comprehensive account of Mandler's (1992) view that infants use motion cues to form conceptual image schemas. The authors outlined seven motion- and mental-related characteristics that infants may use to distinguish animates from inanimates. The motion cues consist of: (a) onset of motion (self-propelled vs. caused motion), (b) line of trajectory (irregular vs. smooth), (c) form of causal action (action at a distance vs. action from contact), (d) pattern of interaction (contingent vs. non-contingent), and (e) type of causal role (agent vs. recipient). The mental-related characteristics, or psychological attributes, of the animate-inanimate distinction include: (a) purpose of action (goal-directed versus without aim) and (b) influence of mental states (intentional versus accidental). Whether infants make use of some or all of these motion and mental cues to make an animate-inanimate distinction is of specific theoretical interest as they "have the capacity to signal quite *abstract* conceptual information, such as agency, intentionality, and goal-directedness." (Gelman & Opfer, in press).

A number of researchers have attempted to determine whether infants truly use motion cues to form an animate-inanimate distinction. Poulin-Dubois and Shultz (1988) found that by 13 months, infants know that inanimates are not capable of self-motion. In a study that examined the claim that an object's ability to demonstrate self-propelled movement may form the basis for the animate-inanimate distinction, Spelke, Phillips, and Woodward (1995) found that 7-month-old infants reacted differently when they saw inanimate objects or people change their motion with or without contact. That is, infants appeared to understand that only people – and not inanimate objects – have the ability to show self-propelled movement. Further studies lend support to the assertion that infants are sensitive to motion cues. Poulin-Dubois, Lepage, and Ferland (1996) observed 9- and 12- month-old infants' reactions when they were in the presence of an unfamiliar inanimate object (a remote-controlled robot) and an unfamiliar animate object (a human stranger), which started to move on their own (i.e., without any outside causal force). Infants as young as 9 months of age showed an increase in negative affect (e.g., fussing/fretting, crying, clinging to mother) when they witnessed the inanimate object (robot) moving independently. The authors interpreted this finding as indicating that infants as young as 9 months have an understanding that inanimate objects are not self-propelled, providing further evidence that young infants discriminate between animate and inanimate objects on the basis of motion cues.

The Inductive Generalization Paradigm

Thus far, studies on categorization seem to indicate that by 24 months infants can recognize similarity or commonness within categories and dissimilarity or distinctions between categories. However, it is nonetheless difficult to decipher to what extent such categories are of a conceptual nature (Mandler, 2000; Quinn & Eimas, 1996; Rakison & Butterworth, 1998). That is, it remains to be determined whether infants' ability to distinguish perceptually different categories such as animal, vehicle, and furniture signifies that they have formed conceptual categories. To address this issue more convincingly, Mandler and McDonough (1996, 1998) conducted a number of studies in which they used the inductive generalization paradigm to test infants' conceptual categories of animate and inanimate objects. In this task, infants are shown an action or property appropriate to a given class (either animate or inanimate) modeled onto toy replicas of objects. Infants are then provided with novel objects from the same and from different classes and the appropriateness of infants' imitations is assessed. Forming an animate-inanimate distinction requires not only the ability to distinguish the items that belong to broad categories, but it further requires the ability to ascribe similar attributes and features to members of each class. Accordingly, the inductive generalization technique provides a means of assessing infants' conceptual categories by providing information on where "the boundaries of given classes lie and the sorts of generalizations infants are willing to make across these classes" (Mandler & McDonough, 1996, p.308).

Using this procedure, Mandler and McDonough (1996) tested 14-month-old infants on two properties typical of animals and two properties typical of vehicles. The animal properties were drinking from a cup and sleeping. The vehicle properties were giving a ride and using a key on a vehicle. Infants were first provided with exemplars from two categories (e.g. a cat and a motorcycle) and a prop (e.g. a bed). Infants were allowed to interact with the objects and a baseline measure of behaviour was obtained. The experimenter then modeled a property (e.g., putting in a bed) using a different member of one category (e.g., a dog). After the demonstration, the experimenter substituted the original test exemplars for the model, and infants' behaviours were coded for performance (or non-performance) of the properties with the animal or vehicle test exemplars. 14-month-old infants generalized the target properties significantly more often to the appropriate category exemplars than to the non-appropriate exemplars. This was taken as evidence that infants understand that animate objects engage in certain actions that inanimate objects do not, indicating that infants have conceptual categories of animals and vehicles. Importantly, the authors maintained that because the exemplars were perceptually different from the object used to model the property, the infants were not making inductions based on perceptual similarity but rather on conceptual knowledge of the categories. More recently, McDonough and Mandler (1998) replicated these findings with 9- and 11-month old infants, using a modified procedure.

Although these studies seem to provide rather compelling evidence that infants' early categories are indeed conceptual categories, they nonetheless do not address the premise that infants make use of motion cues to form animate and inanimate concepts. Thus far, very few studies have examined infants' ability to associate motion with categories (Baker & Poulin-Dubois, in prep; Poulin-Dubois and Vyncke, 2002). Using the inductive generalization task, Poulin-Dubois and Vyncke (2002) sought to determine whether 14- and 18-month-old infants are capable of generalizing motion trajectories from one category to another. Following the baseline phase, infants observed the experimenter model two animate-like motions (climbing up stairs, jumping over a block) and two inanimate-like motions (driving over a triangular ramp, sliding up and down a U-shaped ramp). In the generalization phase, infants were given the prop along with an exemplar from the target domain (i.e., either the vehicle or the animal domain depending on the trial) and an exemplar from the other domain and had the opportunity to imitate these motions. Infants performed significantly more actions with the appropriate exemplar in the generalization trials. Furthermore, infants' use of the appropriate exemplar increased from baseline to generalization. However, because infants' imitation rate on the generalization trials was relatively low (maximum score was 50%), it would be worthwhile to further examine infants' knowledge of the motion properties of animals and vehicles. This study also requires replication and extension with people and animals in order to assess infant's knowledge of motion properties within the animate domain.

The Scope of the Animate Domain in Infancy

Mandler's proposal concerns the development of animate and inanimate object categories, which are broader categories than animals and vehicles. Some research has endeavoured to examine whether infants have a broad category of animates that is comprised of both people and animals. If, as has been proposed, infants begin by acquiring basic-level categories, then it is reasonable to assume that they might classify people and animals into separate categories. On the other hand, if infants' earliest categories are global then they should likely form an animate-inanimate distinction in which animals and humans are all classified into one domain (Pauen, 2000). Thus far, only a few studies have examined infants' understanding of the animate domain and have failed to adequately shed light on which view accurately depicts infants' categorical representations (Oakes, Plumert, Lansink, & Merryman, 1996; Pauen, 2000; Quinn & Eimas, 1998; Ross, 1980). In the first study on this topic, 12-month-olds habituated to the category of men and dishabituated when presented with an animal exemplar in the test phase, indicating that they can differentiate people from animals (Ross, 1980). Similar results are provided by Oakes, Plumert, Lansink, and Merryman, (1996) and by Pauen (2000) who found that infants between 7-11 months distinguished between animals and people in an object-examination task. What these findings clearly suggest is that infants can recognize categories such as people and animals. They do not however, support the hypothesis that infants understand that people and animals share some properties as members of the same global category.

Infant's Attribution of Mental Properties

The animate-inanimate distinction is a pivotal cognitive achievement that is linked to more sophisticated understandings – such as the psychological attributes of animates. While animate and inanimate objects differ with regard to many properties, such as motion characteristics, there is another fundamental distinction that differentiates them. Specifically, animates are creatures that "know, perceive, emote, learn, and think" (Gelman & Spelke, 1981, p.45). A central focus among infancy researchers revolves around when children first appreciate that only animate objects have minds. As such, an evaluation of infants' distinctions between animate and inanimate objects must entail "an assessment of early sensitivity to the role that mental states play in the actions of animates" (Rakison & Poulin-Dubois, 2001, p.211). Researchers such as Tomasello (1995) and Wellman (1993) have suggested that during the second year of life infants begin to attribute mental states such as desire, perception, and emotion to people. No research is as yet available on the attribution of mental properties in infancy however. Studies which examine infants' generalizations of mental states to animates are therefore needed before definitive conclusions can be made about infants' conceptual understanding of the mental properties of animate beings (Rakison & Poulin-Dubois, 2001).

As mentioned previously, one means of assessing conceptual knowledge is by examining the type of *inferences* infants are willing to make about members of a given domain. The only study to date of this kind utilized the inductive generalization task to assess infants' attribution of mental properties to animates (Johnson, 2000). Johnson proposed that if infants' representation of animates as "agents" is a conceptual one, then they should generalize mental properties exclusively to members of the animal domain. Specifically, infants were tested on their willingness to attribute the mental properties of "looking" and "listening" to animals and not to vehicles. 14-month-old infants were more likely to generalize the bodily properties (sleeping on a bed, drinking from a bowl) as well as the mental properties (looking at a picture, listening into a phone) to animals than they were to vehicles. Although infants' attributions of mental properties to members of the animate domain seem to indicate that infants possess a conceptual category of animate beings, it is important to consider that infants' rate of production was quite low for the mental events. One possibility as to why infants performance was low may be that the nature of the task was simply too demanding for the infants. Infants were required to process a large amount of information in order to reproduce the modeled property. For example, the "looking" property was demonstrated by having the model animal approach the side of a sign with a picture on it while the experimenter exclaimed "Look at the picture! Isn't that pretty! Look at the picture!" Nonetheless, these results are promising and provide additional support for the proposal that conceptual knowledge of animate beings in infancy exists.

The Present Study

The literature reviewed thus far indicates that infants have formed global conceptions by the end of the second year of life. However, one of the shortcomings of this line of research is that most studies typically contrast animals with vehicles and focus on bodily activities. Moreover, only a small number of studies have attempted to examine infants' knowledge of the motion properties associated with animate and inanimate objects. As well, considering that infants spend the majority of their time with human caregivers whom they strive to imitate, the shortage of studies on infants' conceptual knowledge of animates is surprising. More specifically, there is a lack of studies examining infants' ability to attribute mental properties to humans and animals. The present study was therefore designed to further address these issues in 16- and 20-month-old infants. One main objective was to examine whether infants understand the motion and mental properties of animate beings (e.g., animals, people) and are therefore able to geneneralize such properties across category members. A second goal was to determine the breadth of the animate category in these young infants. That is, whether 16- and 20-month-old infants have developed a broad category of animates that includes both people and animals. Given the low rate of production found by Johnson (2000) and Poulin-Dubois and Vyncke (2002) with 14-month-old infants, a slightly older age group was selected for the current study. Twenty-four 16-month-old and 24 20-month-old infants were tested using the generalized imitation task. Four trials consisting of two motion properties (jumping over a wall, moving up a set of stairs) and two mental properties (looking at oneself in a mirror, answering a phone) were administered to the infants. The mental properties were the same as in Johnson's study, though they were made somewhat less challenging for the infants. Four animals (tiger, cow, pig and horse) and four people figurines (two males and two females) were used as test exemplars. The first part of each trial was a baseline phase which served to familiarize infants with the toy animals, figurines, and props, as well as to assess infants' previous knowledge of the properties. Following the baseline phase the experimenter used a model exemplar (a monkey doll) to demonstrate the motion or mental property in question. In the generalization phase, infants were presented with the person and animal introduced to them in the baseline phase and were encouraged to imitate the property previously observed. The dependant variable was the first object infants chose to enact a property (maximum score=4). It was expected that 1) infants would choose the animal and person equally often to imitate the motion properties, and 2) infants would be more likely to produce the mental properties of looking and listening on people than on animals.

Method

Participants

The sample consisted of 24 16-month-old (mean=16 months, 2 days, range=15 months, 7 days to 16 months, 8 days) and 24 20-month-old infants (mean=20 months, 3 days, range=19 months 2 days to 21 months 1 day). An equal number of females and males were included in the 16-month-old group. In the 20-month-old group, there were 14 males and 10 females. The infants participating in the study were French- and English-speaking from predominantly middle-class families living in the greater Montreal area. All infants had a minimum 35-week gestation period and none of the infants included in the final sample had visual or auditory impairments, as reported by their parents.

In the 16-month-old sample, an additional 17 participants were tested but not included in the final analyses due to one of three reasons: an inability to successfully complete 2 out of 3 warm-up trials (n=2), fussiness or inability to complete the task trials (n=13), and experimenter error (n=2). Similarly, in the 20-month-old sample, an additional 9 participants were tested but not included in the final analyses due to an inability to successfully complete 2 out of 3 warm-up trials (n=2), fussiness or inability to complete the task (n=6), and experimenter error (n=1).

Participants were recruited from an existing subject pool, available at the Cognitive Development Laboratory at the Centre for Research in Human Development (CRDH) at Concordia University, or through birth lists provided by the Régie Régionale de la Santé et des Services Sociaux de la Région Montréal-Centre, with the approval of the Commission d'Accès à l'Information du Québec. Potential participants were first sent a letter describing the nature of the study and then were contacted by telephone to inquire about their interest in participating with their infants. A copy of the recruitment letters (French and English versions) sent to parents is provided in Appendix A.

Objects and properties tested

The stimuli used in the warm-up trials consisted of a red plastic cup and a small wooden cube (1 inch x 1 inch), a plastic blue cone and accompanying rings, and a set of stackable blocks (warm-up stimuli presented in Appendix B)

For the experimental trials, the stimuli used consisted of a wall and a set of stairs made of Lego blocks, a small plastic telephone, and a round mirror mounted on a wooden base (experimental stimuli presented in Appendix C). Infants were tested on two different types of motion properties and two different types of mental properties. For one motion property, the experimenter modeled a doll jumping over a wall, and for the second motion property a doll moved up a set of stairs. The first of the mental properties was seeing and was modeled by having a doll look in a mirror. The second was listening and was modeled by having a doll answer a telephone. The different motion and mental properties were accompanied by appropriate vocalizations by the experimenter: "Whoop" for the wall jumping, "Tum, Tum, Tum" for the stairs, "Look it's me, How pretty!" for the mirror, and "Ring Ring, Hello?" for the telephone.

For all four types of properties, the model exemplar was a monkey doll. The monkey model had perceptual features common to animals (e.g., a tail) as well as people (e.g., stood on two legs) and therefore ensured that infants' imitations could not be explained by perceptual matching alone. The test exemplars were small model replicas of animals and people. The animal stimuli used were a tiger, a cow, a horse, and a pig.

The people stimuli were a man, a woman, a boy, and a girl figurine. An example of one of the orders of presentation is provided in Table 1 which lists the properties tested, the props used for modeling the events, the test exemplars, and the vocalizations that accompanied the modeling for that order.

Procedure and Design

The infants and their parent(s) were greeted in a reception room arranged as a playroom. During a brief warm-up period, the experimenter played with the infant to enable him/her to become accustomed to both the new environment and the experimenter. During this time, the parent was asked to sign a consent form (for sample consent forms, see Appendix D for French and English versions), and to complete a participant questionnaire. The participant questionnaire requested demographic, familial, and medical information and also served as a screening tool to exclude participants who had physical conditions either before or after birth (i.e., born prematurely, vision/hearing problems). A copy of the participant questionnaire (French and English versions) is provided in Appendix E. Written and verbal instructions regarding the procedure were also provided to the parent. As well, parents were reminded that the testing sessions were videotaped. A copy of the French and English instructions presented to parents is provided in Appendix F. Once the infants seemed at ease (usually after 10-15 minutes), the parent and the infant were accompanied to the testing room where the experiment was carried out. Each infant was seated in a child's seat or on their parent's lap across the table from the experimenter. Each session was videotaped and parents were asked not to influence their child's behaviour by commenting in any way or by calling attention to any

Table 1

Properties tested, props, test exemplars, and vocalizations for order 1.

Property tested	Test exemplars		Vocalization
Motion: moving up stairs	Tiger	Woman	Tum, Tum, Tum!
Mental: looking in a mirror	Boy	Cow	Look it's me, How pretty!!
Motion: jumping over a wall	Pig	Man	Woop
Mental: answering a telephone	Girl	Horse	Ring, Ring, Hello?

of the toys during the study. Each testing session included three warm-up trials and 4 experimental trials. All experimental trials consisted of a baseline and a generalization phase. Infants were tested on four properties: two motion properties appropriate to both animals and people, and two mental properties appropriate to people only.

The three warm-up trials, which served to familiarize infants to the imitation procedure, were administered at the beginning of the study. The first warm-up trial consisted of dropping the block into the cup while saying "Clop!" In the second trial, the experimenter slid a ring onto the cone and said "Wee!" and in the third task, the experimenter stacked one block onto another and said "Boom!" The tasks were modeled three times for the infant, following which the infant was given the opportunity to imitate each action with the same props, and was praised for doing so.

Consistent with previous studies that utilized the inductive generalization task (e.g., Mandler & McDonough, 1996, 1998), infants' responses were assessed at two occasions, once prior to the experimenter's modeling of the property (baseline) and once subsequent to the property being modeled (generalization). In the baseline phase, infants were presented with two test exemplars and a prop (e.g., stairs). Each test pair was comprised of one animal and one person. The experimenter did not demonstrate any property with the prop nor did the experimenter encourage infants to initiate a response. The purpose of the baseline phase was to avoid the possibility that the novelty of the test exemplars would influence performance in the generalization phase, as well as assess infants' previous knowledge of the properties being tested. The infants were allowed to explore the objects for approximately thirty seconds, after which time the experimenter removed the stimuli and the prop. The experimenter then re-introduced the prop and demonstrated a target property with a model exemplar (a monkey doll) for the modeling phase of the trial. Modeling of these target properties was comparable to the modeling in the warm-up trials: the demonstration was performed three times accompanied by appropriate vocalization (e.g., "Tum, Tum, Tum" as the monkey walks up the stairs). The property was modeled once on either side of the infant and once directly in front of the infant, in order to prevent any possible side biases.

Following the demonstration, the experimenter substituted the test exemplars (i.e. an animal and a person figurine) for the model, which were placed simultaneously on either side of the infant. The experimenter encouraged the child to imitate the property by saying, for example, "Can you show me "Tum, tum, tum?" on the stairs trial. Infants were prompted in this manner a maximum of three times and the task ended when infants stopped manipulating the stimuli, or when approximately sixty seconds had elapsed. This sequence (baseline, modeling, generalization) was repeated until each infant was administered the two motion properties (jumping over a fence, moving up a set of stairs) and the two mental properties (looking at oneself in a mirror, answering a phone).

The order of presentation of the four properties tested was counterbalanced across all subjects such that each property appeared equally often in first, second, third, or fourth place. The sole constraint imposed on the counterbalancing procedure was that a motion trial could not be preceded or followed by another motion trial, and vice versa for the mental trials. It was also ensured that across all participants, each test exemplar appeared equally often with each prop, and that it was paired equally often with each test exemplar from the other category. Furthermore, the side on which the test exemplars from the animal and person category were presented to the infants was counterbalanced, as was the side on which the first trial began. A description of the counterbalancing conditions is provided in Appendix G.

Upon completion of the study, a certificate of merit for contribution to science was given to the infants for their participation. In addition, any travel expenses (taxi, bus) were reimbursed to the parents. Finally, a report describing the overall results of the study was sent to all families who participated (see Appendix H for French and English versions).

Scoring and Intercoder Agreement

Infants' responses were coded for performance (or non-performance) of the target actions with the person or animal test exemplars (see Appendix I for sample Coding Summary Sheet). A coding scheme was developed to determine the criteria for a successful imitation. A successful imitation required that infants demonstrate a clear imitation of the modeled property. For instance, on the stairs event, infants were required to move a test exemplar from one step to at least one other step in an upward or downward direction in order to be coded as having performed a successful imitation. Sliding or tumbling down the steps, or stacking the toy on a step did not constitute a successful imitation. For the wall-jumping trial, infants were coded as having responded correctly if they moved the test exemplar from the "ground" on one side (left or right) to the top of the wall, or all the way across. On the telephone trial, infants were granted a correct response if they placed the phone on the ear or the head of a test exemplar. On the mirror trial, infants were coded as having successfully imitated the property if they placed the face or head of a test exemplar in front of the glass part of the mirror. In the case where a participant used both test exemplars to imitate a property, the participant's first choice was recorded. The dependant variable was the first object chosen to enact a property (maximum score = 4).

The primary researcher coded all the data. A second, independent coder, then coded a random selection of 20% of the infants in each age group (n = 5 participants in each age group). The second coder was uninformed of the experimental hypotheses. Intercoder reliability was obtained by computing a percentage agreement between the two coders' ratings of the infants' first choice responses. Intercoder reliability was assessed at 96% for the 16- as well as the 20-month-old age groups.

Results

The dependent variable was the first object chosen to imitate a property at baseline and generalization. Thus, on the motion trials infants could achieve a maximum score of two, and similarly on the mental trials. To examine group patterns, an analysis of variance (ANOVA) for repeated measures was conducted with property (motion, mental), trial (baseline, generalization), and exemplar (person, animal) as within-subjects factors. Age (16 months, 20 months) served as the between-subjects factor. To enable comparisons across age groups and tasks, data are presented here in the form of percentages.

The analysis revealed a main effect of trial, indicating that infants performed more properties during the generalization phase (M=56.8%) than during the baseline phase (M=14.1%), $F(1, 46)=124.92$, $p<.01$. As expected, this main effect of trial was qualified by an interaction with age group, $F(1, 46)= 4.26$, $p<.05$. An analysis of the simple effects revealed that 20-month-old infants performed significantly more properties (M=72.9%) than did 16-month-old infants (M=40.6%) during the generalization phase $F(1,46)=7.43$, $p<.01$, but not during the baseline phase (16 mo: M=8%; 20 mo: M=19.8%, $F(1,46)=7.43$, $p=.08$). Figure 1 illustrates the percentage of properties modeled by 16- and 20-month-old infants at baseline and generalization. In addition, an interaction between property and age was observed, $F(1,46)=4.26$, $p<.05$, which was qualified by an interaction between property, trial, and age, $F(1,46)=4.85$, $p<.05$. Analyses revealed that during the generalization phase, 20-month-old infants performed more imitations on mental properties (M=81.2%) than did 16-month-old infants (M=31.2%), $F(1,46)=4.85$, $p<.01$.

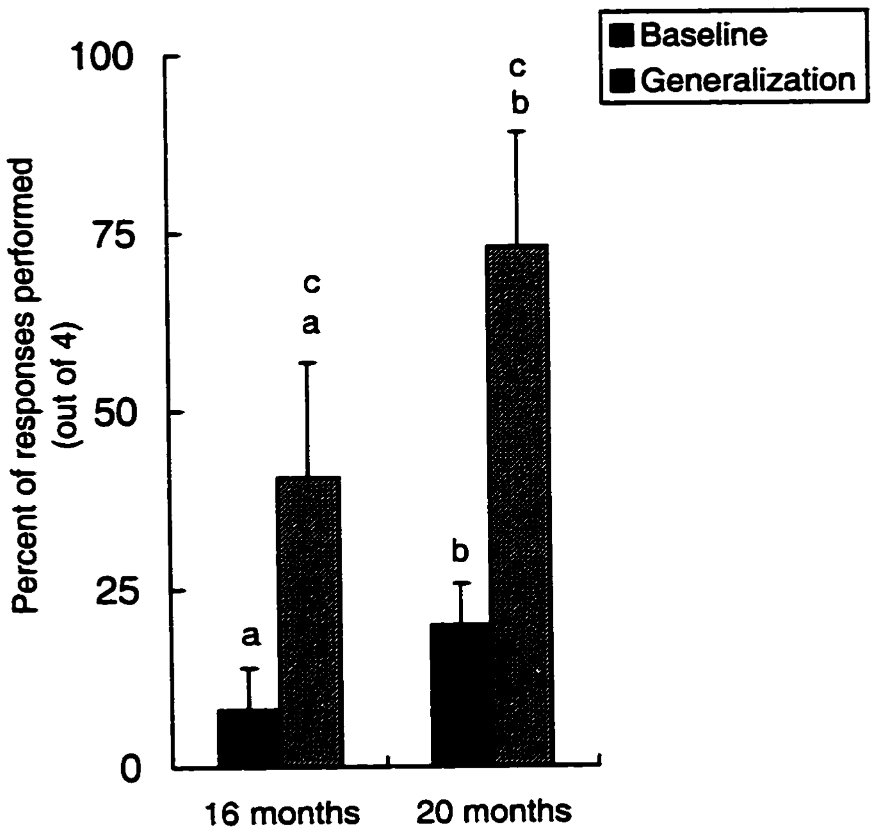

Figure 1. Percentage of responses (+SE) for 16- (n=24) and 20- (n=24) month-old infants in baseline and generalization.

Bars that share same letters are different at $p<.01$

This effect and these interactions were further subsumed under a significant four-way interaction between property, trial, exemplar, and age, F(1, 46)= 6.275, p<.05. Pairwise comparisons using Bonferroni correction revealed that on motion trials, during both baseline and generalization, 16-month-old infants chose the person and the animal equally often to perform the property (baseline: M=2.1%, M=8.4%, F(1,46)=6.275, p= .304; generalization: M=31.3%, M=18.8%, F(1,46)=6.275, p=.234). The same pattern of performance was found for the 20-month-old infants on the motion trials. During both baseline and generalization, 20-month-old infants chose the person (baseline: M=14.6%; generalization M=33.4%) and the animal (baseline: M=6.3%; generalization M=31.3%) equally often to imitate the motion properties, baseline F(1,46)=6.275, p=.120; generalization F(1,46)=6.275, p=.207. This suggests that by 16 months of age infants consider people and animals as members of the same domain, and thus, have developed a broad category of animates by that age. The percentage of responses for 16- and 20-month-old infants on motion properties is illustrated in Figure 2 for the baseline trials and in Figure 3 for the generalization trials.

A different pattern of responses was observed on the mental properties. During both baseline and generalization, 16-month-old infants again chose the person (baseline: M=2.1%; generalization: M=12.5%) and the animal (baseline: M=4.2%; generalization: M=18.8%) equally often to imitate these properties, baseline: F(1,46)=6.275, p=686; generalization: F(1,46)=6.275, p=518. In contrast, 20-month-old infants chose the person (M=52.1%) significantly more often than the animal (M=29.2%) to imitate the mental

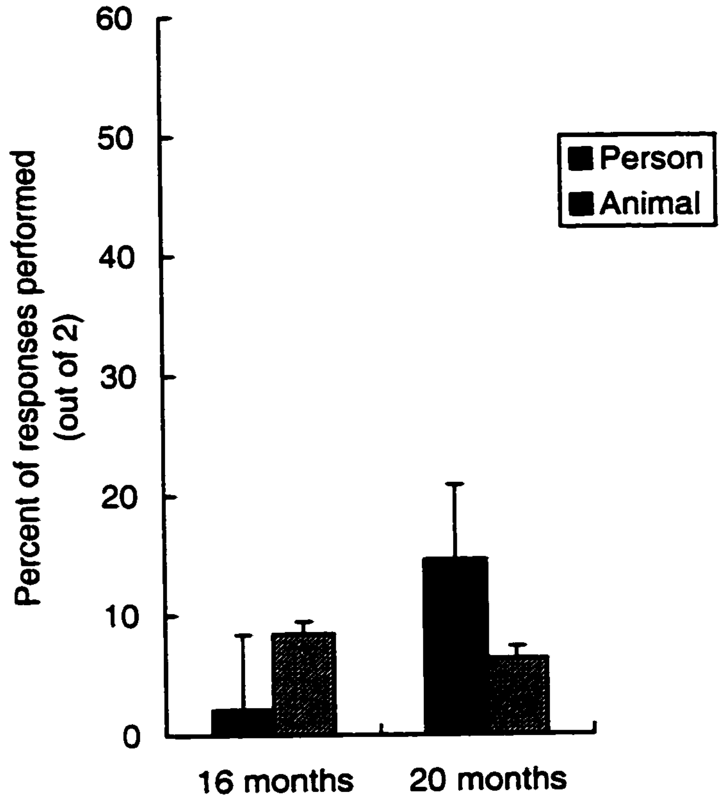

Figure 2. Percentage of responses (+SE) for 16- and 20-month-old infants in baseline on motion trials.

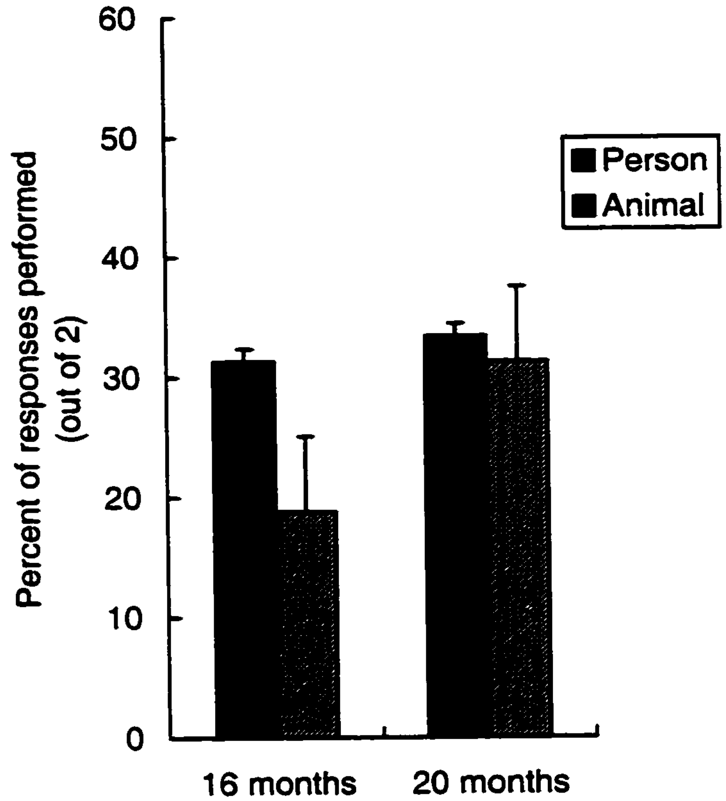

Figure 3. Percentage of responses (+SE) for 16- and 20-month-old infants in generalization on motion trials.

properties during generalization, $F(1,46)=6.275$, $p<.05$, though not at baseline (person: $M=12.5$; animal: $M=6.3$, $F(1,46)=6.275$, $p=.229$. This suggests that by 20 months of age, infants attribute mental properties preferentially to people. The percentage of responses for 16- and 20-month-old infants on mental trials is illustrated in Figure 4 for the baseline trials and in Figure 5 for the generalization trials.

The data were then examined to assess how many children who did indeed generalize mental properties, did so using a person. The results showed that of 16-month-old infants who performed an imitation on the mental trials at generalization, 40.0% did so using the person. In contrast, of those 20-month-old infants who performed an imitation on the mental trials at generalization, 64.1% modeled the property with a person.

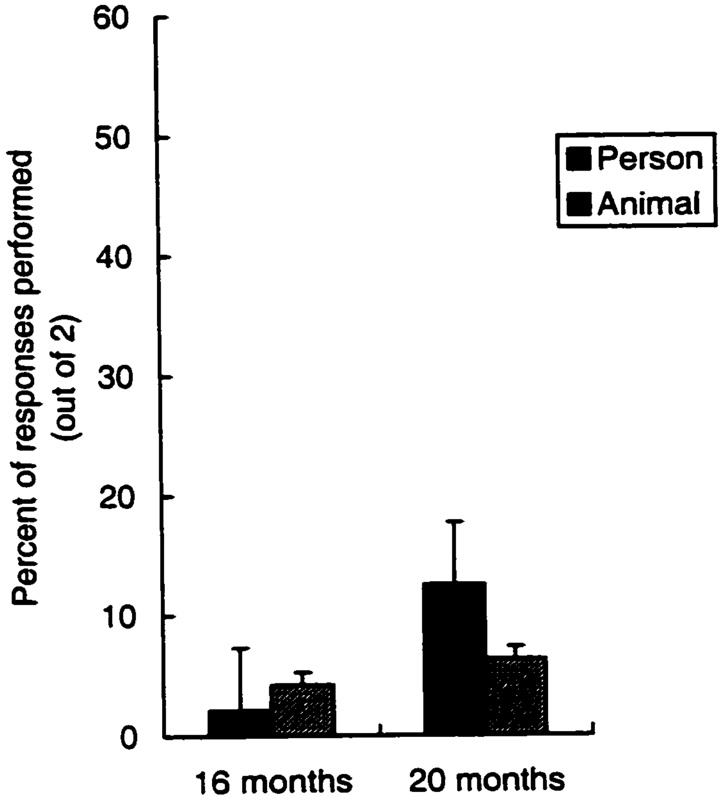

Figure 4. Percentage of responses (+SE) for 16- and 20-month-old infants in baseline on mental trials.

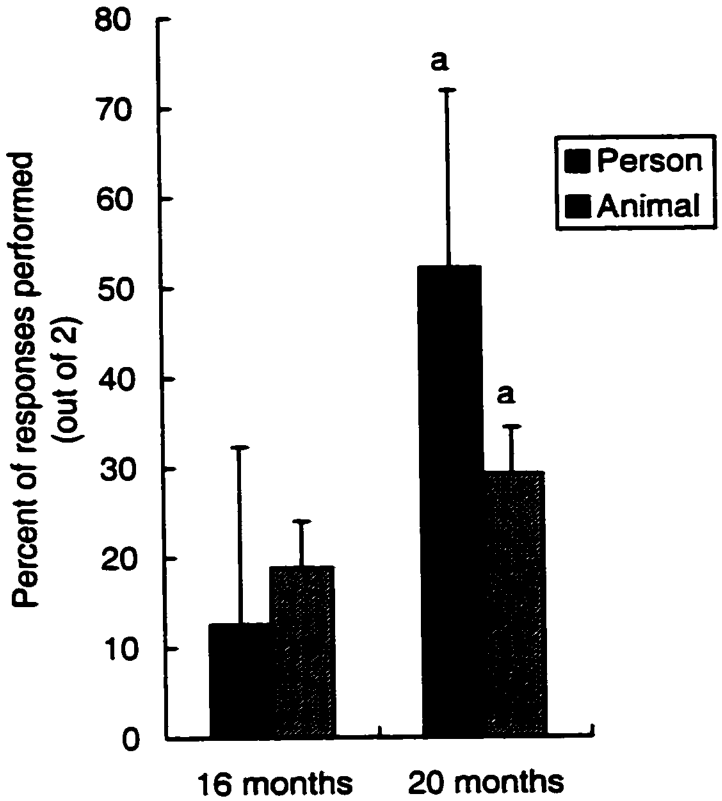

Figure 5. Percentage of responses (+SE) for 16- and 20-month-old infants in generalization on mental trials.

Bars that share same letters are different at $p<.05$

Discussion

Mandler (1992, 2000) has proposed that infants' ability to classify objects into broad categories is directed by conceptual, rather than perceptual, knowledge of objects. She theorized that infants' categorical distinctions of animate and inanimate objects are guided by knowledge about the motion properties characteristic of members of these two categories. Moreover, she postulated that infants abstract motion cues through perceptual analysis and transform these cues into more conceptual image-schemas, which then form the basis of conceptual knowledge.

A diversity of experimental methods and designs have been used to determine whether infants discriminate between animate and inanimate objects. The object-manipulation task for instance has frequently been used to test whether infants understand that physically dissimilar objects may nonetheless belong to the same category. Such studies have demonstrated that by 9 months of age infants have developed an understanding that vehicles are different from animals and by 11 months of age infants understand that different activities are associated with animates and inanimates (Mandler & McDonough, 1993; Mandler & McDonough, 1998; Oakes, Madole, & Cohen, 1991;). In actuality however, these methodological techniques are not tapping into infants' conceptual knowledge of these domains. The principal advantage of employing the inductive generalization paradigm is that it has previously successfully demonstrated that infants are capable of inferring properties typical of various domains to appropriate category exemplars. Recent induction studies have examined infants' knowledge of animals, vehicles, and bodily properties and have established that infants generalize these properties to exemplars from the appropriate domain. The increased use of the exemplars in the generalization phase indicates that the inductive generalization paradigm is an adequate measure of conceptual knowledge.

The present study was designed to further test this premise using the inductive generalization paradigm developed by Mandler and McDonough (1996). Specifically, one goal was to ascertain whether infants can generalize motion and mental properties across category members. A second goal was to examine the breadth of the animate category in young infants. Using the inductive generalization task, two motion (jumping over a wall, moving up stairs) and two mental (looking into a mirror, listening on a phone) properties were administered to 16- and 20-month old infants and the appropriateness of infants' imitations was assessed. Test exemplars were toy replicas of animals and people. One principle finding was that both 16- and 20-month-old infants demonstrated a significant increase in responses from the baseline to the generalization phase. Thus, these results extend Mandler and McDonough's (1996, 1998) findings and further confirm that the inductive generalization procedure is indeed an appropriate means for assessing early conceptual knowledge.

Evidence for the conceptual view of categorization in infancy comes mainly from Mandler and McDonough's (1996, 1998) studies. Findings from recent research using the inductive generalization task for instance, revealed that 14-month-old infants generalized domain-specific properties (such as drinking) to animals and not to vehicles, but generalized domain-neutral properties (such as going into a building) to exemplars from both domains (Mandler & McDonough, 1998). Mandler and McDonough interpreted these findings as indicative of the fact that infants already possess a certain knowledge base of the animate and inanimate domains and use this knowledge to make their generalizations. The present result that 16-month-old infants' response rate on motion properties (which are also domain-neutral) increased from the baseline phase to the generalization is consistent with Mandler and McDonough's results. However, the current study found less domain appropriate responses at 16 months on motion properties with the animal exemplar than did Mandler and McDonough at 14 months on bodily activities. It is possible that the motion properties selected in the present study were too difficult for infants to perform. The motor component necessary to imitate a property (such as moving an exemplar from the ground on one side of the wall to the top of the wall, or all the way across) may have simply been too challenging for this age group.

While the inductive studies reviewed thus far shed light on early conceptual categorization, it is important to note that most studies have typically contrasted animals with vehicles and focused on bodily activities. If, as Mandler (1992, 2000) proposed, infants' initial image-schemas are based on a recognition of the motion properties of objects, then infants' inductions ought to reflect the use of these motion schemas. However, studies on infants' inductions of motion properties are lacking from the literature on early cognitive development. Only one other study has employed the inductive generalization paradigm to test infants' ability to generalize <u>motion</u> properties across category exemplars (Poulin-Dubois & Vyncke, 2002). It was found that infants demonstrated a significant increase in <u>appropriate</u> actions from baseline to generalization. The present study's data also provide support for the prediction that infants can generalize motion properties across category members. Both 16- and 20-month-old infants chose the person and the animal equally often to imitate the motion properties. This finding is consistent with that of Poulin-Dubois and Vyncke's in that infants responses on motion trials using the appropriate exemplars (i.e., the person and the animal) increased significantly from baseline to generalization. Furthermore, in their study, 14-month-old infants performed the appropriate actions 34% of the time during generalization. Comparatively, 16-month-old infants in the current study averaged a response rate of 31.8% with the person and 18.8% with the animal. Thus, motion-based image schemas may well be the basis for determining animacy as early as 16 months of age. It appears that infants have not only formed a global concept of animates that includes people as well as animals but additionally, they understand that motion properties are typical of the animate domain. One may argue that the failure of children to demonstrate a difference between two classes of objects is not unequivocally evidence that they have actually grouped the objects into the same class. That is, it is feasible that infants are simply not making any distinctions at all. However, previous research using the inductive generalization paradigm and contrasting animals and vehicles have demonstrated that null effects are indeed evidence of a broad category and not a lack of differentiation (Mandler and McDonough, 1998; Poulin-Dubois and Vyncke, 2002). Also, considering that object examining studies have demonstrated that infants are indeed capable of making an animal-people distinction, the current result that infants chose the person and the animal equally often to imitate the motion properties seems to support a broad category of animates rather than a lack of differentiation. Finally, given the observations that the pattern of responses on motion trials was consistent across both age groups, as was the rate of production, the interpretation that infants have formed a global concept of animates seems to be an appropriate one. Still, this interpretation would have been strengthened had inanimate objects been included in the study, and had infants been able to differentiate between animate and inanimate but not between human and nonhuman animate objects. An avenue for future studies would be to therefore include animate as well as inanimate objects.

The hypothesis that infants would generalize mental attributes across category members was supported only by 20-month-old infants, who were more likely to produce the mental properties of looking and listening on people than on animals. That is, 16-month-old infants have an undifferentiated category of mental agent. In contrast, at 20 months, infants appear to have formed a prototypical category of mental agent. This result is consistent and extend Johnson's (2000) observation that 14-month-old infants were more likely to generalize the mental properties (looking at a picture, listening into a phone) to animals than they were to vehicles. Though this conclusion is appealing, it nonetheless requires an element of caution given the difficulty of the tasks. That is, it is possible that the failure to obtain an effect with 16-month-olds could be due to task difficulty rather than the existence of a higher level "animate" category. It is also important to note that the rate of production for mental properties was quite low in the present study. Even at 20 months, the average use with the appropriate exemplar was at 50%. As well, infants still modeled the mental properties with the animal 30% of the time. If infants had been able to resolutely demonstrate conceptual knowledge of mental categories, one would have expected their responses to reflect an increased use of the person at generalization but not of the inappropriate exemplar (i.e., animal). It is therefore difficult to make especially strong conclusions about infants' ability to infer mental properties <u>exclusively</u> to people. While Johnson found this effect with a much younger age group, it is useful to note that she contrasted animals with <u>vehicles</u> – a more distinct contrast that might facilitate generalizations to the appropriate domain. As previously mentioned, another possible explanation for the low response rate among both 16- and 20-month-old infants is that the properties selected for the present study were too difficult for infants to imitate. It may be that other motion and mental properties are easier for infants to enact; a possibility that should be considered in future research.

According to Mandler et al., "a characteristic of conceptual activity is that it can operate in the absence of perceptual data" (Mandler, Bauer, & McDonough, 1991, p.294). In previous studies using the object manipulation task, the possibility that perceptual information influenced infants' responses cannot be eliminated. That is, it is plausible that infants' behaviours could be explained in terms of matching based on perceptual cues rather than truly making inductive inferences. According to Rakison and Butterwoth (1998a), infants' attention to parts could account for their generalizations in previous inductive studies as well. In other words, they argued that it is possible that infants generalized bodily properties such as drinking to animals and not to vehicles because they had previously seen the property modeled with an animal and recognized that animals have legs and vehicles have wheels. Infants subsequently used the difference in parts to make their generalizations. In view of this suggestion, a strength of the current study is the model used to demonstrate the properties. A monkey model that had perceptual features common to both animals (e.g., a tail) as well as people (e.g., stood on two legs) was used during the modeling phase, and therefore ensured that perceptual similarity could not solely account for infants' inferences.

One could reason that the data reported here could be accounted for by considering the objects that infants have been exposed to in the past. That is, it may be that infants imitated motion properties equally often with both animate exemplars because they have seen both animals and people going up stairs. On the mental trials, they are not likely to have seen animals answering phones (except in cartoons) and so are less prone to have chosen the animal over the person. Similarly, perhaps infants' performance reflects an understanding of "humans" before "animals" simply because infants have more interaction and experience with humans. Although at first glance this may seem to be a reasonable explanation, it is essential to consider that previous research has shown that infants' familiarity with the exemplars bear little importance in influencing their first choice response. For instance, Mandler and McDonough (1991) found that infants often chose an unfamiliar animal (e.g., an anteater) or an unfamiliar vehicle (e.g., a forklift) for their initial imitations.

Taken together, these results reveal the existence of conceptual knowledge in infancy and extends previous research on early categorization. Specifically, this study demonstrate that infants indeed have conceptual knowledge of animate beings. Not only do infants understand the ways in which humans and non-human animals are similar (i.e., they share similar motion properties) but they also treat humans as different from other non-human animals as evidenced by their attribution of mental properties preferentially to people. Furthermore, the findings from this study support the view that infants' categorization of people and animals might best be represented by an initially global domain (an animate domain), followed by a gradual differentiation within that domain. By 16 months, infants attributed global animate properties to the correct domains (animals and people share similar motion properties). Only at 20 months however, did they attribute human-typical "mental" properties to people, indicating that infants are capable of making finer distinctions between animals and people at that age. These data support research showing that preschoolers believe that people are prototypical mental agents (Gutheil, Vera, & Keil, 1998). Based on the findings of the current study, it appears that infants have an initial awareness of basic properties that differentiate people from animals by the second year. It has been suggested that this provides additional evidence for the existence of an implicit theory of mind in infancy (Poulin-Dubois, 1999).

What remains unknown is the earliest age at which young infants demonstrate knowledge concerning motion and mental properties. It would therefore be important to further examine the developmental changes in infants' conceptualization of animate and inanimate objects. Replicating the current study with properties that do not require extensive motor flexibility, and including animals and vehicles (or objects) as test exemplars, as well as people and vehicles (or objects) would present a more comprehensive assessment of the boundaries of infants' conceptual categories. If 16-month-old infants are capable of differentiating between animate and inanimate but not between human and nonhuman animate objects, then this would be further evidence for a global animate category. If at 20-months, infants are then capable of differentiating between animate and inanimate as well as between human and non-human objects, then this would strengthen the current findings that infants initially attribute global animate properties to the correct domains and only subsequently differentiate within that domain.

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Appendix A

French and English Recruitment Letters to Parents

Concordia
UNIVERSITY

Mai 2001

Chers Parents,

Notre équipe de recherche complète actuellement une étude sur le développement de la compréhension des différences entre les êtres vivants et les objets inanimés. Cette recherche est subventionnée par le Conseil de Recherches en Sciences Naturelles et en Génie du Canada. La Commission d'Accès à l'Information du Québec nous a autorisées de consulter les listes de naissance de la Régie Régionale de la Santé et des Services Sociaux de la Région de Montréal-Centre. Votre nom apparaît sur la liste du mois de février 2000, ce qui indique que vous avez un enfant d'un âge approprié pour notre étude.

Nous vous invitons à participer à une étude que nous complétons présentement. Dans la première partie de l'étude nous étudions la compréhension qu'ont les nourrissons des différences entre les mouvements des êtres vivants et ceux des objets inanimés. Pendant cette étude votre enfant verra des films dans lesquels des objets se déplacent sur un écran d'ordinateur. Nous mesurerons la durée pendant laquelle votre enfant regardera les films. La deuxième partie vise à examiner les catégories conceptuelles d'activités physiques et mentales qu'ont les jeunes enfants. Nous ferons participer votre enfant à un jeu interactif et amusant. L'expérimentatrice fera la démonstration d'activités avec les jouets, puis votre enfant pourra l'imiter avec d'autres jouets. Pendant l'étude, votre enfant sera assis dans un siège pour enfant et vous serez assis sur la chaise derrière. Une caméra video sera utilisée pour enregistrer la session et toute information recueillie restera confidentielle.

Votre participation impliquera une visite d'une durée d'environ 45 minutes à notre centre de recherche situé sur le Campus Loyola de l'Université Concordia, au 7141 rue Sherbrooke Ouest. Les rendez-vous peuvent être fixés, à la date et à l'heure qui vous conviennent, incluant les fins de semaine. Vous pouvez stationner sur le campus sans frais et nous offrons de rembourser tout autre frais de transport. Lors de votre visite, vous recevrez un Certificat de Mérite pour Contribution à la Science pour votre enfant. De plus, un sommaire des résultats de notre étude vous sera posté dès que le projet de recherche sera complété.

Pour la présente étude, nous sommes à la recherche d'enfants âgés de 16 mois, de langue anglaise ou française, et qui n'ont aucun problème visuel ou auditif. Si vous désirez que votre enfant participe à cette étude, ou si vous désirez obtenir des renseignements additionnels, veuillez contacter Sarah Frenkiel au 848-2279 ou Dr. Poulin-Dubois au 848-2219. Nous tenterons de vous contacter par téléphone dans les quelques jours suivant la réception de cette lettre.

Nous vous remercions de votre collaboration,

Diane Poulin-Dubois, Ph.D.
Professeur agrégé
Département de Psychologie

Tamara Demke, B.Sc.
Candidate à la maîtrise

Sarah Frenkiel, B.A.
Candidate à la maîtrise

(Please turn over for English)

7141 Sherbrooke Street West, Montreal, Quebec, Canada H4B 1R6

Concordia
UNIVERSITY

May 2001

Dear Parents,

Our research team is currently conducting research on early understanding of animacy, which is funded by the Natural Sciences and Engineering Research Council of Canada. The Commission d'Accès à l'Information du Québec has kindly given us permission to consult birthlists provided by the Régie Régionale de la Santé et des Services Sociaux de la Région de Montréal-Centre. Your name appears on the birthlist of February 2000, which indicates that you have a child of an age appropriate for our study.

At the present time, we would like to invite you and your infant to participate in a research study which we are currently conducting. In the first part of this study, we are examining infants' understanding of the differences between the motion of living beings and the motion of non-living objects. During the study your child will be shown films in which objects move across a computer screen. We will record how long your child looks at the films. The purpose of the second part of the study is to examine infants' conceptual understanding of physical and mental activities. Your child will watch the experimenter demonstrate activities with some toys. Your child will then be asked to imitate those activities with other toys. During the entire study, your child will be sitting in a child seat and you will be seated directly behind. We will videotape your child's responses and all tapes will be treated in the strictest of confidentiality.

Overall, your participation will involve approximately one 45-minute visit to our laboratory at the Loyola Campus of Concordia University, located at 7141 Sherbrooke Street West. Appointments can be scheduled at a time which is convenient for you and your child, including weekends. Free parking is available on the campus and we will reimburse any other transportation costs at the time of your visit. Upon completion of the study, a Certificate of Merit for Contribution to Science will be given to your child, and a summary of the results of our study will be mailed to you once it is completed.

For the purposes of this study, we are looking for infants who are 16 months of age (15.5 to 16.5 months), who hear English or French spoken in the home, and who do not have any visual or hearing difficulties. If you are interested in having your child participate in this study, or would like any further information, please contact Tamara Demke or Sarah Frenkiel at 848-2279 or Dr. Diane Poulin-Dubois at 848-2219. We will try to contact you by telephone within a few days of your receipt of this letter.

Thank you for your interest and collaboration.

Diane Poulin-Dubois, Ph.D.
Associate Professor
Department of Psychology

Tamara Demke, B.Sc.
M.A. Candidate

Sarah Frenkiel, B.A.
M.A. Candidate

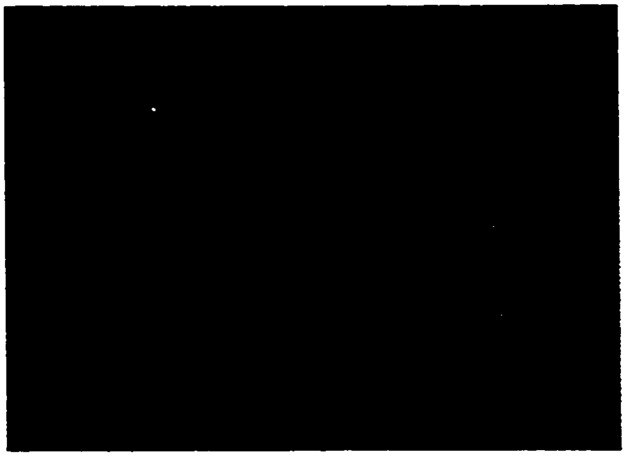
(français au verso)

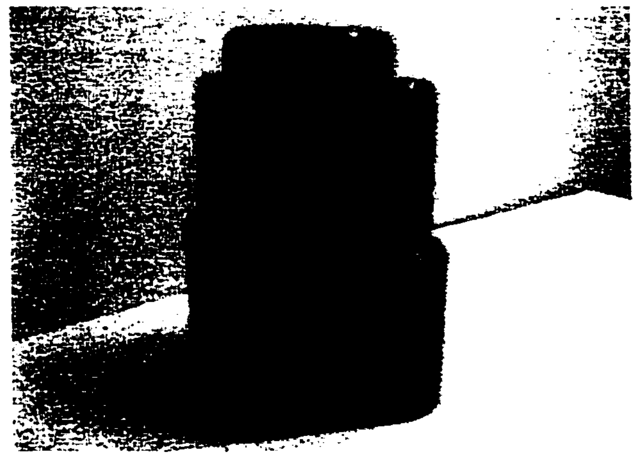
7141 Sherbrooke Street West, Montreal, Quebec, Canada H4B 1R6

Appendix B

Warm-up Trials Stimuli

Warm-up Trials Stimuli





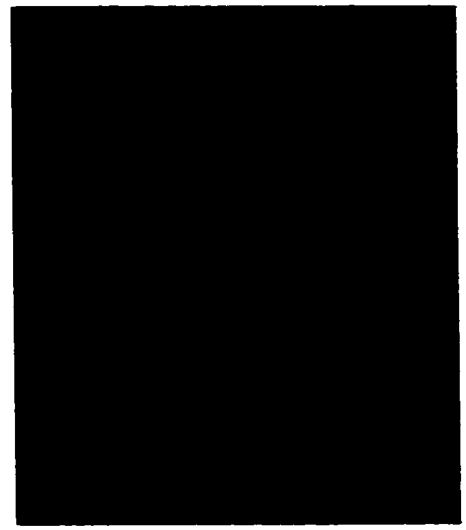
Appendix C

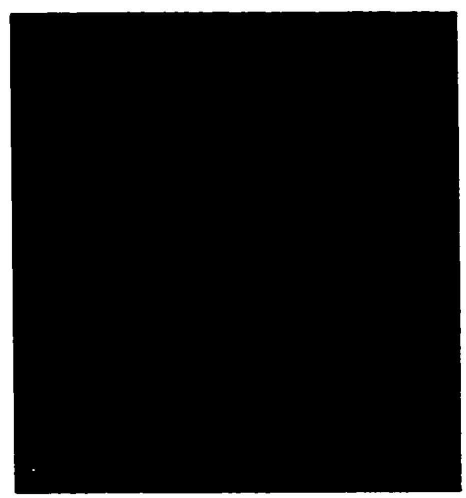
Experimental Trials Stimuli

Experimental Trials Stimuli

Motion

Mental





Appendix D

French and English Consent Forms

Formulaire de consentement des parents

La présente étude cherche à déterminer si les jeunes enfants sont capables de catégoriser les objets autour d'eux. Afin de déterminer ceci, nous avons conçu un jeu dans lequel une série d'actions sera démontrée aux enfants et nous observerons s'ils sont capables de généraliser ces actions à d'autres objets appartenant à la même catégorie que le jouet utilisé pour démontrer l'action. Nous vous demanderons de rester silencieux(se) lors de la session. La session de jeu sera filmée et toute information recueillie restera confidentielle.

Diane Poulin-Dubois, PhD.
Professeur

Sarah Frenkiel B.A
Candidate à la maîtrise

La nature et le but de ce projet m'ont été expliqués de façon satisfaisante. Je consens à ce que mon enfant participe à ce projet. Je comprends que je peux interrompre ma participation à tout moment sans aucune conséquence négative, et que la coordonnatrice répondra à toutes les questions qui seront soulevées durant le cours de la recherche.

_________________________ Signature du Parent

_________________________ Date

Je serais intéressé(e) à être contacté(e) de nouveau pour participer avec mon enfant à de futures études (oui/ non): _________

du sujet: _________

Chercheur: _____________________

Parental Consent Form

In this study, we are examining infants' ability to categorise objects in the world around them, and the tactics they are most likely to use. To do this, we will model an action with a small toy, and then give your child the opportunity to repeat this action with two new toys. You will be asked to remain silent and neutral during the session.

Diane Poulin-Dubois, Ph.D. Professor	Sarah Frenkiel, B.A. M.A. Candidate

The nature and purpose of this study have been satisfactorily explained to me and I agree to allow my child to participate. I understand that we are free to discontinue participation at any time without negative consequences and that the experimenter will gladly answer any questions that might arise during the course of the research.

____________________ Parent's signature

____________________ Date

I would be interested in participating in future studies with my child (yes/ no): ________

Subject # __________ Researcher: ________

Appendix E

French and English Participant Questionnaires

INFORMATION GÉNÉRALE SUR VOTRE ENFANT

Nom de l'enfant:________________________ Date de naissance: ____________________

Sexe:______________ Langue(s) parlée(s) à la maison:________________________

Nom de la mère:_______________________ Nom du père :________________________

Adresse:_____________________________ Numéro de téléphone: __________maison

_____________________________ __________travail

Code Postal:____________ __________travail

Occupation de la mère:________________ Education:____________________________
(plus haut niveau atteint)

Occupation du père:____________________ Education:___________________________
(plus haut niveau atteint)

Statut civil de la mère: ________________ Statut civil du père :____________________

Veuillez s'il-vous-plaît répondre aux questions d'information générale suivantes à propos de votre enfant :

Poids à la naissance: ___________ Durée de la grossesse: ___________ semaines

Rang dans la famille: ___________ (ex., 1 = 1er enfant)

Y a-t-il eu des complications durant la grossesse?_________________________________

Votre enfant a-t-il déjà souffert de problèmes médicaux majeurs? ____________________

Votre enfant a-t-il des problèmes auditifs ou visuels?______________________________

Veuillez s'il-vous-plaît répondre aux questions suivantes à propos de votre famille:

Est-ce-que votre famille possède des animaux? (oui/non) _______ Si oui, veuillez indiquer le genre d'animaux (ex., chat, chien, poisson) et le nombre d'animaux: _______

____

du sujet: __________ *Chercheur:* ___________________

PARTICIPANT INFORMATION

Infant's name:____________________ Date of Birth: __________________________

Gender:____________ Language(s) spoken at home:__________________________

Mother's name: ________________________ Father's name: ___________________

Address: ______________________________ Telephone #: ____________home

______________________________ ____________work

Postal Code:___________________________ ____________work

Mother's occupation:______________ Father's occupation:____________________

Mother's education (highest level attained):____

Father's education (highest level attained):____

Mother's marital status:_________________ Father's marital status:____________

Please answer the following general information questions about your child:

Birth weight:______________ Length of pregnancy:_______weeks

Birth order:_______________(e.g., 1 = 1st child)

Number of siblings:______________

Were there any complications during the pregnancy?_______________________________

Has your child had any major medical problems?___________________________________

Does your child have any hearing or vision problems?______________________________

Please answer the following general information questions about your family:

Does your family have a pet (or pets)? (yes/no) _______ If you answered yes, please list your pet(s) indicating the kind of pet(s) (e.g., dog, cat, fish) and the number of pets:

____

Subject#:___________ Researcher:_______________

Appendix F

French and English Instructions for Parents

DIRECTIVES AUX PARENTS

1. Lorsque nous entrerons dans la pièce où se déroulera l'étude, veuillez s'il-vous-plaît placer votre enfant dans le siège pour enfant et vous asseoir sur la chaise derrière.

2. Avant que nous commencions l'étude, veuillez s'il-vous-plaît vous assurer que votre enfant n=a aucun jouet ou nourriture, car ceux-ci peuvent le distraire.

3. Pendant l'étude, nous vous demandons de ne pas communiquer avec votre enfant. S'il-vous-plaît, ne pointez pas et ne touchez pas aux jouets.

4. Souvent les enfants se détournent durant l'étude. Si votre enfant se retourne vers vous durant l'étude, s'il-vous-plaît ne faites que lui sourire.

5. Si votre enfant devient très agité(e) ou commence à pleurer, nous interromprons l'étude pour que vous puissiez le/la consoler.

INSTRUCTIONS FOR PARENTS

1. When we enter the room where will be doing the study, please seat your child in the infant seat and sit behind your child in the chair provided.

2. Before we begin the task, please ensure that your infant has no toys or food, as these items may be distracting.

3. If possible, do not say anything and do not touch your child during the length of the experiment (about 20 minutes). Please do not point or call attention to any of the toys during the study.

4. During the experiment, your child will probably turn around and look at you a few times. If this occurs, you may respond by smiling, but please try not to say anything.

5. If your child becomes very fussy or starts to cry, we will pause the experiment to give you a chance to comfort him/her.

Appendix G

Counterbalancing Conditions

LIST OF ORDERS
3 Warm-Up Trials, Model = Monkey

Start Side	**Warm up:**
Left	1. Putting block in cup – CLOP!!
Right	2. Sliding ring on cone – WEEE!!
Left	3. Stacking blocks – BOOM!!

Order # 1

Model = Monkey

Start Side	Property	Sound	Target	Distractor
Right	Stairs	**Toom, toom, toom!**	Tiger (R)	Woman (L)
Left	**Mirror**	**Look, it's me, How pretty!**	**Boy (R)**	**Cow (L)**
Right	Wall	Woop!	Pig (L)	Man (R)
Left	**Phone**	**Ring ring..hello?**	**Girl (L)**	**Horse (R)**

Start Side	**Warm up:**
Right	1. Sliding ring on Tube – WEEE!!
Left	2. Stacking blocks – BOOM!!
Right	3. Putting cube in cup – CLOP!!

Order # 2

Model = Monkey

Start Side	Property	Sound	Target	Distractor
Left	Mirror	Look, it's me, How pretty!	Man (R)	Tiger (L)
Right	**Stairs**	**Toom, toom, toom!**	**Cow (R)**	**Girl (L)**
Left	Phone	Ring ring..hello?	Woman (L)	Pig (R)
Right	**Wall**	**Woop!**	**Horse (L)**	**Boy (R)**

Order # 3

Model = Monkey

Start Side	**Warm up:**
Left	1. Stacking blocks – BOOM!!
Right	2. Putting cube in cup – CLOP!!
Left	3. Sliding ring on Tube – WEEE!!

Start Side	**Property**	**Sound**	**Target**	**Distractor**
Right	Wall	Woop!	Tiger (R)	Girl (L)
Left	**Phone**	**Ring ring..hello?**	**Man (R)**	**Cow (L)**
Right	Stairs	Toom, toom, toom!	Pig (L)	Boy (R)
Left	**Mirror**	**Look, it's me, How pretty!**	**Woman (L)**	**Horse (R)**

Order # 4

Model = Monkey

Start Side	**Warm up:**
Right	1. Putting cube in cup – CLOP!!
Left	2. Stacking blocks – BOOM!!
Right	3. Sliding ring on Tube – WEEE!!

Start Side	**Property**	**Sound**	**Target**	**Distractor**
Left	Phone	Ring ring..hello?	Boy (R)	Tiger (L)
Right	**Wall**	**Woop!**	**Cow (R)**	**Woman (L)**
Left	Mirror	Look, it's me, How pretty!	Girl (L)	Pig (R)
Right	**Stairs**	**Toom, toom, toom!**	**Horse (L)**	**Man (R)**

Appendix H

French and English Results Letters

Concordia
UNIVERSITY

Le 23 avril 2002

Chers Parents,

Nous désirons vous remercier d'avoir participé à notre étude sur la catégorisation chez les jeunes enfants. Notre échantillon final inclut des enfants âgés de 16, 18 et 20 mois. Le groupe d'enfants de 18 mois nous a permis d'effectuer des modifications au plan d'expérience initial avant de compléter l'étude avec les enfants de 16 et 20 mois. Nous avons maintenant complété la collecte des données, ainsi que terminé l'analyse statistique des résultats. Il nous fait plaisir de vous informer des principaux résultats obtenus.

La première étude à laquelle vous et votre enfant avez participé fait partie d'un programme de recherche visant à déterminer si les enfants de 16 mois savent que le mouvement des êtres vivants et des objets est différent. Le but de l'étude à laquelle vous et votre enfant avez participé est de déterminer si les enfants comprennent que le résultat sera très différent si un animal ou un véhicule s'approche d'un obstacle. Vous vous souvenez peut-être que votre enfant a vu des films présentés sur un écran d'ordinateur. Pendant la première partie de l'étude, les enfants ont vu des films où un chien s'approche d'un mur et saute par-dessus et des films où une voiture frappe le même mur et rebondit. Ces mouvements (e.g, un animal qui saute par-dessus un mur ou un véhicule qui rebondit) sont ceux qui habituellement associés a ces catégories d'objets. Ces films ont été répétés jusqu'à ce que l'attention des enfants diminue de façon significative. Ensuite, deux films ont été présentés dans lesquels de nouveaux animaux et véhicules ont traversé l'écran. Le comportement du nouvel animal ou du nouveau véhicule était soit le même que pendant la première partie de l'étude (par ex., un chat qui saute par-dessus le mur) soit différent (par ex., un autobus qui saute par-dessus le mur). Nous avons comparé la durée pendant laquelle les enfants regardent les deux films-test. Nous avons fait l'hypothèse que si les enfants sont surpris de voir l'événement incongru (par ex., un véhicule qui saute) ils regarderont cet événement pendant plus longtemps que l'événement typique (par ex., un animal qui saute).

Les analyses indiquent qu'en tant que groupe, les enfants de 16 mois regardent plus longtemps un autobus qui saute par-dessus le mur qu'un chat qui saute, et plus longtemps un chat qui rebondit qu'un autobus qui rebondit. Ces résultats suggèrent que dès l'age de 16 mois, les enfants commencent à attribuer aux animaux et aux véhicules des trajectoires différentes. De plus, cette association semble mieux comprise dans le cas d'un mouvement irrégulier, tel que sauter. Nous avons réalisé une étude similaire avec des enfants âgés de 20 mois afin de déterminer les développements ultérieurs de cette habileté. Nous avons observé le même type de comportement qu'à 16 mois, bien que les résultats soient plus probants. En somme, l'association mouvement-objet émerge à 16 mois mais se renforce entre 16 et 20 mois.

Le principal objectif du deuxième projet de recherche auquel votre enfant a participé était de déterminer si les jeunes enfants sont capables de catégoriser les objets tels que les animaux et les humains. Pour cela, nous avons développé un jeu qui consistait à montrer à votre enfant certaines actions et à lui permettre ensuite d'imiter ces actions avec un choix de deux nouveaux jouets (un animal et une personne). Les actions que nous avons démontrées étaient soit typiques des animaux (monter un escalier) ou typiques des personnes (répondre au téléphone). L'expérimentatrice a d'abord démontré ces activités en utilisant un petit singe. Suite à cette démonstration, l'enfant devait imiter ces actions en choisissant parmi deux objets: un nouvel animal ou une personne. Si les enfants comprennent que les mouvements peuvent être généralisés aux deux objets (par ex. les animaux et les personnes peuvent monter des escaliers). ils devraient imiter ces actions aussi souvent avec l'un ou l'autre objet. Par ailleurs, si les enfants comprennent que les perceptions sont plus souvent associées aux personnes, ils devraient choisir la personne de préférence à l'animal pour imiter ces actions.

De façon générale, les résultats de cette étude indiquent que pour les activités motrices et mentales, les enfants de 16 mois choisissent la personne ou l'animal de façon égale pour les imiter. Ce résultat reproduit et pousse plus loin la recherche sur la formation des catégories en démontrant que dès l'âge de 16 mois, les enfants possèdent une catégorie englobant les personnes et les animaux. Il est important de mentionner que les enfants de 16 mois n'ont pas produit autant d'imitations des activité mentales (31%) que des activités motrices (50%). Par conséquent, il restait à déterminer si des enfants plus âgés imiteraient plus souvent et s'ils réserveraient les activités mentales aux personnes. Nous avons récemment testé cette hypothèse avec un groupe d'enfants de 20 mois. Nous avons observé que les enfants de 20 mois se comportent de la même façon que ceux de 16 mois pour les activités motrices mais différemment pour les activités mentales. Ils choisissent en effet la personne plus souvent que l'animal dans ce dernier cas, ce qui indique que les enfants de 20 mois attribuent les propriétés mentales aux personnes plus qu'aux animaux.

Les résultats de ces études ont été présentés au congrès de la International Society on Infant Studies qui s'est récemment tenu à Toronto. Encore une fois, nous vous remercions de votre participation. L'avancement de nos connaissances sur le développement de l'enfant ne serait pas possible sans la généreuse contribution de familles comme la vôtre. Si vous désirez de plus amples renseignements, n'hésitez pas a contacter Mme. Poulin-Dubois.

Diane Poulin-Dubois, Ph.D.
Professor
Department of Psychology
Telephone: (514) 848-2219
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Tamara Demke, B.Sc.
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Sarah Frenkiel, B.A.
M.A. student
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Telephone: (514) 848-2279
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Concordia
UNIVERSITY

April 23, 2002

Dear Parents,

We would like to thank you for your recent participation in our study on infants' categorization abilities. Prior to conducting these studies with 16- and 20-month-old infants, a group of 18-month-old infants completed the studies. These infants' participation enabled us to make modifications and improvements to our design before further completing these studies with 16- and 20- month-old infants. We would like to acknowledge the contributions of all of the families involved. We have recently completed the data analysis from these studies and we are pleased to share the results with you at this time.

The first study in which you and your child participated was designed to examine whether 16-month-old infants understand that living beings and non-living objects are typically associated with different motion paths. Specifically, we tested whether infants understand that when an animal and a vehicle approach an obstacle, the outcome will be very different. As you may recall, your child was shown animated films on a computer screen which portrayed a dog jumping over a wall, or a car bumping into the same wall. These motions (i.e., animal jumping over the wall or vehicle bumping into the wall) are the "typical" motion paths associated with these categories of objects. Children watched these films until their attention to the films decreased. Then, children were shown two new films featuring other animals and vehicles moving across the screen. The outcome of the new animal or vehicle approaching the wall was either the same as during the first part of the study (e.g., a cat jumped over the wall) or different (e.g., a bus jumped over the wall). We measured how long infants looked at each of the films. We expected that if infants are surprised by seeing the "unusual" event (i.e., a vehicle jumping), then they would look longer at this event, compared to the "typical" event (i.e., a cat jumping into the wall).

The results show that infants looked longer at a bus jumping than a cat jumping, and longer at a cat bouncing than at a bus bouncing. These results suggest that at 16 months of age, infants are beginning to associate motion path with object categories such as animals and vehicles. Additionally, although this association is not completely developed at this time, it nonetheless appears to be more salient for the jumping motion path. We have also completed a similar study with 20-month-olds, to further examine the age that this association emerges. We found that 20-month-olds show the same pattern of understanding as the 16-month-olds, although this understanding is more well-developed. Overall, the evidence suggests that this association is evident at 16 months, and develops in strength between the ages of 16 and 20 months.

The second study in which you and your child participated was designed to determine whether infants have acquired categories such as animals or people. To test whether infants have this ability, the experimenter modelled events for them which were either animal-like and people-like (motion events such as moving up a set of stairs) or exclusively people-like (mental events such as answering a telephone). The experimenter modelled these motion events and

7141 Sherbrooke Street West, Montreal, Quebec, Canada H4B 1R6

mental events using a monkey doll. After the modelling, infants were provided with the opportunity to imitate these events with a choice of two new toys: a new animal and a new person. If infants understand that the ability to carry out the motion events can be generalized to both category members (both animal and people can move up stairs), then they should be equally likely to imitate the motion with either of the new toys. In addition, if infants understand that mental properties are reserved exclusively to people, then they should be more likely to imitate the mental event with a toy from the person category.

Overall, the results of this study indicated that for both motion and mental events, 16-month-old infants chose the animal and person equally often to imitate the events. This finding replicates and extends previous research on early categorization and suggests that by 16 months of age infants consider people and animals as members of the same domain, and thus, have developed a broad category of animates by that age. It is important to note however that at 16 months, infants did not produce as many imitations on the mental events (31%) as on the motion events (50%). Consequently, it remained to be determined whether older infants would imitate more events altogether and therefore enable us to establish whether they indeed reserve mental properties exclusively to people. We have recently tested this hypothesis in a follow-up experiment with 20-month-olds. We found that 20-month-olds show the same pattern of responding as the 16-month-olds for the motion events. Furthermore, the evidence suggests that by 20-month-old infants chose the person significantly more often than the animal to imitate the mental events. These findings indicate that by 20 months, infants attribute mental properties exclusively to people as opposed to animals.

The results of the present studies were recently presented at the biennial meeting of the International Society on Infant Studies, in Toronto. We thank you for your interest and participation in our research. Research on children's early cognitive development is only possible thanks to the contribution of time and effort by families like yours. If you would like further information about the results of the study, or have any questions about issues concerning cognitive development, please do not hesitate to contact Dr. Diane Poulin-Dubois.

Diane Poulin-Dubois, Ph.D.
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Tamara Demke, B.Sc.
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Sarah Frenkiel, B.A.
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Appendix I

Sample Coding Summary Sheet

CODING SUMMARY SHEET

STIMULI

- Props: wall, stairs, phone, mirror
- People: man, woman, boy, girl — Model = Monkey
- Animals: tiger, pig, cow, horse

** Subjects are coded at baseline and at generalization.

WARM-UPS:

Correct Responses =

- "CLOP!" = Places the block inside the cup
- "WEEE!" = Places the ring on the tube
- "BOOM!" = Stacks the smaller block onto the bigger block (opposite responses such as stacking the bigger block over the smaller one are coded as correct responses as well, but make note of them)

CODING SCHEME

- Stairs: Going up or down at least 1 step. Does *not* include sliding or tumbling down the steps, or stacking the toy on a step.
- Fence: making the toy move from the "ground" on one side (left or right) to the top of the fence, or all the way across.
- Phone: placing or leaning the toy's ear or head to the phone.
- Mirror: placing or leaning the toy's face in front of the glass part of the mirror.

CODING SHEET : Order # 1

Subject: ____________________ S # : ____________

Date of Birth: ____________________ Gender: F / M

Appointment date: ________________ Coder: __________________________

	Put block in cup "Clop!"	Slide ring on cone "Weee!"	Stack blocks "Boom!"
Warm-up	Y N	Y N	Y N

Order	Properties Tested	Baseline	Generalization	Comments
1	Stairs	Tiger Woman	Tiger Woman	
2	Mirror	Boy Cow	Boy Cow	
3	Fence	Pig Man	Pig Man	
4	Phone	Girl Horse	Girl Horse	

Comments:

____

____

____

____

____

____

Appendix J

Source Table for Analysis of Variance

Table J. Source Table for Property (Motion versus Mental) X Trial (Baseline versus Generalization) X Exemplar (Person versus Animal) X Age (16 mo versus 20 mo)

Source of Variation	SS	DF	MS	F	Significance of F
Between Subjects					
Age	4.59	1	4.59	167.35	.000
Error	13.24	46	.29		
Within Subjects					
Property	.04	1	.04	.21	.65
Age by Property	.84	1	.84	4.26	.05
Error(Property)	9.12	46	.20		
Trial	17.51	1	17.51	124.92	.00
Age by Trial	1.04	1	1.04	7.43	.01
Error(Trial)	6.45	46	.14		
Exemplar	.84	1	.84	1.72	.20
Age by Exemplar	1.04	1	1.04	2.12	.15
Error(Exemplar)	22.62	46	.49		
Property by Trial	.01	1	.01	.08	.78
Property by Trial by Age	.67	1	.67	4.85	.03
Error(Property by Trial)	6.32	46	.14		
Property by Exemplar	.01	1	.01	.04	.84
Property by Exemplar by Age	.67	1	.67	2.60	.11
Error(Property by Exemplar)	11.82	46	.26		
Trial by Exemplar	.38	1	.38	1.22	.28
Trial by Exemplar by Age	.01	1	.01	.03	.86
Error(Trial by Exemplar)	14.12	46	.31		
Property by Trial by Exemplar	.00	1	.00	.00	1.00
Property by Trial by Exemplar by Age	1.26	1	1.26	6.28	.02
Error(Property by Trial by Exemplar)	9.24	46	.20		