**DO 9-MONTH-OLD INFANTS EXPECT DISTINCT WORDS TO REFER TO
KINDS?**

by

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B. A., The University of British Columbia, 2003

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENT FOR THE DEGREE OF

MASTER OF ARTS

in

THE FACULTY OF GRADUATE STUDIES

(Psychology)

THE UNIVERSITY OF BRITISH COLUMBIA

August 2006

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Abstract

Three experiments investigated the effect of labeling on 9-month-old infants' object representations. During familiarization, a box was opened to reveal two objects inside: either two identical objects or two different objects. Test trials followed the same procedure except, before the box was opened, the contents were described using either two distinct labels ("I see a wug! I see a dak!") or the same label twice ("I see a zav! I see a zav!"). Infants hearing different labels looked longer at two identical objects versus two different objects. This pattern was reversed when infants heard a label repeated twice. The property of shape is a salient cue to kind membership and infants may expect different-shaped objects to be marked by different labels. However, they should not have this expectation for objects that differ in a kind-independent property, like colour. A second and third experiment where different object pairs differed only in shape and colour, respectively, confirmed these predictions. These results suggest that, prior to word learning, infants may expect distinct labels to refer to distinct kinds.

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Acknowledgements

Sincere thanks to my thesis supervisor, Fei Xu, for her invaluable guidance and support, and my committee members, Janet Werker, Susan Birch, and Geoff Hall for their very helpful suggestions and insights. I would also like to acknowledge the members of the Baby Cognition Lab for all of their assistance with these studies, their ideas and discussions.

1. Introduction

Sortal concepts refer to kinds and supply the criteria for individuation (where one object ends and another one begins) and identity (whether an object is the same one as was seen on a different occasion) (Gupta, 1980; Hirsch, 1982; Macnamara, 1986; Macnamara & Reyes, 1994; Wiggins, 1980). Sortal concepts are lexicalized as count nouns in languages that make the count/mass distinction. Sortal/kind information specifies categorization under concepts such as dog, ball, and car, categories of objects united by functional/causal features as well as by perceptual features. The sortal concept *dog*, for example, provides criteria for deciding whether we see one or two dogs, it also provides criteria for deciding whether the dog we see now is the same dog encountered earlier, or whether we have seen a different dog on each occasion.

To appreciate the conceptual role of sortals, consider two questions. Firstly, how many are there? And, secondly, is that the same as what was here before? It is impossible to answer either question without specifying individuals-how many of *what*? One can count cups, desks, people, pages or fingers, but one cannot count the blue, the sleeping, or the metal. Only sortals provide criteria of individuation. Similarly, "same," in the sense of numerical identity, indicates the *same one*, and a sortal is required to specify the individual being traced through time. Max the puppy grows to become an adult dog, changes size, colouring, shape, and location, but is still the same dog. Max's identity is traced by the sortal *dog*.

The criteria of individuation supplied by sortals are logically distinct from the criteria of numerical identity. An example will illustrate this point. Consider two dogs, Max and Penny. As you picture them walking in the park, the criteria of individuation

provided by the sortal *dog* designate two individuals present, and if they run into the woods and reemerge, the sortal *dog* again designates two individuals. But additional criteria are required to determine which individual is Penny and which one is Max; this is accomplished by the principle of identity. Thus, although the criteria of individuation establish two individuals, criteria of numerical identity are required to determine which particular dog is which.

Various studies have sought to determine when young children begin to represent sortal/kind concepts. Spelke, Kestenbaum, Simons, and Wein (1995) and Xu and Carey (1996) determined that at both 4 and 10 months of age, infants are able to use spatiotemporal evidence for object individuation, thus, demonstrating the ability to represent the sortal concept *physical object*. In contrast, it is not until 10-12 months that infants are able to use basic-level sortal/kind information for object individuation (Van de Walle, Carey, & Prevor, 2000; Wilcox & Baillargeon, 1998a, Experiments 1 and 2; Xu & Carey, 1996). More specifically, by 12 months, infants are able to use the differences between a duck and a ball, or a cup and a bottle to establish a representation of two objects. In Xu and Carey (1996), infants were shown an event in which an object, a toy duck, emerged from behind a screen then returned behind it, followed by another object, a ball, emerging from behind the same screen then returning behind it. Adults draw on kind differences; ducks and balls are two different kinds of objects, to conclude that two distinct objects are involved in this event. The screen was then removed to reveal either both objects (the duck and the ball; the expected outcome) or just one of the two objects (the duck or the ball; the unexpected outcome). At 10 months, infants did not look longer at a single object, suggesting that they did not use the kind differences between these

objects to conclude that there were two distinct objects behind the screen. However, by 12 months, infants succeed at this task—they look longer at the unexpected, single object outcome. Two control conditions established that the method was sensitive. First, when spatiotemporal evidence was given (by showing the two objects simultaneously at the beginning of the experiment), infants looked longer at the unexpected outcome of a single object. Thus, 10-month-olds were able to overcome their baseline preference for two objects under certain circumstances. Second, infants were able to perceive the property/featural differences between the two objects. Infants who were shown the alternating sequence duck-ball-duck-ball during familiarization, habituated more slowly than infants who were shown the same object over and over again. Xu and Carey (1996) hypothesized that 10-month-olds do not represent basic-level sortal/kind concepts such as *duck* and *ball*. Subsequently, using both looking time and manual search measures, Xu, Carey, and Welch (1999) and Van de Walle, Carey, and Prevor (2000) provided convergent evidence for this shift between 10 and 12 months (see also Bonatti, et al., 2002; Krojgaard, 2000; Wilcox & Baillargeon, 1998a, Experiments 1 & 2).¹

A recent study has provided evidence that 12-months-olds succeed at this task through the use of sortal/kind information, as opposed to property or featural differences, to individuate the objects. Xu, Carey, and Quint (2004), using the paradigm of Xu and

¹ There is evidence to suggest that infants younger than 12 months of age are able to use property information for establishing the representation of two distinct objects when task demands are reduced. For example, Wilcox and Baillargeon (1998a; Experiments 7 & 8), using a simplified object individuation procedure, showed that 9-month-olds were able to use featural information to individuate objects and Xu and Baker (2005), using a simplified manual search measure, demonstrated this ability in 10-month-olds (see Xu, 2005, for a review). The present discussion focuses on when infants' begin to use sortal/kind information for object individuation, which is a related but distinct question from when they begin to use property information for this purpose.

Carey (1996), conducted a series of experiments with 12-month-old infants in order to determine if the ability to use the differences between, a duck and a ball, for object individuation is based on property differences (i.e., yellow, irregularly shaped, rubbery vs. red, round, and shiny) or kind differences (i.e., a member of the kind duck vs. a member of the kind ball). In order to investigate this contrast, they asked if infants would individuate objects based on property differences alone, e.g. colour differences (i.e., a red ball vs. a green ball), size differences (i.e., a small red ball vs. a big red ball), or combinations of these properties (i.e., a small red ball vs. a big green ball). The results indicated that infants failed to use these property differences for object individuation. Control conditions found that the methods were sensitive. The 12-month-olds succeeded when provided spatiotemporal information for two objects, and infants encoded the property differences between the objects (evidenced by slower habituation to alternating objects compared to the same object shown over and over). These findings suggest that certain salient shape differences enter into the computation of the numerical distinctness of objects before other property differences such as colour and size. For the final experiment of the series, the investigators contrasted within-kind shape changes (i.e., a regular cup vs. a sippy cup of the same size and surface pattern) with cross-kind shape changes (i.e., a regular cup vs. a bottle of the same size and surface pattern). The infants failed to use the within-kind shape changes for object individuation whereas they succeeded in using cross-kind shape changes, even when the two types of shape changes were roughly equally salient to the infants. Since shape differences are often correlated with object kind differences, these results converge with previous findings suggesting that at 12 months, infants' represent some basic-level kinds and it is kind distinctions that

support object individuation. Thus, as a whole, this data suggests that at 12 months of age, infants' success in a complex object individuation task may be based on object kind representations as opposed to property representations (see Xu, 2005 for a review).

Evidence suggests that by the end of the first year of life infants are able to distinguish property and kind information. Waxman and Markow (1995) and Waxman (1999) reported that by 13 months of age, the distinction between property and kind plays a role in infants' categorization. In these studies, infants were sensitive to whether they heard a count noun or an adjective while examining objects. If the children heard an adjective, they were more likely to generalize based on a property (e.g. colour or texture), however, if they heard a count noun, the infants were more likely to generalize to objects of the same kind, based on shape. These findings are consistent with the results of Xu et al. (2004) that the distinction between kinds and properties is present by about 12-13 months, and it maps onto the linguistic distinction between count nouns and adjectives.

How do infants acquire sortal/kind concepts? That is, what is the mechanism that underlies the development of a kind-based system of individuation? Xu (2003) argues that there are two separate systems of object individuation present: an early developing object-based individuation system (present by as early as 2 months of age), and a later developing kind-based individuation system (emerging towards the end of the first year of life). A number of researchers have shown that even very young infants can employ spatiotemporal criteria in the service of object individuation (at 2 months: Aguiar & Baillargeon, 1999; at 4 months: Spelke, Kestenbaum, Simons, & Wein, 1995; at 5 months: Wynn, 1992; at 10 months: Xu & Carey, 1996). Some have argued that the object-based system of individuation may be largely hard-wired (e.g., Spelke, 1990;

Spelke et al., 1992) But what about the second, kind-based system of individuation.

Many have noted that infants begin to comprehend and produce their first words toward the end of the first year, and many of these first words are nouns for object categories (Hall, 1993). Xu (2003) suggests it is not a coincidence that along with acquiring their first words, infants also begin to develop a kind-based system of individuation. Recent studies provide evidence that language may play a causal role in this process (Balaban & Waxman, 1996; Xu, 2002; Xu, Cote, & Baker, 2005).

Balaban and Waxman (1996) found that words, but not tones, facilitate categorization in 9-month-old infants. Infants in this study were familiarized to a set of pictures of a given category (e.g. rabbits). Some of the infants heard a word when shown a picture, in this case, of a rabbit. For other infants, a tone accompanied the presentation of the picture during some trials. The findings indicate that although both the presentation of the words and the tones effectively heightened the infants' attention to the objects, it was only in the label condition that infants succeeded in categorizing the objects. They preferentially looked at an exemplar from a new category (e.g. a pig) compared to an exemplar from the old category (e.g. a new rabbit). These results suggest that when provided a label, infants group exemplars into a single category more readily than in the absence of a label. A post hoc from the study by Xu and Carey (1996) provides further suggestion that language may augment the acquisition of sortal/kind concepts. The looking time data from the 10-month-olds infants was analyzed as a function of whether they comprehended any of the words that named the objects used in the experiment. The infants who were reported to understand at least one of the words looked longer at the single-object, unexpected outcome, whereas those infants who were said not to

understand any of the words did not. Although, as a whole, the 10-month-olds failed at the task of object individuation, those 10-month-olds with some linguistic knowledge of the objects were able to perform more like their 12-month-old counterparts. Perhaps having labels for objects is a means of establishing that they belong to different kinds.

In order to more directly examine the role of language in such a task, Xu (2002) presented 9-month-olds with the same object individuation task as was used in Xu and Carey (1996), with one crucial manipulation: as each object emerged from behind the screen, the infants heard a label for the object in infant directed speech, "Look, a duck!" (when the duck emerged) and "Look, a ball!" (when the ball emerged). In the one-label condition, the infants heard a single label applied to both objects, "Look, a toy." On the test trials, the screens were removed to reveal either both objects (the duck and the ball; the expected outcome) or one of the two objects (the duck or the ball; the unexpected outcome). In the two-word condition, but not in the one-word condition, infants looked longer at the unexpected outcome. Thus, upon hearing two contrastive labels when seeing the emerging objects, even 9-month-old infants were able to use the differences in object kind to establish a representation of two distinct objects. This effect was not due to merely hearing some words since the infants failed the task when only a single label was provided. In addition, 9-month-olds succeeded on this task when a pair of unfamiliar objects labeled with nonsense words (e.g., "a fendle" and "a toma") was used. Because familiarity with the objects and the labels was not necessary to succeed at this task, it suggests that it is the presence of distinct labels, per se, that allows the infants to establish a representation of two distinct individual objects.

Are these facilitation effects language specific? Would other types of auditory information be equally helpful for this individuation task? In subsequent experiments in this study, Xu (2002), instead of using two words, two tones or two distinct sounds (e.g., a car alarm sound or a spaceship sound produced by a gadget) were used. Under these conditions, 9-month-old infants did not look longer at the one-object, unexpected outcome during the test trials. In the last experiment of this series, two emotional expressions were used in place of words. Emotional expressions provide a particularly good contrast to words because both types of expressions are intentional and are produced by the human vocal tract. Yet, only words are symbolic; they represent objects or object categories. People may have their preferences, e.g., someone may say "Yuck" when they see parsnips on their plate and another may say "Ah," but they both call this food "parsnips." Using the same individuation task, 9-month-olds were presented with unfamiliar objects and provided either two distinct words ("a blicket" and "a tupa") or two emotional expressions ("Ah," denoting approval or satisfaction, and "Ewy," signaling dislike or disgust). The infants looked longer at the unexpected outcome of one object on the test trials in the word condition but not in the emotional expression condition. Taken as a whole, these findings suggest that infants are able to use distinct labels to help them to succeed earlier (i.e., at 9 months, as opposed to 12 months) in a task of object individuation, and these facilitation effects appear to be language specific.

How powerful are words in guiding object individuation? Xu, Cote, and Baker (2005), using a manual search procedure, asked if 12-month-olds could use labeling to establish object representations even when the objects were never shown to them. Many word learning studies with young children have shown that children pay close attention to

the intentional act of referring and factors such as joint attention and speaker's gaze play a critical role in how children decide which object is the referent of a new word (e.g., Baldwin, 1991, 1993; Bloom, 2000; Tomasello, Strosberg, & Akhtar, 1996; among others). In Xu et al. (2005), these intentional and referential cues were provided to assess whether 12-month-olds are able to use these cues to establish object representations based on labeling information. The question was whether the number of labels would help infants determine the number of objects inside a box whose content was invisible to them. On a two-word trial, an experimenter looked into the opening of a box and referred to what was inside (i.e., "Look, a fep!" and "Look, a wug!"). On a one-word trial, the experimenter looked into the box and used the same word twice (i.e., "Look, a zav!"). The box was then presented to the infant and search behaviour was measured. Infants reached into the box and always retrieved one object. The box was then empty and sat within reach of the infant. Even without having seen the objects beforehand, the act of referring lead the 12-month-olds to posit objects inside the box, and the number of labels appears to inform the infant the number of distinct objects to be expected inside the box. If they had heard two distinct labels, babies reached in a second time to look for another object and they did not reach in again if they had heard only a single label. In addition, this effect seems to be specific to linguistic expressions since the number of emotional expressions did not help infants establish the number of objects inside the box (Experiment 2). Thus, labeling, when presented with abundant intentional and referential cues, can guide the process of establishing the number of distinct objects involved in an event for infants as young as 12 months of age.

One empirical question remains unanswered from the results of Xu (2002) and Xu et al. (2005); did the infants in this study interpret the distinct words as referring to distinct kinds of objects (types) or distinct individual objects (tokens). The studies investigating the facilitating effect of language on object individuation (Xu, 2002; Xu et al., 2005) provide evidence that the use of two distinct labels leads infants to posit two objects involved in the event, but, what cannot be determined from the empirical evidence to date is whether infants expect there to be merely two individual objects present or whether the objects involved must be of two different kinds. The evidence so far, however, is also consistent with the view that words pick out distinct object tokens for infants, as opposed to object kinds. Further empirical evidence is required to establish that the presence of two distinct labels leads infants expect two different kinds of objects.

The current study seeks to address this question directly by examining the effect of labeling on 9-month-old infants' expectations regarding the nature of named objects. Infants watched events presented on a puppet stage. The study employed intentional and referential cues, like those used in Xu et al. (2005), in order to allow infants to establish object representations based on labeling information. During the familiarization trials, a box was opened to reveal two objects inside. The revealed objects were either two identical objects or two different objects. The tests trials followed the same procedure, and use the same objects, as familiarization except that before the box was opened, the experimenter looked into the top of the box and described its contents using two distinct object labels (e.g., "I see a wug!" and "I see a dak!") or the same label twice (e.g., "I see a zav!" and "I see a zav!"). The box was then opened to reveal the object-pair outcome (either two identical objects or two different objects). The question of interest is whether

the number of distinct labels will help infants determine the nature of objects inside the box. If an adult were to view these events, hearing the contents of the box labeled with two different words would lead to the expectation of seeing two different objects revealed when the box is opened and, conversely, hearing the same label repeated twice would lead to the expectation of seeing one type of object. If the infants are able to use the given labels to individuate the objects, they should share adults' intuitions regarding revealed object outcome. If infants expect that distinct labels refer to distinct kinds of objects, when two distinct labels are used to refer to unseen objects inside a box, they should look longer when shown two identical objects inside. If, however, infants expect only that distinct labels refer to distinct individual objects, then, when two distinct labels are used, they should look equally long whether two identical objects or two different objects are revealed because, in both outcomes, two distinct individual objects are present. In a second experiment, using the same procedure, infants were presented either identical pairs of objects or pairs of objects that were the same in every property but shape. The property of shape is a very salient cue to kind membership (Landau, Smith, & Jones, 1988), and infants may expect that objects that differ in shape should have different labels. However, if the different objects differed along a property dimension not linked to kind membership, infants might show a different looking pattern. This possibility was examined in a third experiment, in which, objects pairs were either identical or differed only in colour. The current set of studies addresses the question of whether infants, at the beginning of language acquisition, expect distinct words to refer to distinct kinds of objects.

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2. Experiment 1

The role of Experiment 1 was to determine infants' expectations regarding the nature of labeled objects. When infants hear two distinct labels, do they expect those labels to refer to distinct objects? Conversely, when infants hear one repeated label, do they expect the duplicated label to refer to identical objects?

2.1. Method

2.1.1. Participants

Participants were 24 full term infants, 12 male and 12 female (mean age 9 months, 0 days; range 8 months, 8 days to 9 months, 15 days). All infants were recruited from the Greater Vancouver area by mail and subsequent phone calls. The infants received a token gift (a t-shirt or a bib with a university logo) after completing the study. English was the predominant language spoken at home for all infants. An additional four infants were tested but were excluded due to fussiness (3) or parental interference.

2.1.2. Materials

Objects were presented in a 28 x 19 x 23 cm box constructed out of foam core. The box was purple with pastel-coloured circus scenes appearing on its front and sides. The top of the box had an opening that measured 18 x 10 cm and was covered by light blue spandex, which had a horizontal slit through the center. The front of the box swung open to the right in a door-like movement. When the front of the box was opened, the infant had a clear view into the inside of the box. A magnetic latch secured the front of the box when the door was closed. Two magnets on the floor of the inside of the box were spaced 14 cm apart and held the objects in place. Four pairs of objects were used in the study: a toy frog and a plush toy lion, the frog was green and sat atop a transparent

ring containing brightly-coloured beads (approximately 8 x 14 cm in size) and the lion was red with a yellow face and a blue mane (approximately 14 x 8 cm in size); a plush toy dog and a plush bird, the dog was white with black spots and a red collar (approximately 10 x 12 cm in size), the bird was brown with a yellow beak and a red underbelly (approximately 9 x 12 cm in size); a toy train and a star-shaped puzzle, the train was multicoloured, made up of yellow, red, and green parts (approximately 9 x 6 cm in size), the puzzle was constructed of multicoloured sticks assembled into a three-dimensional star-shape which was held together by magnetic silver balls (approximately 10 x 10 cm in size); a double pinwheel and a ball figure, the double pinwheel was made up of two pinwheels (a yellow-silver pinwheel and a pink-silver pinwheel) mounted on a yellow stick with one pinwheel at the top of the stick and the other at the bottom (approximately 9 x 17 cm in size), and a ball figure yellow in colour with bright orange, pink, and green swirls connected to a vertically positioned 'tail' made of blue, green and yellow foam. Each of the eight objects had a duplicate. Each object sat atop a square of white foam-core with a magnet on the bottom so that the objects could be spaced a uniform distance apart. See Figure 2.1 for an example of the identical and different object outcomes.

2.1.3. Apparatus

The events were presented on a three-sided stage (59 cm in length, 102 cm in width, and 55 cm in height) with a white surface. A black curtain hung from the ceiling to the floor in front of the stage. A square, cut out from the curtain, framed the stage so that the display area measured 94 cm in width and 55 cm in height. The portion of the curtain from the bottom of the stage to the floor concealed a video camera underneath. When

seated behind the stage, the experimenter's upper body was fully visible to the infant. When presenting events on the stage, the experimenter wore a light blue smock so that infants' view of the experimenter was uniform across participants.

The video camera was connected to a 19 inch colour TV placed in one corner of the room. An observer watched the infant on the TV monitor and recorded the infant's looking times. The observer was not able to see what was presented on the stage nor were they aware of the order of the trials. A key on a laptop computer was pressed during infants' on target looking. A computer program written specifically for looking time studies (Xhab; Pinto, 1995) was used to record the looking times.

The stage was lit from above; otherwise the room was dark. The infant sat in a high chair about 30 cm from the stage, with eye level slightly above the floor of the stage (about 8 cm). The parent sat next to the infant with his/her back toward the stage, and was instructed not to look at the displays and not to draw the infant's attention in any way. A video camera, set up under the stage, focused on the infant's face and recorded the entire session. The videotape record did not provide information about what was presented on the stage so an observer scoring from the videotapes could be completely blind to the combination of objects shown and the order of the trials.

2.1.4. Design and Procedure

The experimenter began by waving a set of keys at all six corners of the stage (the top and bottom of the left, right, and center of the stage) in order to draw the infant's attention to the stage as well as to define the window of looking for the observer. During the experiment, the experimenter sat behind the stage in view of the infant at all times.

To begin the experiment, the experimenter looked into the top of the empty box, pulling apart the spandex covering while looking inside. The box was then pushed toward the infant and the front door of the box was opened to show that the box is empty. In infant-directed speech, the experimenter said, "Look, it's empty! There's nothing in there!" The front door of the box was then closed and the box turned around so the back of the box was facing the infant. The familiarizations trials were then started.

Familiarization trials. Each infant received 8 familiarization trials. Each familiarization trial began with the back of the box facing the infant. The front of the box was turned away from the infant so that the experimenter could place two objects inside the box, without the infant being able to see which objects were being placed inside. Once the objects were in place and the front door of the box was closed, the box was turned to face the infant. The experimenter then looked into the top opening of the box, pulling apart the spandex, so she was looking at the objects inside. While looking into the box, the experimenter said, "I see something!" Experimenter looks at the baby's face. "There's something there!" Experimenter looks at the baby's face. The box was then pushed forward and the front door of the box opened to reveal the objects inside. As the door was opened, the experimenter said, "[Baby's name], look!" The experimenter lowered her eye gaze so that she was looking at the back of the box; this ensures that the experimenter was not making eye contact with the infant while the objects inside the box were visible. The box was left open so the infant could look at the objects until he/she turned away; looking times were recorded. When the infant turned away for two consecutive seconds, the trial ended. The door of the box was closed and the box turned around so that the objects could be removed and new objects could be placed inside the

box in order to begin the next familiarization trial. Objects from each of the four pairs (frog-lion, dog-bird, train-puzzle, ball-pinwheel) were shown during the familiarization trials (either both objects of the pair were shown (different objects), or one object from the pair was shown with its duplicate (identical objects)). Objects from each of the four pairs were shown to the infants in familiarization trials 1-4. Familiarization trials 5-8 were a repetition of trials 1-4 with the same objects being shown in the exact same order. Which objects were shown (an object appeared either with the other object from its pair or with its duplicate), which side of the box an object was positioned on, and the order of object pairs (either the pair of objects, or an object from the pair appearing with its duplicate) were counterbalanced across infants.

Test trials. At the end of the 8 familiarization trials, the test trials were begun. The test trials followed an identical procedure to that of the familiarization trials with one critical difference: before opening the front of the box, the experimenter looked into the top of the box and labeled the objects inside with either the same label twice (i.e., "I see a zav! I see a zav! There's a zav! There's a zav! [Baby's name], a zav! [Baby's name], a zav!"), or with two different labels (i.e., "I see a wug! I see a dak! There's a wug! There's a dak! [Baby's name], a wug! [Baby's name], a dak!"). Each sentence was spoken in infant-directed speech as the experimenter looked into the box. At the end of every sentence, the experimenter turned to look at the infant's face then returned to look back into the box. Then the box was opened so that the infant could see the two objects inside. When the infant looked away for two consecutive seconds, the trial ended. Each infant was shown four test trials, alternating between two outcomes. There were two possible label/object combinations for both the expected and unexpected outcomes. For an

expected outcome, an infant either heard two different labels applied to the objects inside the box and two different objects were revealed when the box was opened or, conversely, an infant heard one label applied to the objects inside the box and two identical objects were revealed when the box is opened. For an unexpected outcome, an infant either heard two different labels applied to the objects inside the box and two identical objects were revealed when the box was opened or, conversely, an infant heard one label applied to the objects inside the box and two different objects were revealed when the box was opened. See Figure 2.2 for a schematic representation of the procedure. Thus, there are four outcomes an infant was shown during the 4 test trials: same label-identical objects (expected outcome), different labels-different objects (expected outcome), same label-different objects (unexpected outcome), different labels-identical objects (unexpected outcome). The 8 objects were labeled with nonsense words (fep, zav, wug, dak, toma, blicket, muba, and tupple). Each object was labeled with the same nonsense word throughout the study. The same objects from each of the four pairs (frog-lion, dog-bird, train-puzzle, ball-pinwheel) that were shown during the familiarization trials were shown on the test trials (either both objects of the pair are shown; different objects, or one object from the pair is shown with its duplicate; identical objects), but the order of object presentation differed from that of the familiarization trials. The order of outcome was counterbalanced across infants.

2.2. Results

The main results of Experiment 1 are shown in Figure 2.3. An alpha level of 0.05 was used in all statistical analyses. Preliminary analyses found no effects of gender, or animacy (animate vs. inanimate) of the object pairs. Subsequent analyses were collapsed

over these variables. All infants were off-line observed by a second observer who was completely blind to the order of outcome of the experiment.

2.2.1. Familiarization trials

The familiarization trials were divided into two blocks, as familiarization trials 5-8 (block 2) were a repetition of trials 1-4 (block 1). A paired sample t-test was used to determine that looking times decreased significantly across these two blocks of trials ($t(23) = 2.62, p = .02; M_{\text{block 1}} = 14.97 \text{ s}, SD = 5.68, M_{\text{block 2}} = 11.74 \text{ s}, SD = 5.21$).

Averaging across all 8 of the familiarizations trials, it was found that infants looked slightly longer when two different objects were revealed ($M_{\text{different}} = 14.04 \text{ s}, SD = 6.03$) than when two identical objects were revealed ($M_{\text{identical}} = 12.61 \text{ s}, SD = 4.91$), however, this difference was not significant ($t(23) = -1.14, p = .27$).

2.2.2. Test trials

Infants' looking times to the test outcomes were compared by means of a 2×2 repeated measures analysis of variance (ANOVA), with number of labels (one vs. two) and object-pair outcome (identical vs. different) as within-subject factors. The analysis revealed a significant interaction ($F(1, 23) = 5.06, p = .03$; effect size (partial eta squared) = .18). Planned comparisons were performed for each label number (one repeated label vs. two different labels) in order to determine whether infants looked longer to one of the two object outcomes (either identical objects or different objects). When infants heard the box contents described using two repeated labels, they looked significantly longer when two different objects were revealed (the unexpected outcome) ($M = 10.02 \text{ s}, SD = 7.86$) than when two identical objects were revealed (the expected outcome) ($M = 5.41 \text{ s}, SD = 3.57$), $t(23) = -2.93, p < .01$. When infants heard the box contents described using two

distinct labels, they looked longer when two identical objects were revealed (the unexpected outcome) ($M = 11.20$ s, $SD = 10.04$) then when two different objects were revealed ($M = 8.38$ s, $SD = 9.53$), although, this difference was not significant, $t(23) = 1.13$, $p = .27$. Examination of individual infants' pattern of looking, by means of non-parametric analyses, yielded similar looking patterns between these conditions. When one repeated label was applied to the box contents, 16 of 24 infants looked longer when two different objects were revealed (unexpected outcome) than when two identical objects were revealed (expected outcome), Wilcoxon Signed Ranks Test, $z = -2.23$, $p = .01$, 1-tailed. Conversely, when two distinct labels were applied to the box contents, 16 of the 24 infants looked longer when two identical objects were revealed (unexpected outcome) then when two different objects were revealed (expected outcome), Wilcoxon Signed Ranks Test, $z = -1.66$, $p < .05$, 1-tailed.

2.3. Discussion

During familiarization, infants were shown that the box opened to reveal either two identical objects or two different objects. Thus, babies were given evidence that, despite the fact that multiple object pairs were presented, the box contents were always either identical or different. Hence, two possible object outcomes are established: the object pairs alternate between identical and different objects. During the test trials, when labels were applied to the unseen contents of the box, labeling provides a cue as to which object outcome would be revealed. Thus, when infants hear two identical labels, they might expect to see two identical objects inside the box (and would be surprised to see two different objects). Conversely, when infants hear two distinct labels, they might

expect to see two different objects inside the box (and would be surprised to see two identical objects). Indeed, this is what was found.

A potential reason why infants might not have seemed quite as surprised to see two identical objects after hearing two distinct labels is that this looking pattern forced infants to overcome their baseline preference for the different object outcome. In general, infants prefer to look at objects that are different rather than those that are identical. Thus, in order for infants to look longer at the identical object pair (the unexpected outcome) after hearing two distinct labels, they must overcome this preference. On the other hand, infants increased looking time to different objects, after hearing two identical labels, is in accordance with this preference and, thus, produced a greater difference between the surprising (different objects) and unsurprising (identical objects) outcomes. It is certainly not the case, however, that infants simply preferred to look longer at the different object outcome, in general, evidenced by the fact that there was not a main effect of object outcome. Infants did, indeed, look longer to two identical objects after hearing the box contents described using two distinct labels; yet, this difference in looking time was not as substantial as the difference between the different object outcome and the identical object outcome when a single, repeated label was heard.

The conclusion that can be drawn from this first study is that when infants hear two distinct labels, they seem to expect those labels to mark different objects. Conversely, when infants hear one repeated label, they expect that duplicated label to mark identical objects. Up until now, studies investigating the facilitating effect of language on object individuation (i.e., Xu, 2002; Xu et al., 2005) have provided evidence that the use of two distinct labels leads infants to posit two objects involved in the event,

but, what was not able to be determined from previous evidence was whether infants expect there to be merely two individual objects present in the event or whether the objects involved must be two different kinds of objects. In the current study, we have shown that infants do not merely expect two distinct labels to refer to two individual objects. Instead, they expect those individual objects to be different in some way. What remains to be demonstrated is whether or not the infants expect these different objects to vary from each other in a specific fashion. In other words, must the two objects simply be dissimilar from each other in some respect, or is the way in which the objects differ important? We use distinct words in order to designate different kinds of things (i.e., objects within a kind share the same label). And, in general, objects that vary along a property dimension that does not affect kind membership are not marked by differing labels. However, the property difference, shape, is closely connected with kind membership (Landau, Smith, & Jones, 1988; Rosch, Mervis, Gray, Johnson & Boyes-Braem, 1976; Soja, Carey, & Spelke, 1991). Broadly speaking, objects that differ in shape are usually different kinds of things and are marked by different labels. Therefore, it might be the case that hearing two distinct labels should suggest two different kinds of objects in the box. It is predicted that infants will look longer to the unexpected outcomes if the property difference between the objects implies a difference in kind (e.g., shape) but infants will not look longer to the unexpected outcomes if the property difference between the objects does not imply a difference in kind membership (e.g., colour). In the following experiment, we used the same procedure as the first study, except that, the different object pairs differed only in shape.

Figure 2.1. Examples of an identical and a different (or different-shaped, or different-coloured) object outcome from Experiments 1, 2, and 3

Figure 2.2. A schematic representation of the experimental procedure for Experiment 1

Figure 2.3. Mean looking time (s) as a function of the number of distinct labels heard and the revealed object pair outcome for Experiment 1

2.4. References

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3. Experiment 2

3.1. Method

3.1.1. Participants

Participants were 16 full term infants, 8 male and 8 female (mean age 9 months, 2 days; range 8 months, 15 days to 9 months, 13 days). All infants were recruited from the Greater Vancouver area by mail and subsequent phone calls. The infants received a token gift (a t-shirt or a bib with a university logo) after completing the study. English was the predominant language spoken at home for all infants. An additional five infants were tested but were excluded due to fussiness (4) or parental interference (1).

3.1.2. Materials and Apparatus

All materials and apparatus were the same as were used in Experiment 1 except for the objects presented to the infants. Four pairs of objects were used in this study. The objects in each pair were identical in material, texture, and colour; thus, the objects in each pair only differed from one another in shape. All objects for this study were constructed out of painted Styrofoam. The pairs of objects used in this study were: a rectangular block (approximately 10 x 15 cm in size) and a sphere attached to a half-ring (approximately 14 x 12 cm in size), both were blue in colour and spotted with purple and green polka dots and both had multiple lengths of pipe-cleaners protruding from their tops with silver stars attached to the ends; a cone with a sphere on top (approximately 6 cm x 15 cm in size) and a cylinder atop a square base (approximately 8 cm x 10 cm in size), both were pink in colour with multi-coloured vertical strips and both were decorated with multi-coloured pompoms forming a vertical line up the midline of each object; a sphere with smaller spheres attached to either side (approximately 11 cm x 12

cm in size) and a rainbow-shaped arch (approximately 12 cm x 11 cm in size), both were purple in colour and spotted with multi-coloured sequins and each had eyes attached and “feet” constructed of blue foam; a egg-shape constructed to look like a chick (approximately 8 cm x 12 cm in size) and a sphere attached to a triangle decorated to look like a cat (approximately 12 cm x 10 cm in size), both were yellow in colour and had “parts” made of orange foam (i.e., the chick’s comb, beak, and feet and the cat’s eyes and nose) and each had eyes made of black foam. Every object had a duplicate (16 objects total; 4 pairs of objects (differing only in shape), each with a duplicate). Each object sat atop a square of white foam-core with a magnet on the bottom so that the objects could be securely anchored inside the box and the object pairs could be spaced a uniform distance apart. See Figure 2.1 for an example of the identical and different-shaped object outcomes.

3.1.3. Design and Procedure

The design and procedure of this study was identical to that of Experiment 1.

3.2. Results

The main results of Experiment 2 are shown in Figure 3.1. Preliminary analyses found no effects of gender, or animacy (animate vs. inanimate) of the object pairs.

Subsequent analyses were collapsed over these variables.

3.2.1. Familiarization trials

The familiarization trials were divided into two blocks, as familiarization trials 5-8 (block 2) were a repetition of trials 1-4 (block 1). A paired sample t-test was used to determine that looking times decreased significantly across these two blocks of trials ($t(15) = 3.06, p < .01$; $M_{\text{block 1}} = 14.36 \text{ s}, SD = 4.22, M_{\text{block 2}} = 10.94 \text{ s}, SD = 3.33$).

Averaging across all 8 of the familiarizations trials, it was found that infants looked equally long whether two different objects were revealed ($M_{\text{different}} = 12.52$ s, $SD = 3.42$) or when two identical objects were revealed ($M_{\text{identical}} = 12.93$ s, $SD = 3.75$) ($t(15) = .44$, $p = .66$).

3.2.2. Test trials

Infants' looking times to the test outcomes were compared by means of a 2×2 repeated measures ANOVA, with number of labels (one vs. two) and object-pair outcome (identical vs. different) as with-subject factors. The analysis revealed a significant interaction ($F(1, 15) = 8.16$, $p = .01$; effect size (partial eta-squared) = .35). Planned comparisons were performed for each label number (one repeated label vs. two different labels) in order to determine whether infants looked longer to one of the two object outcomes (either identical objects or different objects). When infants heard the box contents described using two repeated labels, they looked significantly longer when two different objects were revealed (the unexpected outcome) ($M = 10.34$ s, $SD = 6.06$) than when two identical objects were revealed (the expected outcome) ($M = 6.89$ s, $SD = 3.41$), $t(15) = -2.14$, $p = .05$. When infants heard the box contents described using two distinct labels, they looked longer when two identical objects were revealed (the unexpected outcome) ($M = 10.04$ s, $SD = 8.84$) than when two different objects were revealed ($M = 5.72$ s, $SD = 3.72$), although, this difference was marginally significant, $t(15) = 2.03$, $p = .06$. Examination of individual infants' pattern of looking, by means of non-parametric analyses, provided similar results. When one repeated label was applied to the box contents, 12 of 16 infants looked longer when two different objects were revealed (unexpected outcome) than when two identical objects were revealed (expected

outcome), Wilcoxon Signed Ranks Test, $z = -1.86$, $p = .03$, 1-tailed. Conversely, when two distinct labels were applied to the box contents, 9 of the 16 infants looked longer when two identical objects were revealed (unexpected outcome) than when two different objects were revealed (expected outcome), Wilcoxon Signed Ranks Test, $z = -1.55$, $p = .06$, 1-tailed.

To compare Experiments 1 and 2, the data from the two experiments were combined and infants' looking times to the test outcomes were examined by means of a 2×2 repeated measures ANOVA, with study (1 vs. 2) as the between-subjects factor and number of labels (one vs. two) and object-pair outcome (identical vs. different) as within-subject factors. The analysis revealed that the three-way interaction (study $\times$ number of labels $\times$ object-pair outcome) was not significant ($F(1, 38) = .005$, $p = .94$). Thus, infants' pattern of looking to each of the test outcomes did not differ between Experiments 1 and 2. However, a significant two-way interaction was found between number of labels and object-pair outcome ($F(1, 38) = 10.81$, $p < .01$; effect size (partial eta-squared) = .22). Planned comparisons were performed on the combined looking times for each label number (one repeated label vs. two different labels) in order to determine whether infants looked longer (across the two experiments) to one of the two object outcomes (either identical objects or different objects). When infants heard the box contents described using two repeated labels, they looked significantly longer when two different (either completely different or different in shape) objects were revealed (the unexpected outcome) ($M = 10.15$ s, $SD = 7.11$) than when two identical objects were revealed (the expected outcome) ($M = 6.00$ s, $SD = 3.54$), $t(39) = -3.66$, $p < .01$. When infants heard the box contents described using two distinct labels, they looked longer when two

identical objects were revealed (the unexpected outcome) ($M = 10.73$ s, $SD = 9.48$) than when two different (either completely different or different in shape) objects were revealed ($M = 7.31$ s, $SD = 7.79$), $t(39) = 2.00$, $p = .05$. Non-parametric analyses of the combined data provided similar results. When one repeated label was applied to the box contents, 28 of 40 infants looked longer when two different objects were revealed (unexpected outcome) than when two identical objects were revealed (expected outcome), Wilcoxon Signed Ranks Test, $z = -2.87$, $p < .01$, 1-tailed. Conversely, when two distinct labels were applied to the box contents, 25 of the 40 infants looked longer when two identical objects were revealed (unexpected outcome) than when two different objects were revealed (expected outcome), Wilcoxon Signed Ranks Test, $z = -2.29$, $p = .01$, 1-tailed.

3.3. Discussion

In this experiment, the only dissimilarity between the different object pairs was the property of shape (they were identical in colour, texture, pattern, material, and size). Therefore, the different-shaped object pairs shared many more features than the different object pairs of the first experiment. In Experiment 1, the different object pairs differed maximally along all property dimensions. Consequently, the dissimilarity between the different object pairs was much more subtle in the current study. Yet, the results of the current study mirror those of the previous experiment. Indeed, infants' looking time patterns were equivalent in both experiments. Thus, it seems that for 9-month-old infants, objects that differ in shape, like objects that differ completely, are expected to be marked by distinct labels.

It could be the case, however, that infants expect that objects that differ along any perceptual dimension should be marked by distinct labels. Perhaps infants displayed looking time patterns similar to those of the first experiment when shown object pair outcomes that alternated between identical objects and objects that differed in shape, not because shape is closely tied to kind membership, but because any perceived difference between the different object pair would have produced this effect. This possibility is explored in the next experiment. In Experiment 3, the different object pairs differed only in colour. For the kinds of objects we have used in this study, colour is a property independent of kind membership. If any perceptual dissimilarity between the different object pairs is enough for 9-month-olds to expect they should be marked by distinct labels, then the results of this study should replicate those of the previous two studies. If, on the other hand, infants expect that only objects that differ in kind should be marked by distinct labels, then it is expected that infants' looking time pattern should differ from those of Experiments 1 and 2.

Figure 3.1. Mean looking time (s) as a function of the number of distinct labels heard and the revealed object pair outcome for Experiment 2

4. Experiment 3

4.1. Method

4.1.1. Participants

Participants were 16 full term infants, 8 male and 8 female (mean age 9 months, 0 days; range 8 months, 15 days to 9 months, 14 days). All infants were recruited from the Greater Vancouver area by mail and subsequent phone calls. The infants received a token gift (a t-shirt or a bib with a university logo) after completing the study. English was the predominant language spoken at home for all infants. An additional six infants were tested but were excluded due to fussiness (5) or parental interference (1).

4.1.2. Materials and Apparatus

All materials and apparatus were the same as were used in Experiment 1 and 2 except for the objects presented to the infants. Four pairs of objects were used in this study. The objects in each pair were identical in material, texture, and shape; thus, the objects in each pair only differed from one another in colour. The objects used in this study were identical to the objects used in Experiment 2. Each object used in Experiment 2 was duplicated except that every colour of the original object was changed resulting in an identical pair that differed only in colour. Every object used in this study also had a duplicate (16 objects total; 4 pairs of objects (differing only in colour), each with a duplicate). Each object sat atop a square of white foam-core with a magnet on the bottom so that the objects could be securely anchored inside the box and the object pairs could be spaced a uniform distance apart. See Figure 2.1 for an example of the identical and different-colour object outcomes.

4.1.3. Design and Procedure

The design and procedure of this experiment were identical to that of Experiments 1 and 2.

4.2. Results

The main results of Experiment 3 are shown in Figure 4.1. Preliminary analyses found no effects of gender, or animacy (animate vs. inanimate) of the object pairs. Subsequent analyses were collapsed over these variables. All infants were off-line observed by a second observer who was completely blind to the order of outcome of the experiment.

4.2.1. Familiarization trials

The familiarization trials were divided into two blocks, as familiarization trials 5-8 (block 2) were a repetition of trials 1-4 (block 1). A paired sample t-test was used to determine that looking times decreased significantly across these two blocks of trials ($t(15) = 2.87, p = .01; M_{\text{block 1}} = 12.89 \text{ s}, SD = 7.18, M_{\text{block 2}} = 8.03 \text{ s}, SD = 3.97$). Averaging across all 8 of the familiarizations trials, it was found that infants looked equally long whether two different objects were revealed ($M_{\text{different}} = 9.68 \text{ s}, SD = 4.11$) or when two identical objects were revealed ($M_{\text{identical}} = 11.24 \text{ s}, SD = 7.11$) ($t(15) = .92, p = .37$).

4.2.2. Test trials

Infants' looking times to the four test outcomes were averaged and compared by means of a 2×2 repeated measures ANOVA, with number of labels (one vs. two) and object-pair outcome (identical vs. different) as with-subject factors. The analysis revealed a significant main effect of object pair outcome ($F(1, 15) = 7.61, p = .02$; effect size

(partial eta-squared) = .34). Thus, collapsing over number of labels heard, infants looked longer when different-coloured objects were revealed ($M_{\text{different}} = 9.20$ s, $SD = 6.24$) than when two identical objects were revealed ($M_{\text{identical}} = 6.46$ s, $SD = 4.22$). More importantly, the interaction was not significant ($F(1, 15) = 1.88, p = .19$).

The data from experiments 1, 2 and 3 were combined and infants' looking times to the test outcomes were compared by means of a 2×2 repeated measures ANOVA, with study (1, 2, or 3) as the between-subjects factor and number of labels (one vs. two) and object-pair outcome (identical vs. different) as with-subject factors. The analysis revealed a significant three-way interaction (study $\times$ number of labels $\times$ object-pair outcome) ($F(1, 53) = 3.77, p = .03$; effect size (partial eta-squared) = .13). Thus, infants' pattern of looking to each of the test outcomes differs between Experiments 1, 2 and 3. Comparing infants in Experiment 1 and 3 only, a significant study $\times$ number of labels $\times$ object-pair outcome interaction was found ($F(1, 38) = 5.52, p = .02$). Therefore, infants' pattern of looking to each of the test outcomes differs between Experiment 1 and 3. Furthermore, comparing those infants in Experiment 2 and 3 revealed a similar finding; the study $\times$ number of labels $\times$ object-pair outcome interaction was significant ($F(1, 30) = 9.55, p < .01$). Thus, infants' pattern of looking to each of the test outcomes differs between Experiment 2 and 3. Because it is already established that the looking time patterns for infants in Experiments 1 and 2 are statistically equivalent, it can be said that the looking patterns obtained in Experiment 3 are different from those obtained in Experiments 1 and 2.

4.3. Discussion

The results of the current study differed from those of both Experiment 1 and 2. Therefore, it appears that not just any perceptual dissimilarity between the different object pairs is sufficient for infants to expect that they should be marked by distinct labels. Moreover, it seems that infants expect that only objects that differ in kind relevant features (i.e., shape) should be marked by distinct labels.

What is to be made of the looking time pattern in Experiment 3? When the object pair outcomes were either identical or differed only in shape, regardless of the number of distinct labels given, infants looked slightly longer when two different-coloured objects were revealed than two identical objects were revealed. This represents a return to baseline looking preferences: infants prefer to look longer at two objects that differ in some respect than two objects that are the same. Here, it appears, that the labeling was not a cue to object outcome. In the previous two studies, the object outcomes alternated between identical objects and different kinds of objects. Thus, labeling was a cue to object outcome: hearing distinct labels lead to the expectation of seeing two kinds of objects (different (shaped) object outcome), while hearing one repeated label lead to the expectation of seeing one kind of object (identical object outcome). However, in this experiment, when infants were shown, during familiarization, that the object outcomes alternated between identical and different-coloured objects, both outcomes involved only one kind of object. Thus, if infants expect labels to pick out kinds, then the labeling in Experiment 3 was uninformative, because both object outcomes involved only one kind of object. In this case, the labeling was not predictive of object outcome and, therefore, it was ignored.

Figure 4.1. Mean looking time (s) as a function of the number of distinct labels heard and the revealed object pair outcome for Experiment 3

5. General Discussion

After seeing the contents of a box alternate between either two identical objects or two different objects (Exp. 1), 9-month-old infants who, subsequently, heard the hidden contents of the box referred to using one repeated label, looked longer (indicating surprise) when the box was opened to reveal two different objects inside. Conversely, upon hearing the hidden contents referred to using two distinct labels, infants looked longer when the box was opened to reveal two identical objects. The same pattern of results were obtained when infants were shown that the box contents alternated between either two identical objects or two objects that different only in shape (Exp. 2). In the case of both Experiments 1 and 2, infants were given evidence that there were always two objects inside the box and that these objects would either be identical or different/different-shaped. For infants watching these events, labeling acts as a cue to object pair outcome. Under these circumstances, when infants hear two repeated labels used to describe the (unseen) box contents, they expect that the box will open to reveal two identical objects and when they hear the contents described using two distinct labels, they expect to see two different (or different-shaped) objects inside the box. However, these expectations are not upheld when infants are first shown that the box contents alternate between either two identical objects or two different-colored objects (Exp. 3). In this case, infants simply look longer when the box is opened to reveal two different-colored objects, independent of the number of labels heard. Here, labeling does not appear to be adding any predictive cues as to what infants can expect to see when the box is opened.

It should be noted that, in the case of all three of these experiments, infants were presented with both animate and inanimate object pairs. In a given different object pair, both of the objects were either animate or inanimate. For each of the three experiments, no effects of animacy were found. Thus, the 9-month-olds, in the current study, reacted equivalently regardless of the animacy of the object pairs with which they were presented.

An empirical question that remained unanswered from the results of previous experiments examining the effect of labeling on infants object representations (Xu, 2002; Xu et al., 2005) was whether the infants in these studies interpreted the distinct words as referring to distinct kinds of objects (types) or distinct individual objects (tokens). The current set of experiments provides evidence that even young babies expect distinct words to refer to kinds. In each of the three experiments, the object pair outcomes alternated between two identical objects or two objects that differed in some respect. If it is the case that infants merely expect distinct words to refer to distinct individual objects, then when infants hear two distinct labels, they should look the same length of time to two identical objects as they do to two different objects because each of these outcomes is comprised of two individual objects. The results of the current study suggest that this is not the case. Furthermore, it is not enough to say that infants expect distinct words to refer to different objects: it is evident from these results that the ways in which the different objects differ is important. The property of shape is a very salient cue to kind membership (Landau et al., 1988; Roch et al., 1976; Soja et al., 1991) and it was hypothesized that infants may expect that objects that differ in shape should have different labels. The results of the second experiment (identical objects vs. different-

shaped objects) lend support to the notion that, even for young infants, objects that differ in shape are seen as different kinds of things. Here, the results mirrored those of the first study (identical objects vs. different objects), thus, infants reacted to the object pairs that differed only in shape equivalently to the object pairs that differed along every property dimension. In these experiments, the two object pair outcomes alternate between one kind (identical objects) and two kinds (different/different-shaped objects); thus, labeling can be used to distinguish between these two object outcomes. However, if the different objects varied along a property dimension not linked to kind membership, it was hypothesized that infants might show a different looking pattern. This prediction was confirmed in the third experiment (identical objects vs. different-colored objects). Here, infants did not use labeling information to help them predict object pair outcome. It is suggested that the reason that labeling is not assisting infants when the objects are either identical or different-colored is because both object pair outcomes represent only one kind of thing. Because distinct labels are used to mark distinct kinds, if the box contents do not alternate between identical and different kinds, the labeling information cannot be used to predict object pair outcome. It is clear from the results of this series of experiments that infants are sensitive to perceptual dimensions that are related (or unrelated) to kind membership.

Many word learning studies with young children have shown that children pay close attention to the intentional act of referring and factors such as joint attention and speaker's gaze play a critical role in how children decide which object is the referent of a new word (e.g., Baldwin, 1991, 1993; Bloom, 2000; Tomasello, Strosberg, & Akhtar, 1996; among others). It has been previously shown that infants as young as 12 months of

age are able to use labeling to generate object representations even when the objects were never shown to them (Xu et al., 2005). The results of the current study provide indirect evidence that even younger infants are able to use intentional and referential cues (i.e., speaker's gaze) to establish object representations based on labeling information.

It should be made clear that there is no evidence that the 9-month-olds in this study actually learned the labels applied to the objects, nor were they expected to. The events presented to the infants involved both novel objects and novel labels. In addition, the labels were only presented when the objects were not visible (i.e., when the box was closed). These certainly aren't optimal conditions for word learning, especially for infants of this age. However, what is important to note is that even in the absence of particular mappings, infants as young as 9 months seem to expect distinct words to refer to different kinds.

What is the mechanism through which labeling is thought to impact infants' object representations? It has been proposed that words for object categories, or kinds, serve as "essence placeholders" (Gelman, 2003; Medin & Ortony, 1989; Xu, 2005). Infants may expect that words for objects map onto distinct kinds in their environment. Given this expectation, the fact that one object is called "a duck" and one object seen on a different occasion is called "a ball" is sufficient evidence for infants to infer two distinct kinds or essences. Thus, by virtue of being called "a duck," the infant learns that this is a kind, and the word "duck" becomes a placeholder for a distinct duck-essence. If an object, seen at a different time, is called "a ball," the infant assumes that the word refers to a different kind and it will have a different set of properties from the ducks that are referred to by the word "duck." Simply hearing and learning words for object kinds does

not confer upon the infant the concepts duck and ball, but words such as “duck” and “ball” may direct the infant to establish “placeholders” for the relevant concepts and through subsequent interactions with the world, these concepts are developed and beliefs about these concepts are expanded. One of the fundamental tenets of psychological essentialism (Gelman, 2003; Medin & Ortony, 1991) asserts that essences determine the surface features and properties of objects. Thus, if two objects share a label, they should belong to the same kind and their perceptual property similarities should be examined, as in a categorization task. For example, Balaban and Waxman (1996) found that words, but not tones, facilitate categorization in 9-month-old infants, suggesting that when provided a label, infants group exemplars into a single category more readily than in the absence of a label. In addition, if two kinds of objects are inferred in an event because two distinct labels are heard, there must be two distinct tokens of objects present, as in the object individuation task (e.g., Xu, 2002). Moreover, objects that share a label and, thus, are the same kind of thing, should share certain non-obvious properties, as in an inductive inference task. For example, at 13 and 18 months, when objects share a common label, infants are more likely to produce a non-obvious property, e.g., squeeze it to make a sound (Graham, Kilbreath, & Welder, 2004; Joshi and Xu, under review; Welder & Graham, 2001). The current study is consistent with these lines of research as it indicates that when infants as young as 9 months, hear a repeated label, they expect the referents of that label to be identical (i.e., the same kind of thing), but, when they hear two distinct labels, they expect the referents of those labels to be different in kind.

Do young children understand that shape is a salient cue to kind membership, or have they simply formed an association between labeling and shape, such that objects

that are referred to by the same label share the same shape and objects that are marked by distinct labels have different shapes? Studies conducted with much older children (preschoolers) offer some insight into this distinction. In an article advancing the notion of a “shape bias” in word learning, Landau et al. (1988) proposed that many words partition the world according to shape. Thus, at least for young children, a shared count noun captures the shape similarity between objects. A longitudinal study by Smith, Jones, Landau, Gershkoff-Stowe & Samuelson (2002) following children as young as 17 months, lends support to the notion that shape’s importance in labeling might develop over the course of early word learning. In this study, children who repeatedly heard names for members of unfamiliar object categories well organized by shape formed the generalization that only objects with similar shape have the same names. The authors concluded that children who learn names for things in categories with a common organizing property (in this case, shape) learn to attend to that property for learning more object names. However, a more recent study from this research group (Samuelson & Smith, 2005) suggests that children may name objects by shape from the earliest points of productive vocabulary development.

Because kind membership is so highly correlated with shape similarity it is extremely difficult to tease the two apart experimentally. However, a few studies examining preschoolers’ naming of pictorial representations are highly suggestive that children do not always apply labels on the basis of shape alone. In one such task conducted by Gelman and Ebeling (1998), 2- and 3-year-old children were shown line-drawings roughly shaped like various namable objects. For half the participants, each line-drawing was described as depicting a shape that was created intentionally (e.g.

someone painted a picture). For the remaining participants, each drawing was described as depicting a shape that was created accidentally (e.g. someone spilled some paint). Participants were asked to name each picture. The findings suggest that subjects use shape as the basis of naming primarily when the shapes were intentional. These results suggest that, although shape does play an important role in children's early naming, other factors are also important, including the mental state of the picture's creator. Similarly, Bloom and Markson (1998) found that when a picture was ambiguous, (i.e., resembling both a balloon and a lollipop), 3- and 4-year-olds named the picture based on the creative intent of the artist. These results demonstrate that the sameness of shape is not sufficient in determining children's naming preferences. Something can be shaped like a lollipop, but not called "a lollipop." The results from these studies examining preschoolers' naming of pictorial representations suggest that, for young children, labels for objects (and representations of those objects) are not wholly determined by shape similarity. If shape alone does not determine labeling, perhaps, shape may simply be a proxy for kind membership. The current study, conducted with children much younger than those previously studied, provides support for the position that shape is a cue to kind membership. The results suggest that, even before infants begin using language, infants expect that objects that differ in shape should be marked by distinct labels.

A proposed study seeks to determine if young children understand shape as a cue to kind membership or whether they have simply formed an association between labeling and shape. In the realm of many objects and artifacts (those things represented by count nouns), shape is a very salient cue to kind membership. However, for things in the world represented linguistically as mass nouns (i.e., substances like pudding and sand) shape is

not the best correlate of kind membership. In this case, a property dimension like colour or texture might be much better indicators of kind. What would be the expectations of infants, in the procedure of the current study, if the objects were replaced with familiar substances (i.e., differing flavors of baby food)? We propose to use this experimental procedure in a new domain (food) where shape is no longer a reliable predictor of kind. If 9-month-olds expect that differing labels correspond to distinct kinds of things, when they hear two different labels, they should expect the presence of objects/substances that display kind relevant property differences. In the case of objects, this property difference is shape but for substances, this property difference is more likely colour or texture. If infants have learned an association between shape and labeling: a “shape bias” that compels them to extend labels on the basis of shape alone, the results of the proposed study should mirror the finding of the current study. However, if infants understand shape as merely a predictor of kind, then in this food experiment, colour should become the more reliable predictor of kind membership. Here, infants should react to different-coloured substance pairs just as they would react to completely different substance pairs. The proposed experiment seeks to examine whether 9-month-old infants expect distinct labels to correspond to things that differ in shape or, instead, whether they expect distinct labels to correspond to things that differ in kind.

The current study also offers insight into the nature of infants’ representation of early words. Infants begin to comprehend words for object categories at around 9 months of age. One controversial issue is whether these early words are count nouns that refer to kinds or proper names that refer to individual objects. Most early word learning studies address this issue by asking infants to generalize a newly learned word to other members

of the same kind and success has been found at 13 months (e.g., Woodward, Markman, and Fitzsimmons, 1994). The present study used a new method to address this question by examining the effect of labeling on 9-month-olds' expectations regarding their representation of the named objects.

According to the literature, older children (2- to 4-year-olds), seem to assume that a novel word applied to an unfamiliar object refers to a basic level kind, and will be extended to objects of similar shape (and kind). Thus, for expert word learners, novel words are thought of as count nouns that can be readily generalized to like objects. But, what remains an open question, is whether this representation of novel words operates similarly in children just beginning to learn words. Do young infants have the same assumptions about novel words as their older counterparts? In other words, do infants show evidence that their earliest labels for objects are count nouns that refer to kinds?

Two theories dominate the literature on extendibility. The "broad-to-narrow" view holds that words license attention to object categories (Hall & Waxman, 1993; Waxman & Markow, 1995; Balaban & Waxman, 1997). Thus, when infants embark on the process of lexical acquisition, they might, initially, interpret a word applied to an object as referring to that object and other members of its kind. Children already have rich conceptual systems by the end of their first year of life (Mandler & McDonough, 1996) and they might assume that words map onto these categories from the outset. The alternative hypothesis, the "narrow-to-broad" view, holds that words label individual exemplars and, only later, generalize to categories, either on the basis of shared shape or on the basis of highlighted perceptual similarity (Hirsh-Pasek, Golinkoff, Hennon, &

Maguire, 2004; Smith, 2000). An examination of the word-learning literature provides empirical support for both views.

The origin of the narrow-to-broad view, which stipulates that words are first represented as proper names restricted to the named object, dates back as far as Locke ([1690] 1964) and the British empiricists. According to Locke, at the earliest stages of word learning, children know only proper names. This position is supported by anecdotal evidence describing the way in which infants first begin to apply labels. There are reports of some of children's earliest object labels being overly narrow and highly context dependent (Bates, 1979; Bloom, 1973). For instance, a child might only label the rubber duck he plays with in the bath "duckie," but will not extend the word to other members of the kind, like his plush toy duck, or real ducks he encounters in the park. Thus, this view suggests that children begin with a conservative strategy of word learning where they refrain from generalizing a newly learned word beyond the first exemplar until they are given positive evidence to the contrary (i.e., hearing the label extended to other members of the same kind). There is some experimental evidence that appears to support such a view. In two studies by Hennon, Rocroi, Chung, Hollick, Driscoll, Hirsh-Pasek & Gollinkoff (1999) using a preferential looking procedure, it was found that both 10- and 12-month-olds (but not 19- and 24-month-olds) failed to generalize a newly learned label. The authors concluded that the younger infants were demonstrating a proper-noun bias with no evidence of word extension, thus, providing support for the conservative strategy. However, their data did not demonstrate that 10- and 12-month-olds had even learned the word in the first place (Markman & Jaswal, 2004). In their first study, following training on a novel label, on one test trial, babies were shown the originally

labeled object and a distractor while hearing the novel label. On this trial, 10- and 12-month-olds showed no preference for the target object over the distractor, meaning there was no evidence that they learned the novel word at all. In a second study, Hennon et al. (1999) included only a generalization trial, again failing to provide evidence that the infants had learned the word. It seems impossible, in the case of these studies, to evaluate whether 10- and 12-month-olds failed to generalize or whether they had just not learned the word to begin with. Research demonstrating clear learning of a new label by young babies is required to provide a definitive test of this hypothesis. At present, there is no strong empirical evidence for a conservative strategy by which infants first learn words as proper names that refer only to the labeled exemplar and wait for positive evidence that a term should be generalized.

Generalization studies with slightly older children provide empirical support for the broad-to-narrow view. It has been proposed that children extend newly learned labels in accordance with the "taxonomic assumption," a word-learning constraint that motivates children to extend newly learned labels to other members of like kind. The taxonomic assumption was originally introduced to explain why children extend things to like kind rather than to things strongly associated with each other (Markman & Hutchinson, 1984). Katz, Baker, and Macnamara (1974) found that by 24 months (girls as young as 17 months), children treated a common name (e.g., a *dax*) as referring to a basic-level kind, regardless of the animacy of the labeled item. A similar finding was reported by Woodward, Markman, and Fitzsimmons (1994) who found that both 13- and 18-month-olds who heard a novel object labeled nine times learned the word and extended it to other members of like kind (differing in color). A longitudinal study by

Oviatt (1980) examining infants' word comprehension, demonstrated that by 12 to 14 months, infants appeared flexible and categorical in their use of a learned word.

Production data focusing on infants' earliest words shows that, even at the outset of spontaneous production, children's object names are symbols, which encode object categories (Huttenlocher & Smiley, 1987). Furthermore, Huttenlocher and Smiley's (1987) findings from early spontaneous speech failed to show early restrictions in word extension.

The ability to generalize a novel word to similar category members is well documented in older children (i.e., at 20 months: Hall, 1991; at 29 months: Golinkoff et al., 1992; at 36 months: Imai, Gentner, & Uchida, 1994). Indeed, preschool-aged children expect that a count noun, applied ostensively to an individual object (e.g., "This is a *dax*") will refer to that object and to other members of the same basic and superordinate level object categories (Markman & Hutchinson, 1984; Soja, Carey, & Spelke, 1991; Waxman & Gelman, 1986; Waxman & Hall, 1993; Waxman & Kosowski, 1990). In addition, it appears that children rely on perceptual properties, specifically; shape, when generalizing words. When given a new count noun that refers to a rigid object, children will extend that noun to other rigid objects of the same shape, but not to those of the same size, color, or texture (Jones, Smith & Landau, 1991; Landau, Smith & Jones, 1988; 1998; Smith, Jones & Landau, 1992; 1996). The evidence seems to show that as soon as children have demonstrated clear learning of a word, they also generalize that word to new exemplars. However, this phenomenon has not been demonstrated in infants younger than 13 months (predominantly because infants 12 months and younger have not been able to demonstrate clear learning of the target word). Empirical evidence demonstrating

word learning by younger babies is required in order to provide a more definitive test of the hypothesis that infants' earliest words are count nouns that refer to kinds.

Although the current study did not involve actual word learning, the findings do inform the literature on early word extension. Much of the research on word generalization has found that infants, as young as 13 to 15 months of age, will extend a newly learned label beyond the target object to other members of like kind. What has not yet been demonstrated is whether younger babies, 9- to 12-month-olds, who are just on the cusp of word learning, also understand that words for objects are count nouns that refer to kinds. It could be that these very young infants expect that object labels simply designate individuals and, thus, function as proper names. However, the current findings suggest that a "proper name bias" in earlier word-learners may be untenable. If, for 9-month-olds at least, words serve as proper names and map to individuals, it should have been the case that there was no differentiation between looking times in each of the conditions (because in each trial, the box opened to reveal two individual objects). This scenario was not supported by the evidence. In addition, it was found that the 9-month-olds established specific expectations about the object outcome when two distinct labels were heard. When two labels were used, not only did the babies expect to see two different objects inside the box, they expected that the objects would differ along a kind relevant property dimension (shape), but they did not expect the objects would differ along a property dimension that was independent of kind membership (colour). Thus, it seems that, even for very young infants, the presence of differing labels leads to the assumption that those labels correspond to objects that are distinct only in kind. Such a

finding is clearly suggestive that, at the beginning of word learning, infants understand words for objects as count nouns that designate kinds.

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Appendices

Appendix A