The Role of Object Parts in the Development of Early Semantic Categories

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A Thesis

in

The Department

of

Psychology

Presented in Partial fulfilment of the Requirements
for the Degree of Master of Arts at
Concordia University
Montreal, Quebec, Canada

July, 1990

ISBN 0-315-59137-4

ABSTRACT

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Concordia University, 1990.

The main objective of this research was to investigate the role of parts in determining membership in object categories in infancy. Using a preference-looking paradigm, whereby subjects are shown two pictures while being instructed to find a target object, 81 12-, 15-, and 18-month-old infants were tested both for word knowledge and response to missing parts. To test for word knowledge, looking time to a picture of a referent and a non-referent of each target word was measured. To test for sensitivity to missing parts, looking time to a picture of a complete referent and a referent with a part-removed was measured. Increased looking time at referents over non-referents, for the 18-month-old group, supported the hypothesis that word knowledge would increase with age. Increased looking time at complete over part-removed referents, for the 18-month-old group, supported the hypothesis that the importance of parts in making category membership judgements would increase with age. Although parental report of word knowledge increased with age, no word by word relationship was established between parental report of word knowledge and the percentage of time spent looking at referents vs. non-referents.

Acknowledgements

This research would not have been possible without the cooperation of my subjects, and especially their parents, many of whom wrestled with inclement weather and snowsuits, in order to get their babies to the lab on time:

My lab-mates, Véronique Lacroix and Lorrie Sippola, lent their practical and moral support throughout the project. Thanks go to Wendy Seifert, who assisted in data collection, and Andrea Kenney, for Systat tutorials.

The Centre for Research in Human Development is a wonderful supportive working environment. Keith Marchessault and Kim Powlishta were generous with their time and statistical expertise. My coworkers in the Child Development Laboratory, and especially Pascale Finet, helped me to "hang in there".

I am grateful to my family and friends, who have been supportive in many ways throughout the years, and especially to Dayle King, for her unfailing confidence in me.

My readers, Norman Segalowtiz and Lisa Serbin, were supportive and constructive in their feedback on this work.

Finally I would like to thank my supervisor, Diane Poulin-Dubois. She has patiently endured through seemingly endless technical delays, and has provided skillful guidance throughout the process. I continue to be inspired by her creativity, dedication, and enthusiasm for research, and look forward to our future collaborations.

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Understanding how young children acquire the meaning of object words is of primary importance in order to account for early lexical development. The proportion of general nominal words corresponds to 41% of the first ten words acquired, (at approximately 15 months) and 62% of the first 50 words acquired (at approximately 19 months) (Nelson, 1973a). The meaning of a word consists of two levels. "The extension of a term of reference includes all the objects which an individual is willing to denote with that term of reference. The intension of a term of reference is the set of properties which an individual believes to be true of the instances of the category denoted by the term" (Anglin, 1977, p.27). Therefore the extension of the word animal might consist of cat, dog, horse, cow, etc., and the intension of the word might include the properties of animate, has four legs, has a tail, does not speak, etc. (Dromi, 1987).

As noted by Dromi (1987), it is extremely difficult, if not impossible, to study how early word intensions emerge and develop over time. Infants and very young children cannot be asked to define their intension of a word. Consequently, much of the research and theories on early word meaning have been based on studies of the extension of early object words (e.g. Barrett, 1986; Bowerman, 1978, 1980; Clark, 1973a), and more specifically, on the errors early language learners make in those extensions.

Children's and adults' word meanings can be related in five logical ways: identity, partial overlap, mismatch, underextension, and overextension (Dromi, 1987). The most common error is that of overextension, whereby the child generalizes the word to non-members of the category. For example, a child may use the word "dog" to refer to several other animals, including horses and cows in the "dog" category. A second type of error is that of underextension, whereby the child uses a word only for a very specific instance of a concept (Anglin, 1977). Bloom (1973) documents her daughter's use of the word "car" only for cars which she could see moving on the street from her bedroom window. Of these two types of errors, overextension errors have been most frequently drawn upon as evidence for theories of early word meaning acquisition (Dromi, 1987).

Models of early object word meaning

Among the major theories which have emerged in recent years to account for extension errors in describing the nature of early object word categories, are the semantic feature hypothesis (SFH) proposed by Clark (1973), the functional core hypothesis (FCH), proposed by Nelson (1974) and the prototype model, proposed by Bowerman (1978).

According to Clark's (1973), semantic feature hypothesis, overextension errors occur because the child has acquired only partial meanings for the overextended words. A list of semantic features (e.g. size, colour, movement, shape) are acquired, and these designate to what objects the word is to be extended. Easily perceptible features of the environment are learned first (e.g. that a ball is round), followed by more complex features (such as being "throwable"). Secondly, general features, (e.g. that a cat is four-legged, small, and furry) are learned before specific features (e.g. that it has whiskers and meows). In this way, children gradually add new and more specific features until they acquire adult word meanings (Clark, 1983).

Overextension errors have been drawn upon as major support for Clark's theory. Thus with an initial list of general features for dog, a child might overextend the word to cows, horses, and sheep, but when more specific features are added, the concept will be appropriately narrowed. Evidence from infant overextension studies shows that children respond to features when making overextensions. In a test of overextension in comprehension and production with children aged 20 to 27 months of age, Chapman & Thompson (1980) documented many instances of overextension in production based on common features. For example, the concept of dog was overextended by one child to include eight different kinds of four-legged animals (i.e. cow, horse, cat, hippopotamus, rhinoceros, lamb, donkey, and wolf). Another child appeared to be responding to the feature of "round" in extending the word apple to balls of soap, a rubber ball, a ball lamp, a tomato, peaches, cherries, strawberries, an orange, a pear, an onion, and round biscuits. Barrett (1982) also documents overextensions based on specific features, such as having wheels (bus used for bus and truck), and being round (tick-tock used to refer to watches, clocks, gas meter, fire hose wound on a spool, round eraser). Poulin-Dubois & Laurendeau-Bendavid (1984), testing children 17 to 29 months of age, also found that some features were shared by common referents of an overextended word. For example, within the animal category, dog, horse, and cow were extended to other four-legged animals, and car and truck were used for other wheeled vehicles. However, when categories had features which were specific to the category, these same overextension errors did not occur. Elephant was not overextended to other animals, and airplane was only overextended to another "flying" vehicle, the helicopter. It would appear, then, that while some general features are used in making erroneous overextended category membership judgements, some specific features can be used to make correct judgements.

Nelson (1974) has argued that rather than abstracting features in order to form concepts of words, children first construct concepts based on <u>functions</u> of objects in their own experience. The <u>functional core model</u> was based on the fact that the vast majority of objects which children first choose to name are things that perform interesting actions (e.g. ball, dog, car) rather than inanimate things (e.g. tree, kitchen) (Nelson, 1985). Thus it was proposed that a child's first concepts are formed on the basis of their experience with objects in functional situations, and that information about actions and reactions of objects in relation to the child and other people form the "functional core". Perceptual features are seen ss critical information in the early stages of word meaning acquisition, and are located outside the "core" (Nelson, 1985). Therefore, although perceptual features are part of the concept, the initial concept is seen as being bound to the functional script, being based on the actions of the object and the actors in the situation.

It is only in the second half of the second year that holistically-experienced event-bound concepts can be partitioned (Nelson & Lucariello, 1985). At this stage, infants' vocabulary rapidly increases, as discrete naming of objects independent of events makes it possible for them to learn and generalize object concepts on the basis of perceptual, as well as functional, features (Nelson, 1985). This model, while acknowledging that perceptual features are part of early concepts, relegates them to a secondary role which becomes important only when the early language learner is capable of analytically separating individual object concepts from events. Perceptual features then become important in generalizing the concept to new instances on the basis of form, rather than function (Nelson, 1979).

Support for this theory has been found both in early vocabulary studies and in object concept learning studies. For instance, preverbal infants (8-12 months) have been found to remember and attend to the dynamic qualities (functions) of things over their perceptual features (colour and form) (Nelson & Lucariello, 1985). While children under 18 months of age can learn a name for a novel object, they do not generalize the concept to new exemplars (Oviatt, 1982). However, when one- to two-year-old children are allowed to play with objects judged by adults as being more or less similar to a ball on the basis of both function and shape, they select appropriate exemplars on the basis of function more often than when they are only allowed to look at the object (Nelson, 1973b).

Bowerman (1978) has also proposed a model to account for the early stages of vocabulary. According to the prototype model, infants initially make judgements of category membership based on comparison to a single referent or an averaged representation of a small group of highly similar exemplars to which they have first heard an object word applied (Bowerman, 1978). Thus the initial category definition is made up of a central, or "prototype" instance (Anglin, 1977). The prototype object to which the word refers is made up of several features which co-occur in members of that category to which the child has been exposed

(Bowerman, 1978). Initial categories are experienced as unanalyzed wholes (Bowerman, 1978), but as new exemplars are encountered, comparison to the prototype is made using both holistic (i.e. determining whether it is a match to the prototype) and analytic (i.e. determining how "good" a member of the category it is) processes (Greenberg & Kuczaj, 1982). The "goodness" or centrality of an exemplar is based on the number of attributes it has in common with other referents of the word, or family members (Rosch & Mervis, 1975). New exemplars are admitted to the category on the basis of attributes shared with the prototype, but all new exemplars need not share all attributes with the prototype, nor do they need to share attributes with other category exemplars (Rosch & Mervis, 1975).

Support for this model has been provided by analysis of errors in children's early object word use. Children will label a new exemplar on the basis of possession of one or more features of the prototype. Thus a child may name an object (e.g. lampshade, ball) "moon" because it shares one or more features with the prototype moon, e.g. shape, colour, being viewed from below (Bowerman, 1978). In this way, the word may be overextended to objects which do not belong in an adult's category. Overextension is more likely to occur when the new object is perceptually similar to a central instance than when it is similar to a non-central instance (Kay & Anglin, 1982). In contrast, when children underextend a word, they are more likely to do so when presented with a peripheral, rather than a central, instance of the concept (Kay & Anglin, 1982). In an experimental test of this theory, Kuczaj (1986) found that when children were presented with good exemplars, peripheral exemplars, and non-exemplars of a target word, and were repeatedly asked to present the experimenter with a referent for the target word, they first indicated appropriate central exemplars, then moved to less typical members of the category. These studies show that children as young as two years of age determine category membership on the basis of comparison to prototypes, and that perceptual features which objects have in common seem important in their judgments of category membership.

In a recent update of the prototype model, Barrett's (1982, 1986) developmental hypothesis proposed three stages of word meaning acquisition which include components of the three theories presented above. In the first stage, early words are applied to holistic representations of events which are limited in scope (i.e. consist of a single person, a single object, and a single action scheme which connects the two). In the second phase, called "decontextualization", a concept and the word which denotes it are separated from the event representation. Only when the word is attached to a prototype are novel referents recognized as members of the category. This occurs when one or more features shared by the prototype and novel referents are recognized. In the third stage, the process continues as prototypes are compared, and contrastive features which delineate the limits of categories are added.

The primacy of basic-level object categories

All the theories reviewed above have attempted to explain the development of basic-level terms of reference. One reason for this interest is that basic level object names are the first concrete nouns acquired by children (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). Basic-level nouns (e.g. dog) predominate over superordinate (e.g. animal) and subordinate (e.g. poodle) labels because they have greater "cue validity" (Rosch et al, 1976). Basic level categories have greater cue validity than either superordinate or subordinate categories because members of these categories are maximally discriminable both from each other and from members of other categories. For instance, while two members of a superordinate category (e.g. dog and bird) are easily discriminable from each other, placing them in the same overall category is somewhat difficult, due to their great dissimilarity. In contrast, two different types of poodles (subordinate level category) may be so similar that it is difficult to tell the difference between them without some expertise, although it is easy to see that they belong to the same category. The basic level object, dog, has greater cue validity because it allows differentiation between category members while preserving overall similarity.

Basic-level categories also share the greatest number of attributes or features. For instance, while adult subjects list few attributes for superordinate categories such as furniture, vehicle, and tools, they list many more attributes for the categories table, car, and hammer. Few attributes are added when the subordinate categories of card-table, two-door car, and ball-peen hammer, are described (Rosch, 1978). An examination of the type of attributes shared at different levels reveals that while superordinate categories share functions (e.g. vehicles are for transport, tools are for fixing things,), basic-level objects share more perceptual features. A closer look reveals that many of the features shared by basic-level category members are parts (Tversky & Hemenway, 1984). Parts often refer to both a perceptually identifiable segment of an object as well as a specialized function of that particular object. In addition, a part-whole relationship can be expressed as "a dog has a..., or a chair is made of..." (Miller & Johnson-Laird, 1976). When adults are asked to list attributes for superordinate, basic, and subordinate level objects, parts do indeed predominate in attribute lists (Tversky & Hemenway, 1984).

It has recently been suggested that parts are also important in children's judgements of category membership, although their word extensions may not be identical to adults'. In a study of her son's evolving word meanings, Mervis (1987) found that between the ages of 10 and 20 months, Ari's "duck" category was formed and reshaped on the basis of parts which he found important, i.e. having a duck-like head and torso, and a long bill, as well as functional similarity. Despite corrective adult linguistic input, even at 20 months, Ari's concept of duck sometimes included a goose and a swan. Ari appeared to be using an analytic strategy in generalizing his concept of duck to featurally-similar objects, although the features belonging to his prototype did not match adult representations.

The holistic to analytic shift in category acquisition

Despite their divergent perspectives on early object word meaning, all the theories reviewed above share the implicit assumption that infants are capable of abstraction of features or attributes of objects during the second year of life. Experimental evidence from the cognitive developmental literature indicates a gradual shift from primarily holistic to analytic processing that takes place between approximately five and nine years of age. Younger children categorize primarily on the basis of overall similarity, while older children gradually shift to an analytic style of comparing individual properties of multidimensional stimuli (Kemler, 1983). Thus as overall familiarity and exposure to category members increases, there is a shift from a holistic judgment based on overall resemblance to the category to analytic judgments based on features or parts of which the child has knowledge (Keil & Batterman, 1984). Studies with five-year-olds have reported that holistic strategies are used in making category membership judgements (e.g. Kemler, 1983; Shepp, 1978; Smith & Kemler, 1977). However, as has been noted by Mervis & Greco (1984), these studies have used stimuli which are best described as members of subordinate-level categories, and which, therefore, do not allow discrimination on the basis of parts. These studies were also limited in that stimuli were two-dimensional and were not appropriate for differentiation on the basis of function (Mervis & Greco, 1984). Other studies, using real-world type objects, have shown that young children are indeed capable of analytic judgements which focus on specific features or parts. Using line drawings of invented category exemplars which resembled a mammal, an insect, a scooter, and an airplane, Ward, Vela, Peery, Lewis, Bauer, & Klint (1989) presented preschoolers, second-graders, and adults with versions of category exemplars which varied along the dimensions of number of parts, type and shape of parts, body size and body shape. Subjects were asked to identify a modified version of the exemplar after learning a nonsense name for the original exemplar. Very few of the subjects actually used holistic strategies (i.e. identifying exemplars on the basis of overall family resemblance) but there were differences in what children and adults focused on in making membership judgments. Specifically, preschoolers focused on single specific features or parts (e.g. number of legs, number of wings, shape of head, etc), while second graders and adults tended to require that two or more attributes matched the prototype in order for the new exemplar to be declared a match (Ward et al, 1989).

The co-existence of holistic judgements based on clusters of features and the use of single parts to determine category membership can be explained by the child's experience with the concept being tested (Kemler, 1983). Because a child's initial concept for an object is based on one or a very few objects, the extension of the concept is based on holistic identity judgements. As experience with the category is gained, a variety of different exemplars are included in the concept, and the child is able to derive the meaning of the word by analytically comparing the features or parts to the prototype. As age, object familiarity, and memory capacity increase, more parts are used in making category membership judgements, and holistic processing drops correspondingly. Real-world objects, because of their familiarity to children, could then be expected to allow parts-based judgements at an earlier age.

Experiments using artificially created stimuli to test category extraction have indicated that infants as young as three to four months of age can abstract a prototype of a form category (e.g. circle, square) (Bomba & Siqueland, 1983). By seven months of age, infants can abstract information specific to male and female adult faces, and use an average of grouped features to form a prototype which is used for later face recognition (Fagan, 1976; Strauss, 1979). By 10 months, infants shown degraded patterns of dots can abstract an averaged prototype and respond to a novel prototypical stimulus as a member of the same category (Younger & Gotlieb, 1988).

Shown artificial, animal-like novel objects, infants as young as four months are able to make category membership judgments based on individual features, and 10-month-olds are able to base their judgments on the correlated appearance of clusters of parts, such as length of neck, number of feet, and type of tail (Younger & Cohen, 1985).

These studies show that while very young infants will base their judgments of geometric forms, faces, artificial animal-like drawings, and patterns of dots on overall resemblance to a feature-derived prototype, older infants and young children will focus on salient features or parts, and will increase the number of parts required to match before membership criteria are met.

Corresponding to the lack of real-world categories used in research to date, there has yet been no evidence gathered to determine whether infants can abstract parts in linguistically relevant categories. Indirect evidence for the importance of parts in forming linguistically relevant categories has been provided by Mervis (1984) in a longitudinal study of mother's and children's contribution to the learning of object names. In learning the categories of bell, ball, bank, candle, bead, and ornament, all of which might fit in an infant's category of "ball", due to featural similarity, children's comprehension of the differences between these objects was consistently preceded by the mother pointing out specific parts which differentiate the objects from one another (e.g. the slot in the bank, the wick on the candle). Thus children's appropriate extensions appeared to be based upon attention to relevant parts.

The preference looking paradigm

An experimental method previously used in studies of perceptual and cognitive development (e.g. Walker, 1982, Spelke, 1985) has recently been adapted to the study of infant language comprehension, and is also suited to the study of object word extensions. The preference-looking paradigm requires the subject to respond to a verbal prompt to look at or find the referent of a word, when shown two pictures or video events simultaneously. The method is especially appropriate to working with young infants because it demands minimal motor movement, and no productive speech.

Using this paradigm, Golinkoff, Hirsh-Pasek, Cauley, & Gordon (1987) found that at 16 months of age, infants looked significantly longer and oriented more quickly towards the correct referent when asked to find a dog, a hand, and a cookie, when these were compared with a sock, juice, and a bottle, respectively.

In a more recent study, Reznick (in press) used this paradigm successfully with infants ranging in age from 14 to 20 months. Some longitudinal stability for word comprehension was shown between 14 and 20 months, and test-retest reliability was established at 14 and 20 months. This series of experiments established the usefulness of the paradigm with infants as young as 14 months. In addition, data was collected from parental reports on subjects' comprehension and production of the words tested. However, no word by word comparison was made between evidence of comprehension in the preference looking task and results of the traditional parental report method.

The parental report method, which involves asking parents to report the words their child understands, is acknowledged to be an excellent comprehensive measure of child language. In contrast to the laboratory observer, the parent has the advantage of a much larger sample of the child's behaviour on which to base an estimate of the child's comprehension (Dale, Bates, Reznick & Morrisset, 1989). However, the method has been criticized because natural parental pride and lack of specialized training may lead to either overestimation or underestimation of the child's knowledge (Thal & Dale, 1990). The preference-looking paradigm described above is a structured test which can be adapted both to a direct comparison with parental report methods and to testing the importance of parts in infants' object word concepts.

Goals

The goals of the present study were twofold. The primary aim of this study was to determine whether 12- to 18-month-old infants use individual parts as criteria in making category judgements. It was hypothesized that if parts are important in guiding extensional behaviour, children would react differently to a whole exemplar than to the same object with a part removed. It was also hypothesized that familiarity with object words, as reflected in age, would increase the probability of observing a differential reaction to whole and part-removed objects.

A second objective was to assess the usefulness of the preference-looking paradigm in detecting object word comprehension with infants, and to try to extend the usefulness of the paradigm to subjects younger than 14-months-old. Usefulness of the paradigm was determined by directly comparing results obtained by this method and the traditional parental report method. It was expected that subjects would look longer at, and orient more quickly towards, a correct referent than at a non-referent, and that if the paradigm could accurately detect word knowledge, infants who were reported to know the word would also look longer at the correct referent. Further, it was expected that word knowledge, as measured by both the preference looking paradigm and parental report, would increase with age.

Study 1

Method

Subjects Subjects were 81 12-, 15-, and 18-month old infants from predominantly middle-class English speaking families. There were 12 boys and 15 girls in the 12-month group (range 11;17 to 12;25, M=12;10), 12 boys and 15 girls in the 15 month group (range 14;12 to 16;01, M =15;04), and 13 boys and 14 girls in the 18 month gr‚up (range 17;21 to 19;21, M = 18;15). Subjects were solicited from newspaper birth announcements and birth lists provided by the Conseil de la Santé et Services Sociaux du Montréal Métropolitain.

Apparatus The parent and his/her child were seated in a three-sided cubicle which was designed specifically for this study (see Appendix I). All three sides of the cubicle were painted black in order to reduce visual interest in the room. The subject was placed in an infant seat 3 1/2 feet away from the front panel, and a parent was seated in a chair directly behind the child. The front panel display consisted of two Apple IIGS colour computer monitors, which were placed two feet apart; an audio speaker, centred between the two monitors; a light which flashed on and off at the beginning of each trial, a hole for a video camera, and a peephole, covered in loosely woven black cloth, for the experimenter to look through. Hidden behind the front panel were a VCR, two Apple IIGS computers, and an Apple IIGS keyboard, used to record where the child looked.

Stimuli Stimuli were digitized pictures of exemplars of nine basic-level categories from each of three superordinate categories (bird, cat, dog, bed, chair, telephone, airplane, bicycle, car) chosen from children's earliest object words reported as comprehended or produced in recent studies: (Barrett, 1982; Goldin-Meadow, Seligman & Gelman, 1986; Gruendel,1977; Nelson, 1973a; Rescorla, 1981). Only words which were reported to be comprehended or produced by over 50% of the children between the ages of 12 and 24 months in the above-mentioned studies were selected.

Lists of parts associated with the referents of these words were collected by asking 20 adult (16 female and 14 male, M age = 25 years, range 20-48) judges to draw and then label the features of 20 objects. Five words from each of four superordinate categories (animal, furniture, vehicle, and clothing) were included. The final nine object words used with infants were chosen on the basis of having at least two parts which could be removed from the object by deleting them from a picture of the object. Parts to be removed were chosen on the basis of high relative frequency (50% or more) of inclusion as a part by the 20 adult judges. Frequencies ranged from 10 for telephone dial to 20 for telephone receiver (M = 15.6).

For each word, a video-digitized image of the complete object was made, using the "ComputerEyes" program and hardware (Digital Vision, Dedham, MA). The "Paintworks

Gold" program (Activision, Mountain View, CA), was used to modify the image by removing one of two parts. In total, 27 stimuli were created, consisting of nine complete category exemplars and two incomplete (part-removed) exemplars for each category (see Appendix II).

Verbal stimuli consisted of recordings of a female voice saying "Where's the 'X'" and "Find the 'X'" (where X is the target object). Recordings were digitized using the "Supersonic" digitizer and program (MDIdeas, Foster City, CA). Several modifications of object names frequently used by parents were also created (e.g. dog, doggie, and woof-woof for "dog") (see Appendix III).

Procedure Parents signed a consent form before proceeding with the experiment, which consisted of three phases. In the first phase, parents were asked if their child understood each of a list of 40 object words, which were chosen from diary studies (Goldin-Meadow et al, 1976;, Nelson, 1973a). The 40-word checklist was used in the context of another study, but the nine words used in preference looking testing were embedded in the list, and scores for these words were extracted. The criterion for word comprehension was that the child responded by looking, pointing, going towards, or picking up an object when directed to do so, and generalized this knowledge to at least two exemplars (e.g. dog in a picture book, dog in the street). In phase two, the experimenter reviewed the nine target words with the parent, asking which, if any, modifications were used most frequently with the child. The appropriate modifications were then entered into the computer program to create a personalized protocol for the child. In the third phase the parent and child entered the testing cubicle. The parent was instructed to seat the child in the infant seat and to sit on the chair directly behind the infant. The parent was instructed not to influence the child's attention to one screen or the other by word or gesture, and to refrain from speaking to the child. When parent and child were settled, the experimenter activated video recording of where the child was looking, and activated the program to begin presentation of the stimuli.

There were a total of four trials for each word being tested, for a total of 36 trials per subject. Each trial lasted a total of 11 seconds, and consisted of two parts. Each trial began with the light flashing on while the voice said "Where is the X?", and both screens were blank. At the end of three seconds, the light went off, images appeared on the screens for eight seconds, and the voice said "Find the X". The entire presentation was controlled by a custom-designed computer program.

Design There were three different types of trials for each target word, when the following pairs of stimuli were presented on the two screens: 1) for control trials, a complete referent of the target word was paired with an identical complete referent; 2) for word knowledge trials, a complete referent of target word was paired with a complete non-referent; 3) for part-removed trials, a complete referent of target word was compared with an incomplete (part removed) referent of target word (see Appendix IV for list of trials). The side on which the target referent was presented was randomized across all trials. Trials were presented in randomized order with the constraints that no trial followed another in which an identical image was shown. Pairings of complete referent vs. complete non-referent were rotated so that equal numbers of subjects at each age group saw the complete referent paired with each complete referent in the other two superordinate categories (see Appendix V for sample protocol). Each complete object was shown a total of five times to each subject, and each incomplete object was shown twice.

Data collection Data were collected while the experiment was being run by the experimenter/observer. While watching through the viewing hole, the experimenter, who was blind to the location of the target stimulus, pressed keys on the keyboard to indicate whether the child was looking to the left or right screens, or elsewhere. A timemaster HO timer installed in the computer synchronized data collection time with presentation time. Data were recorded with accuracy to 1/1000 of a second, and included information on each shift of attention. Printouts provided information on total time for each screen and off screen, as well as latency to orient to each screen. Backup data, used for reliability, was collected on videotape.

Results

Of the original 125 subjects tested for study 1 and study 2 (see below), 13 were eliminated due to experimenter error, computer malfunction, or subject irritability and inattention to task.

Data from 14% (n=13) of the final sample of 93 subjects used in this and the following study were coded for reliability between live coding and coding from videotape by the experimenter- observer. Reliability was obtained by calculating the correlation between live and taped codings for time on screen and latency to each screen across all trials. Within-rater reliability coefficients were .90 for total time on left and right screens, and .80 and .82 for latency to left and right screens, respectively. Due to problems with the computer program used to recode data, between-rater reliability was only available for 11.8% (n=11) of the subjects. Between-rater reliability coefficients were .98 for time on left and right screens, and .92 and .94 for latency to left and right screens, respectively.

In the first level of analyses, percentage time on left and right screen for the control (two identical pictures) trials was calculated, and 17 subjects were eliminated on the basis of an idiosyncratic preference for one screen of 65% or more over the nine control trials. (This criterion was arbitrary, but was previously used by Golinkoff et al, 1987). The 81 subjects remaining in study 1 were equally distributed across the three age groups. Therefore a total of 2916 trials (81 x 36) were available for further analyses.

Of the 2916 trials available, a total of 85 trials (3.9%) were deleted. Trials were deleted due to computer or experimenter error (e.g. the wrong picture was shown on one screen, or one of the voiced instructions was incorrect), and subject's inattention to the task. All trials in which total looking time to both screens totalled less than two seconds (25% of total time available) were eliminated. Trials deleted due to inattention by this method included trials where the child was fussing, crying, squirming, looking at the parent, and otherwise not attending to the task. The decision to delete these trials was based on the belief that attention of less than two seconds to both screens indicated that the child's performance on that trial was not dictated by a response to the request to "Find the X", and was therefore unreliable. All deleted trials were coded as missing data, and were replaced differently according to the type of trial.

For control trials, the subject's mean time on screen across the remaining words was substituted for the missing data. A total of 82 (11.25%) trials were replaced in the control analysis. For word knowledge trials, the group mean for each word replaced the missing data. A total of 83 (11.38%) trials were replaced in word knowledge analysis.

For part-removed trials, if one of two part-removed trials for a particular word was missing, the data from the remaining trial served as the subject's score for both trials for that word. If both part-removed trials for a specific word were missing, then the group mean for the word was substituted. Although a total of 170 (11.66%) of the part-removed trials were deleted, most of these were replaced by the subject's score on the remaining trial for that word. A total of 20 (2.74%) trials were replaced by the group mean in the part-removed analysis.

The moderate number of total deletions compares favourably with Reznick's (in press) sample, in which 24% of trials were deleted at 14 months and 21% of trials were deleted at 20 months. It should be noted, however, that Reznick used an additional criterion for eliminating data, which will be discussed later.

Analyses of control condition

To determine whether there was an overall preference for a particular side after subjects with side preferences were removed, a three (age) x 9 (word) x 2 (side) mixed design analysis of variance, with word and side as repeated measures, was conducted on time on left versus right screens. There was no significant effect for age, indicating that no age group looked longer overall than any other. There was, however, a trend towards preference for the left screen $F(1,78) = 3.943$, $p = .051$ (See figure 1).

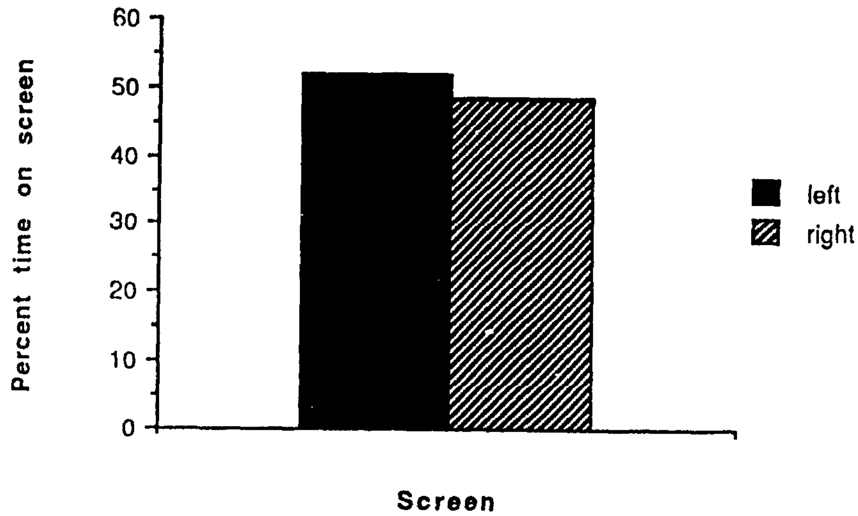

Figure 1: Mean percent time on left and right screens

A significant effect for word indicated that overall, subjects looked longer when some words were targets than others $F(8,624) = 3.919$, $p<.001$. Post-hoc analyses, using Tukey's LSD, showed that cat, bird, dog, phone and bicycle were looked at significantly longer than chair, bed, airplane and car ($p<.01$). As expected, all interactions (age x side, age x word, and age x side x word) were not significant.

In order to test for side preference on latency to each screen, a 3 (age) X 9 (word) X 2 (side) mixed design analysis of variance, with word and side as repeated measures, was also performed on latency to each screen for control trials. A highly significant main effect, indicating shorter latency to the left side, was found $F(1,78) = 20.202$, $p<.001$. On the basis of this analysis, it was reasoned that analyses on latency for word knowledge and part-removed trials would not be valid. Such a strong initial attraction to the left side would likely eliminate any effect of latency to the target object, and thus make further analyses of latency nonsensical. An examination of the apparatus used in this experiment showed that a loud click occurred when the centrally located light turned on and off. The light-switch control box was located on the left side behind the panel. The loud click which occurred when the light turned off, just before the pictures were shown, may have been sufficient to draw the child's attention to the left screen at the beginning of the trial, thus creating a strong latency effect to the left side. It should be noted, however, that initial attraction to the left side would not necessarily have the same effect on analyses which used time on side as the dependent variable. Latency is only measured once, while time or particular side is comprised of a total of several shifts to a particular side, and therefore is more likely to reflect the child's true response to the task.

Word knowledge trials

In order to determine whether subjects recognized the objects presented to them as referents of the words, the next set of analyses were performed on word knowledge trials (i.e. complete dog vs. complete chair). A 3 (age) x 9 (word) x 2 (side) mixed design analysis of variance, with word and side as repeated measures, was performed on time on target and nontarget screens. As expected, there was no main effect for age $F(2,78) = 1.442$, $p=.243$), indicating that no particular group looked longer overall at the stimuli. As in the control analysis, there was a main effect for word $F(8,624) = 2.414$, $p<.02$). Post hoc Tukey LSD tests performed on the word effect indicated a pattern somewhat similar to that for control trials. Subjects looked longer at both objects overall when the target item was a dog, phone, bird, cat, or chair than when the target item was a bicycle ($p<.01$). In addition, they looked longer overall when the dog was the target than when the bird, cat, chair, bed, airplane, and car were target objects ($p<.01$), and looked longer when the telephone was target than when the bed, airplane, and car were target ($p<.01$). There were no significant differences between age groups in overall looking time to specific target words.

As was hypothesized, there was an overall side effect, indicating longer looking time at target objects overall $F(1,78) = 4.571$, $p<.04$. Mean looking time overall was 2.77 and 2.65 seconds to the target and non-target screens, respectively, corresponding to 51.14% and 48.89% of total time on screens. This side effect was not consistent across ages, however. Post-hoc t-test analyses on a significant age x side effect $F(2,78) = 3.299$, $p<.05$ revealed that only the 18-month-old group looked significantly longer at the target than at the non-target object (M difference = .295 seconds), $t(26) = 2.848$, $p<.01$, but the 12-month- and 15-month-old subjects showed no preference. Mean looking times on referent and nonreferent were 49.27% vs. 50.73%; 51.12% vs. 48.88%; and 52.80% vs. 47.20%; for the 12-, 15-, and 18-month old groups respectively (see Figure 2).

There was also a significant word x side effect, indicating longer looking time towards target objects for some words and not for others, across ages. Individual post-hoc t-tests indicated a significant preference for the

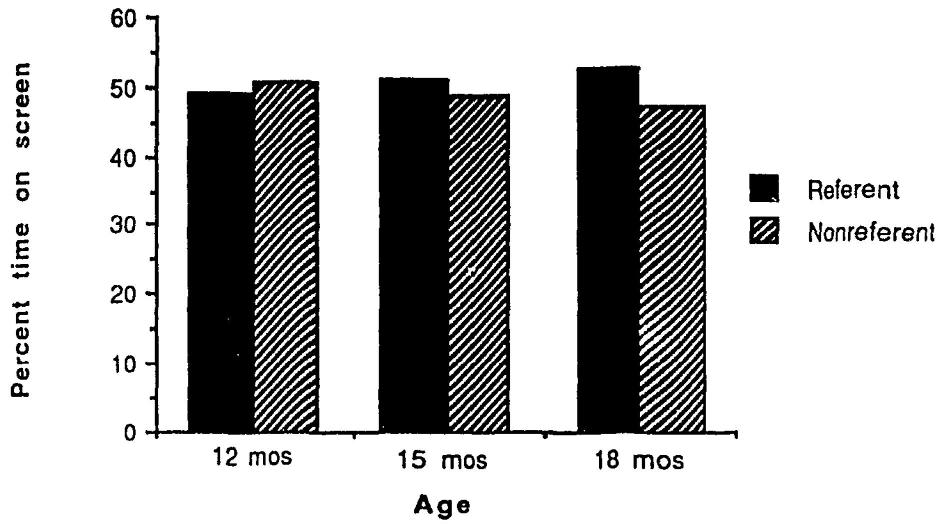

Figure 2. Mean percent time on referent and nonreferent, as a function of age

correct referent when the target word was bird, cat and dog, and a significant preference for the non-referent when the target word was bed, chair, and airplane (See table 1).

A significant 3-way (age x word x side) interaction $F(16,624) = 1.683$, $p<.05$, indicated that these preferences were not uniform across ages. Post hoc t-tests indicated that 12 month-olds looked significantly longer at the referent when the target word was cat and dog. The 12-month-old group looked longer at the non-referent when the target object was bed, chair, airplane, and car (see Appendix VI). At 15 months, a significant preference for the referent was shown when the target word was dog and no preferences for non-referents were shown (see Appendix VII). At 18 months, preference for the referent was shown when the target word was bird and cat. The 18-month-old group also looked longer at the non-referent when chair was the target word (see Appendix VIII).

Analyses of part-removed trials

The next set of analyses was performed on part-removed trials, in order to determine if subjects (particularly 18-month-olds, who demonstrated overall recognition of the nine objects as referents of the words) responded to missing parts by indicating their preference for the complete objects as the best examples of the referents. A three-way (age x word x side) analysis of variance was performed on the time spent looking at the complete versus part-removed

Table 1

Means for individual stimulus pairs

	TIME ON SCREEN	
TARGET WORD	REFERENT	NON-REFERENT
BIRD	3.08**	2.41
CAT	3.36***	2.08
DOG	3.63***	2.19
BED	2.38	2.92*
CHAIR	2.20	3.22***
PHONE	2.95	2.77
PLANE	2.40	2.89**
BIKE	2.46	2.59
CAR	2.48	2.76

Note: Referents or non-referents were preferred by the probabilities indicated.
*p<.05 **p<.01 ***p<.001

objects. There was no significant effect of age $F(2,78) = 1.027$, $p=.363$, indicating that no age group looked significantly longer overall than any other.

As in the control and word knowledge analyses, there was a significant effect for word. Tukey LSD post hoc tests revealed a pattern which was similar to the previous analyses. On part-removed trials, subjects looked longer overall at both the complete and incomplete objects when the referents were cat and dog, than at the other seven objects ($p<.01$). Telephone, bird, bicycle, and car were looked at longer than bed ($p<.01$). All other differences were not significant.

In contrast to the word knowledge condition, a significant age x word effect was found for part-removed trials $F(16,624) = 1.832$, $p<.03$. Tukey LSD post-hoc analyses revealed different patterns of longer overall looking time at both complete and incomplete objects for each age group (see Appendix IX, X, and XI).

Also in contrast to the word knowledge condition, there was no main effect for side, but there was an age x side interaction $F(2,78) = 6.347$, $p<.01$. Post hoc t-tests indicated that, consistent with their performance on word knowledge trials, only 18-month-olds looked significantly longer at the complete referents than at the part-removed referents $t(26) = .272$, $p<.01$, but the 12- and 15-month-olds showed no preference. Mean overall percentages on complete vs. part-removed objects were 48.9% vs. 51.1%; 50.0% vs.

50.0%; and 52.5% vs. 47.5%; for 12-, 15-, and 18-month olds, respectively (See figure 3).

A significant word X side effect was also found $\underline{F}(8,624) = 2.232$, $p<.03$. Post-hoc t-tests indicated that when all ages were combined, there was a significant preference for the complete over the part-removed chair ($\underline{M}$ difference = .373 seconds), $\underline{t}$ (80) = 2.68, $\underline{p}<.01$, and for the complete over the part-removed telephone ($\underline{M}$ difference = .356 seconds, $\underline{t}(80) = 2.68$, $\underline{p}<.01$. There were no other significant differences, and no age x word x side effect.

<u>Comparison between parental report and preference looking</u>

The next set of analyses was conducted to determine whether the preference looking paradigm is comparable to the parental report method of assessing word comprehension. Summary results of the parental report of word comprehension were calculated for each of the nine words separately, and across words by age. For each word, the child was assigned a score of 1 (knows word) or 0 (does not know word). The proportion of subjects reported to know words ranged from ranged from .15 for bicycle at twelve months, to 1.0 for telephone at 18 months, with an overall mean proportion of .74 words known by all subjects. (see Table 2).

When the percentage of all words reported by parents as known was calculated by age group, it was found that 62% of 12-month-olds, 69% of 15-month-olds, and 92% of 18-month-olds knew the words. An analysis of variance on proportion of words across subjects showed a significant effect for age

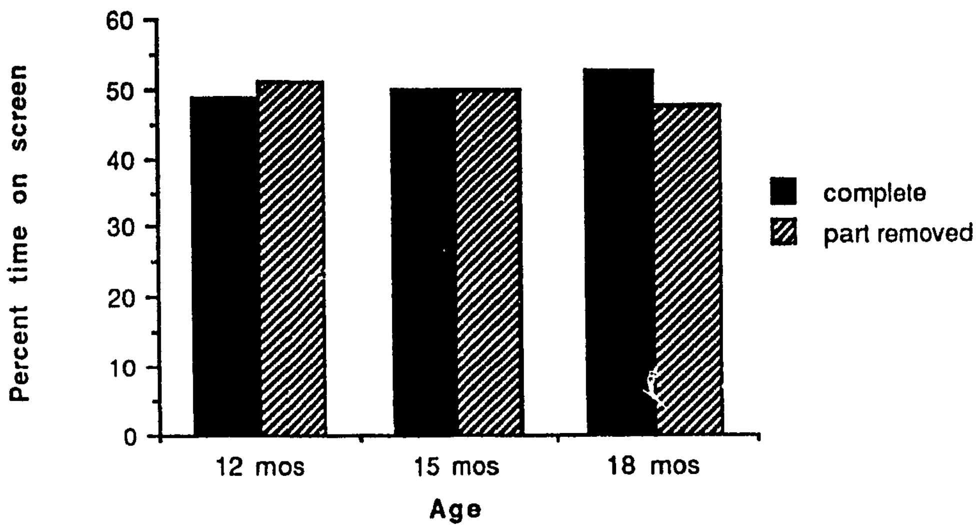

Figure 3. Percent looking time at complete and part-removed referents, as a function of age

Table 2

Proportion of subjects who were reported to know each word, by age group

WORD	AGE			
	12 MONTHS	15 MONTHS	18 MONTHS	ALL AGES
BIRD	.44	.63	.93	.67
CAT	.82	.74	.89	.82
DOG	.82	.78	.96	.85
BED	.67	.82	.89	.79
CHAIR	.63	.78	.89	.77
PHONE	.96	.96	1.00	.97
PLANE	.37	.41	.93	.69
BIKE	.15	.33	.82	.43
CAR	.59	.78	1.00	.67

$\underline{F}(2,78) = 19.802$, $\underline{p}<.001$. A post-hoc Scheffé analysis showed that the 18-month-old group were reported to know significantly more of the target words than the 12-month-old and 15-month-old groups, but the 12- and 15-month-old subjects did not differ in their word comprehension (see Figure 4).

This result mirrors the results of the word knowledge data, in that the 18-month-old group exhibits significantly more general word knowledge overall than the other two groups combined. In order to directly assess whether the two methods are equivalent, a series of point-biserial correlations were conducted using percent time spent on the target referent in word knowledge trials and the child's parental report score. When all subjects were combined for each word separately within age group, all correlations were non-significant (see Table 3).

When correlations between percent time on target and score on parental checklist were computed for each age group across the nine words, there was a trend to significance only for the 18-month old group $r(25) = .31$, $\underline{p}<.10$. Correlations for the 12- and 15-month-olds were -.06 and .01, respectively. It would appear, then, that although the results obtained in word knowledge trials were not a good direct measure of performance on individual words, when looking time for all words is compared with overall scores on the parental report, a relationship between the two measures can be established.

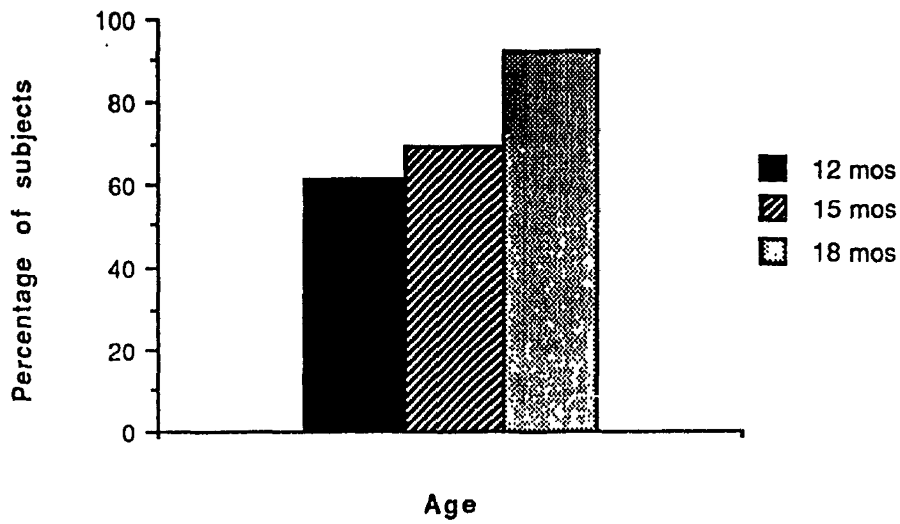

Figure 4. Mean percentage of subjects who knew each of the 9 words, as a function of age

Table 3

Point-biserial correlations for percent time on target and reported word knowledge, for each age group

	AGE		
	12 MONTHS	15 MONTHS	18 MONTHS
BIRD	-.003	.174	-.095
CAT	-.026	.039	.122
DOG	-.004	.062	-.171
BED	-.170	.161	-.012
CHAIR	.142	-.368	.149
PHONE	.282	-.211	*
PLANE	.080	.132	.251
BIKE	-.012	.177	.285
CAR	-.201	.072	*

Note: correlations could not be computed for phone and car at 18 months because all subjects were reported to know the word

Study 2

Rationale

The result of interest in the part-removed analyses was the finding that 18-month-olds, who had shown overall recognition of the target objects in word knowledge trials, also showed a preference for the complete object over the part-removed object. This result, although it supports the hypothesis that parts are indeed important in making category membership decisions, leaves a question unanswered. Specifically, when the older subjects look longer at a complete dog versus a dog with a part missing, is it because the complete dog is "a better dog" or is it because the object with the part removed is, in the mind of the child, "not a dog", and therefore the complete dog is the only choice? In order to determine whether 18-month-olds recognized the incomplete object as a referent (albeit a poor referent) of the category, a second study was conducted in which the part-removed object was compared with a complete object from another category. It was predicted that if 18-month-olds recognized the part-removed object as a referent for the word, they would look longer at the part-removed target object than at the complete non-target object. If the part-removed object was unrecognizable as a referent of the word, looking time to the two objects would be equal.

Method

Subjects Subjects were five male and seven female 18-month-old infants (range 17;17 - 18;26, M=18;09). Two additional subjects were eliminated due to non-completion of the task. Subjects were solicited by newspaper birth announcements and birth lists provided by the Conseil de la Santé et Services Sociaux du Montréal Métropolitain.

Apparatus, Stimuli, and Procedure The apparatus and stimuli were the same as for study 1. The procedure was the same as for study 1, except parents were not asked to complete a vocabulary checklist.

Design In this study, part-removed referents were compared with complete non-referents. Since there were two part-removed referents for each word, subjects viewed a total of 18 pairs (9 words x 2 parts) of stimuli. For each subject, the two part-removed referents were paired with two different non-referents (e.g. for one subject, dog without legs might be paired with an airplane, and dog without tail might be paired with a bicycle). As in the first study, the side on which the target was presented was randomized, and no two consecutive trials showed an identical stimulus. Twelve different protocols were created, and pairings of referents and non-referents varied across the protocols such that no two subjects saw a particular part-removed referent paired with the same non-referent. Each complete object was shown twice, and each incomplete object was shown once, for a total of 18 trials per subject. (see Appendix XII for sample protocol).

Results

The same criteria used in the previous study were applied to delete and replace data. This group of subjects was highly attentive overall, and no trials were replaced due to inattention to the task. In addition, no trials were eliminated due to errors in the protocols or computer errors. A total of 216 (18 x 12) trials were available for analysis. The mean visual fixation time across the two part-removed trials was calculated for each subject, and only one mean was replaced by the group mean for that word, due to total looking time less than two seconds.

In order to determine whether 18-month-olds did recognize the part-removed objects as category referents, a two-way (word X side) repeated measures analysis of variance was conducted on total looking time to part-removed referents and non-referents. A significant main effect for side $F(1,11) = 41.481$, $p<.001$ was found, indicating that when 18-month-olds are given a choice between a referent with part removed and a complete non-referent, they will look longer at the referent of the word. Percentage time on part-removed referents was 59.79 vs. 40.21 for non-referents. (See Figure 5).

There was no effect for word, and no word X side interaction.

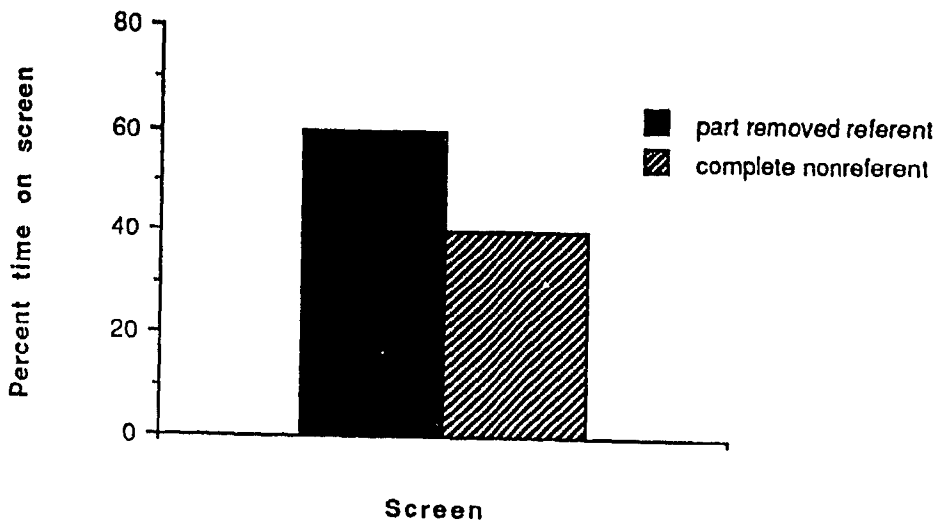

Figure 5. Mean percent looking time at part removed referent and complete non-referents

General Discussion

The hypothesis that with increasing age, subjects would look longer at word referents than at non-referents, was supported. Although there was an overall effect for target side, this effect was carried by the 18-month-old group. This result is consistent with Reznick (in press) who found an increase in word knowledge scores from 14 to 20 months. Within the 18-month age group, there was a significant target-side effect for two words only. These results are consistent with the findings of Golinkoff et al (1987), who found that 16-month-olds comprehended only three of six tested words, and Reznick (in press) who found that 14-month-olds comprehended a mean of 2.3 of the 15 words tested, while 20-month-olds comprehended an average of 3.2 words of 15 tested. The data from our parental reports indicates that the preferential looking procedure may not be sensitive enough to detect word knowledge for individual words comprehended, although it appears to be a good global measure of word comprehension, especially at 18 months. One explanation for the relatively few words shown as comprehended in this method, in contrast to parental reports, is that we used only one trial of one particular referent to test word comprehension. Although we deliberately chose category referents which adults would judge to be typical of the categories tested, these particular referents may not have been good matches to the prototypes which our subjects, in their limited experience, knew as referents. As an example of this problem, although "telephone" was reported to be the best known word, across all ages, many parents said that their children had never seen a phone that looked like our "typical" example, i.e. a standard table-top rotary-dial telephone. Parents reported that their children's experience with telephones included only touch-tone models, in a variety of styles. This problem of underextension could be corrected, as suggested by Reznick (in press) by showing subjects several exemplars of each category, and using a mean value of their looking time to target across several trials to indicate their comprehension of the concept. This modification would be especially useful at younger ages, when infant's categories are more narrow than at older ages.

Problems in demonstrating reported word knowledge were not all related to inadequate referents. Although parents reported that concepts such as airplane and bird were generalized to at least two instances, knowledge of these concepts was often context-bound. For several children, the response to the prompt "Where is the airplane" or "Where is the bird" was to look at or point towards the ceiling, rather than look at the screen. This is evidence that for some subjects, decontextualization has not taken place, and therefore, consistent with Barrett's (1986) theory, generalization to novel exemplars did not occur. Therefore it is not surprising that although parents reported moderate word knowledge at 12 and 15 months, evidence of this knowledge was not detected in the laboratory. A further problem in demonstrating correspondence between the two methods may have been that for our 18-month-olds, the words we selected were too well known. Indeed, for the oldest group, correlations between word knowledge scores and checklist scores could not be calculated for two words (car and phone) because all subjects were reported to know the words.

The hypothesis that parts would be important to children's object word meaning was also partially supported. In accordance with Barrett's (1986) model, 12- and 15-month-olds did not demonstrate a sensitivity to parts, and this was consistent with their lack of demonstrated knowledge about the words tested. The finding that 18-month-olds look significantly longer at whole referents when they are compared with part-missing referents is evidence for the use of parts in making category membership judgements. The 18-month-old subjects also demonstrated that they knew that the objects with parts missing were, nevertheless, referents of the word, but were poorer examples of the category than the whole referents. Unlike the 18-month-olds, the younger subjects looked equally long, overall, to both complete and parts-missing referents. There is no doubt that perceptual differences between the two stimuli were detected by the 12- and 15-month old infants, as three- to four-month-old infants are already sophisticated at perceptual discrimination (Spelke, 1985). However, since the younger children were not able to match the exemplar to the object word, there was no cue with which to guide their looking time to one or the other stimulus, and the differences between complete and part-removed objects were not linguistically relevant. By 18 months, as children have more experience with referents, perceptual differences between the two stimuli do become relevant, and an analytic strategy is used to make category membership judgements. This supports Barrett's (1986) developmental hypothesis, that with increasing word knowledge (as demonstrated both by our word knowledge trials and parental report) and familiarity with the category, featural comparisons begin to take place.

This study has been useful in illuminating several problems inherent in using the preference looking paradigm with infants. Specifically, idiosyncratic preferences for looking more to one side than to another may have a strong effect on total looking time. In this experiment we attempted to control for individual side preferences by removing subjects who showed a strong side preference (65% or more) to one side or another when shown two identical stimuli. A more stringent criterion, (e.g. 60%) though it would have contributed to a greater loss of subjects, may have resulted in stronger results. Further testing needs to be done to determine a cutoff point for side preference which will lead to maximal results while maximally limiting this source of error. In addition, if latency to the target screen is to be used as a measure of word knowledge in conjunction with total looking time, special attention must be paid to creating a set-up which will not bias the subject, even in the most subtle way, to look first at one side.

Reznick (in press) used different objects for target and non-target stimuli, and found that although every attempt was made to balance for visual interest, some objects were looked at longer overall even when no prompt was given. In our experiment, we attempted to control for stimulus preference both by making all objects as equal as possible in size, colour, and brightness, and by using each referent as a non-referent in other trials. Although there were differences in overall word preferences across age and trial types, it should be noted that animate objects (i.e. animals) seemed to hold a particular fascination for the infants in this study. This highlights the importance of counterbalancing all objects as both referent and non-referent, as well as controlling for visual interest as much as possible. An additional control method consisted of showing each pair of pictures in a "no-voice" trial. The word knowledge score was then calculated based on the difference between looking time at the target referent in the "no-voice" control trial and the "voice" test trial, thus controlling for idiosyncratic preferences for one of the pair of objects. Ideally, this method of using each subject as his or her own control to determine individual preferences for particular objects, in addition to counterbalancing each picture as target and non-target, would help to uncover the relationship between preference for a certain object and knowledge about it as a referent of a word. A further control used by Reznick involved eliminating all test trials where the subject looked <u>only</u> at one side. Reznick reasoned that by looking at one side only, the child was being influenced by stimulus saliency, rather than indicating that the looked-at object was, in fact, his choice as a match for the word. In this experiment, a more stringent criterion to control for stimulus saliency was adopted. All trials for which the subject looked a total of two seconds or less were eliminated.

Of equal importance to the contributions to the methodology of preference-looking is the finding that parts are indeed important in making category membership judgments at a stage of lexical development corresponding to decontextualization of object words. If future preference-looking studies demonstrate, with younger infants, word knowledge comparable to that reported by parental reports, it may then be possible to determine whether the proposed holistic-to-analytic shift does take place between the ages of 12 and 18 months. Although Reznick (in press) was able to show evidence of some word knowledge at 14 months, this study was not able to establish a direct word-by-word relationship between parental report of knowledge for specific words and word knowledge as demonstrated in preference-looking. Since our pictures were digitized reproductions of photographs, the somewhat degraded stimuli available to our subjects may have contributed to the lack of demonstrable word knowledge at 12 and 15 months. If the sensitivity of this paradigm can be increased, it may also be possible to relate knowledge of specific categories to use of parts in making category membership judgements for those concepts, thereby demonstrating that the holistic-to-analytic shift varies with experience with specific objects, independent of age.

The range of proportion of words reported by parents as understood at each age suggests considerable individual differences in comprehension of the words used in this study, especially at the younger ages. The words used in this study were deliberately selected from among the first words comprehended or produced in diary studies, and thus it was expected that most children would comprehend most words. Although the overall percentage of all words reported as comprehended at each age ranged from 62% to 92%, there was considerable variability within each age group, ranging from 11% to 89% at 12 months, 0% to 100% at 15 months; to 78% to 100% at 18 months. Is it possible that differences in comprehension of words in general, and use of parts in particular, might be related to a holistic or analytic <u>style</u>

of concept acquisition? The literature on individual differences in language acquisition has established holistic and analytic styles of language learning, which are used by expressive and referential vocabulary learners, respectively. Specifically, referential children seem to specialize in naming objects, and have a higher proportion of nouns in their early vocabularies than do expressive children. In contrast, expressive children have a smaller proportion of nouns in their early vocabularies, and have a higher proportion of personal/social and function words (Nelson, 1973a). Referential children are described as being more analytical in their acquisition of language because they acquire language in small parts (mainly single object words) rather than unanalyzed wholes (such as the phrases often learned by expressive children) (Bretherton, McNew, Snyder, & Bates, 1983). Are there parallels between analytic language learning and use of analytic strategies in learning object concepts? Some supplemental analyses conducted on performance on word knowledge and part trials, compared to word knowledge as reported by parents, give us some hints that the analytic style may cross boundaries from language learning to concept acquisition. When we divided each age group into three equal groups (n = 9), based on their scores on the nine-word checklist, we found that the highest-scoring "referential style" group of 15-month-olds showed a trend to look longer at the referent than at the non-referent in word knowledge trials, but the other 15-

month-olds did not. Similarly, the middle "mixed style" group of 18-month-olds looked significantly longer at the referent than at the nonreferent, and the high "referential style" group also showed a trend to significance, while the low-scoring "expressive style" 18-month-group did not look significantly longer at the referent. This relationship was also reflected in the part-removed trials, where the medium and high (mixed and referential style) 18-month-olds looked longer at the complete object, but the low group (expressive style) did not. While these results must be treated with caution due to the very limited vocabulary sampling and the small sample sizes, they do suggest that the importance of parts in category membership judgements may be influenced by a non-verbal equivalent of language-learning style, as well as age and experience with category members.

Much work remains to be done in this area. By incorporating the suggested refinements to the preference-looking paradigm, a clearer relationship between word knowledge as reported by parents and word knowledge as tested with this method may be established. In addition, the importance of parts in making category membership judgements may be shown at younger ages, and with the addition of a more comprehensive vocabulary checklist, may be related to individual language-learning styles. Establishing relationships between language learning styles and cognitive strategies for concept learning will make an important addition to the individual differences literature.

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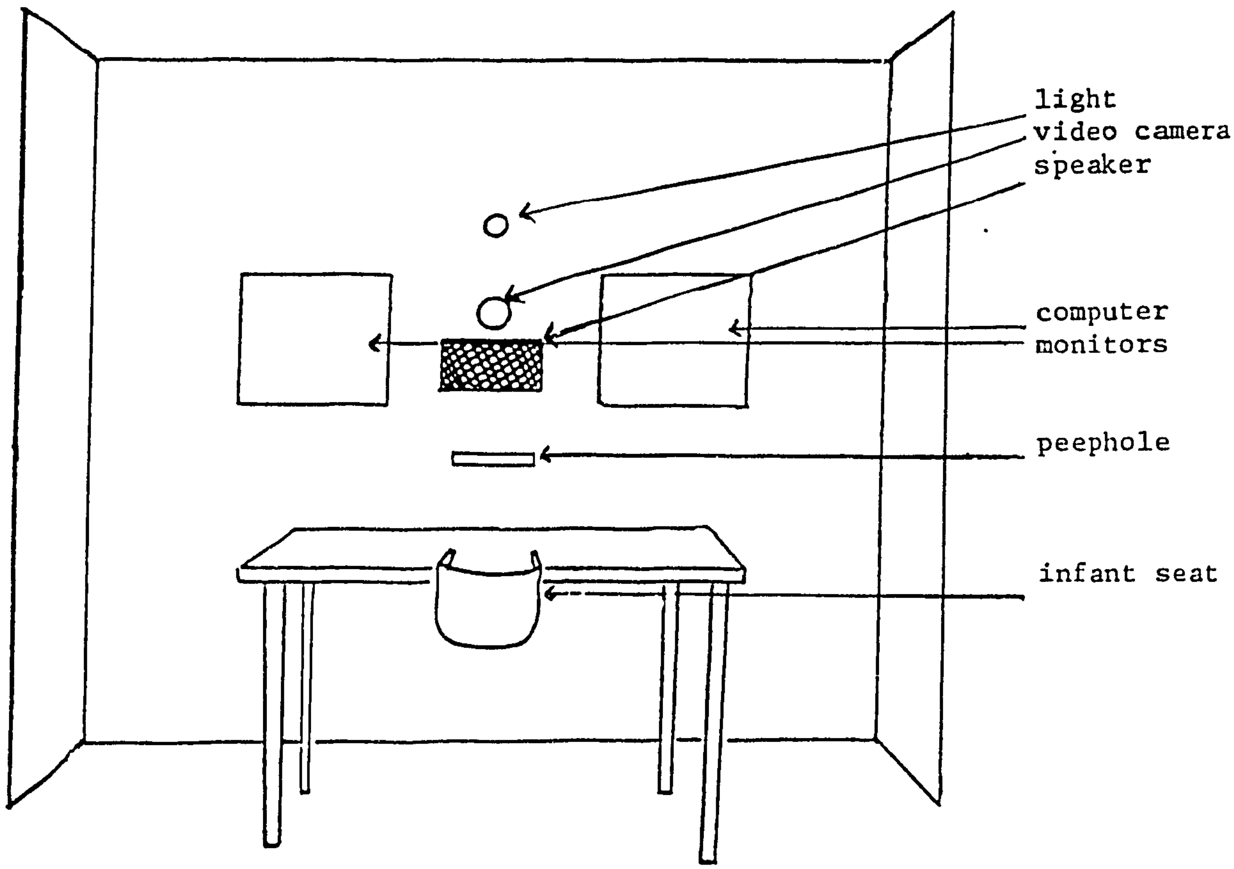
Appendix I

Preference-looking set-up



Appendix II

<u>List of original picture stimuli and modifications</u>

Category	Parts removed
bird	wings beak
cat	whiskers ears
dog	legs tail
bed	legs mattress
chair	legs seat
telephone	receiver dial
airplane	wings windows
bike	seat wheels
car	wheels windows

Appendix III

Word Modifications

CATEGORY NAME	VARIANTS				
Bird	birdie				
Cat	kitty	kittycat	pussycat	pusscat	meow-meow
Dog	doggie	woof-woof			
Bed					
Chair					
Telephone	phone				
Airplane	plane				
Bicycle	bike				
Car					

Appendix IV

Trial types used in Study 1

	Type	Stimuli
1)	complete referent vs. complete referent	complete dog vs. complete dog
*2)	complete referent vs. complete non-referent	complete dog vs. chair
3a)	complete referent vs. incomplete referent	complete dog vs. dog with no legs
3b)	complete referent vs. incomplete referent	complete dog vs. dog with no tail

Appendix V

Sample protocol for Study 1

Target word	Picture 1	Picture 2
bird	bird	bird
	bird	bed
	bird	bird no beak
	bird	bird no wings
cat	cat	cat
	cat	chair
	cat	cat no tail
	cat	cat no whiskers
dog	dog	dog
	dog	telephone
	dog	dog no legs
	dog	dog no tail
bed	bed	bed
	bed	airplane
	bed	bed no legs
	bed	bed no mattress
chair	chair	chair
	chair	bicycle
	chair	chair no legs
	chair	chair no seat
telephone	telephone	telephone
	telephone	car
	telephone	telephone no dial
	telephone	telephone no receiver
airplane	airplane	airplane
	airplane	bird
	airplane	airplane no windows
	airplane	airplane no wings
bicycle	bicycle	bicycle
	bicycle	cat
	bicycle	bicycle no seat
	bicycle	bicycle no wheels
car	car	car
	car	dog
	car	car no wheels
	car	car no windows

Appendix VI

Mean preferences for individual stimulus pairs, for the 12-month-old group

	TIME ON SCREEN	
TARGET WORD	REFERENT	NON-REFERENT
BIRD	2.88	2.48
CAT	3.48***	1.96
DOG	3.97***	1.92
BED	2.08	2.76*
CHAIR	1.83	3.48***
PHONE	2.70	2.82
PLANE	2.16	3.07**
BIKE	2.55	2.70
CAR	1.89	2.93**

*$p<.05$ **$p<.01$ ***$p<.001$

Appendix VII

Mean preferences for individual stimulus pairs, for the 15-month-old group

	TIME ON SCREEN	
TARGET WORD	REFERENT	NON-REFERENT
BIRD	3.12	2.46
CAT	2.95	2.41
DOG	3.94***	2.25
BED	2.47	3.12
CHAIR	2.47	3.09
PHONE	2.91	2.91
PLANE	2.67	2.90
BIKE	2.31	2.63
CAR	3.01	2.80

***$p < .001$

Appendix VIII

<u>Mean preferences for individual stimulus pairs, for the 18-month-old group</u>

	TIME ON SCREEN	
TARGET WORD	REFERENT	NON-REFERENT
BIRD	3.23*	2.29
CAT	3.64***	1.87
DOG	2.98	2.40
BED	2.59	2.88
CHAIR	2.30	3.07*
PHONE	3.23	2.56
PLANE	2.38	2.70
BIKE	2.51	2.44
CAR	2.55	2.55

*$p < .05$ ***$p < .001$

Appendix IX

Twelve-month-olds patterns of overall word preference, part-removed trials.

WORD	DOG	CAT	BIRD	PHONE	BIKE	PLANE	CAR	BED	CHAIR
DOG									
CAT									
BIRD	**	**							
PHONE	**	**							
BIKE	**	**	*						
PLANE	**	**	**						
CAR	**	**	**	**	*				
BED	**	**	**	**	**				
CHAIR	**	**	**	**	**	**	**		

Note: Referents on horizontal axis are preferred over referents on vertical axis by the probabilities indicated
*$p<.05$ **$p<.01$

Appendix X

Fifteen-month-olds patterns of overall word preference, part-removed trials.

WORD	DOG	CAT	CHAIR	BIRD	PHONE	CAR	BIKE	BED	PLANE
DOG									
CAT	**								
CHAIR	**	*							
BIRD	**	**							
PHONE	**	**							
CAR	**	**							
BIKE	**	**	*						
BED	**	**	**	**					
PLANE	**	**	**	**	**	**			

Note: Referents on horizontal axis are preferred over referents on vertical axis by the probabilities indicated
*$p < .05$ **$p < .01$

Appendix XI

Eighteen-month-olds patterns of overall word preference, part-removed trials.

WORD	PLANE	CAR	CAT	BIKE	PHONE	DOG	CHAIR	BED	BIRD
PLANE									
CAR									
CAT	*								
BIKE	*								
PHONE	**								
DOG	**								
CHAIR	**								
BED	**	**	**	**	*				
BIRD	**	**	**	**	*				

Note: Refe.'ents on horizontal axis are preferred over referents on vertical axis by the probabilities indicated
*$p<.05$ **$p<.01$

Appendix XII

Sample protocol for experiment 2

Target word	Picture 1	Picture 2
bird	bird no beak	bed
	bird no wings	chair
cat	cat no tail	chair
	cat no whiskers	telephone
dog	dog no legs	telephone
	dog no tail	bed
bed	bed no legs	airplane
	bed no mattress	bicycle
chair	chair no legs	bicycle
	chair no seat	car
telephone	telephone no dial	car
	telephone no receiver	airplane
airplane	airplane no windows	bird
	airplane no wings	cat
bicycle	bicycle no seat	cat
	bicycle no wheels	dog
car	car no wheels	dog
	car no windows	bird