WHEN IS A "NEEM" NOT A "NEEM"?:
THE INFLUENCE OF SENTENCE STRUCTURE ON WORD-OBJECT ASSOCIATIONS IN INFANCY

by

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This research was designed to address the question of whether 14-month old infants’ ability to associate word-object pairings is influenced by sentence structure. Lloyd, Werker, and Cohen (1993) have shown that 14-month old girls notice changes in word-object pairings in an habituation/dishabituation paradigm, but 8-, 10- and 12-month old infants and 14-month old boys do not. Using video images, infants were habituated to two instances of word-object pairings. A set of test trials was then shown: One in which the word-object pairing changed, and one in which it remained the same. The present research used the same habituation/dishabituation procedure in two experiments with 14-month old infants. In Experiment 1 the nonsense words were presented alone, and in Experiment 2 the nonsense words were embedded in a set of carrier phrases. The first critical question was whether the infants would notice that the word-object pairing had been changed. The second critical question was whether this ability varied across conditions: word in isolation vs word in a set of carrier phrases. The results from Experiment 1 provide clear evidence that 14-month old girls, but not boys, are able to make word-object associations when the object labels are presented in isolation. Findings from Experiment 2, in which the target words were presented in a set of carrier phrases, indicate that the particular carrier phrases presented in this study do not facilitate word-learning at this age.
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When Is A "Neem" Not A "Neem"?:
The Influence Of Sentence Structure On Word-Object Associations In Infancy

"In the beginning was the word. But by the time the second word was added to it, there was trouble. For with it came syntax..."

(John Simon, 1980, p. 111)

1.0 Introduction

The set of experiments in this thesis proposal was designed to investigate the influence of sentence structure, that is, syntax, on lexical acquisition in infancy. We know that by about nineteen months of age children are producing an average of fifty words, and that they are beginning to combine them into 2-word utterances (Nelson, 1973). A longitudinal diary study by Benedict (1979) has shown that infants comprehend words in their ambient language much sooner than they start to produce them. Although Benedict acknowledges enormous individual differences in rate of acquisition, the infants in her study were able to comprehend an average of 50 words (both nouns and verbs) at 14 months, but they were only able to produce 10 words. Similar estimates derived from diary studies have been provided by Snyder, Bates, and Bretherton (1981) and Goldfield and Reznick (1990).

The question the research described here begins to address is: Does sentence structure play a role in infants' acquisition of nouns? That is, are infants aged fourteen months able to learn a word-object association just as easily when the word is presented in isolation as when it is presented in the context of a carrier phrase, or is learning facilitated (or inhibited) if the noun is preceded by a carrier phrase? The results of the experiments described here will help shed some light on the role of syntax in lexical acquisition.

For centuries philosophers, and more recently linguists and psycholinguists, have been interested in language learning because it is a uniquely human ability, and because it occurs so rapidly and apparently incidentally. The pinnacle debate that led to the current controversy over an explanation for language acquisition transpired during the late 1950s and early 1960s when
the strong behaviorist view promoted by B.F. Skinner (1957) was forcefully rebuked by Noam Chomsky's (1959) strong nativist position.

Briefly, Skinner's behaviorist position holds that language is learned through classical conditioning involving such operations as simple stimulus-response associations, reinforcements, and extinctions. Verbal learning, according to the behaviorist view, involves the same laws of learning as those shown to occur in animal learning; there is no special status given to humans' ability to learn and use language.

*Finite State Grammar* is an example of grammar theory originating from the behaviorist tradition. *Left-to-right grammar*, a "thinly disguised 'stimulus-response' theory", according to some critics (Ashcraft, 1989, p. 393), is a specific case of finite state grammar. This theory proposes that each word in a sentence elicits a response-word, which then becomes the next word in the sentence. The response-word is chosen based on some fixed probability of it occurring after the stimulus word. For example, in the sentence "The old woman liked movies", *woman* has a ten percent chance of being chosen to follow *old*, and *liked* has a four percent chance of being elicited by the word *woman* (Ashcraft, 1989, p. 392).

Chomsky's nativist argument against the behaviorist view of language acquisition is that classically conditioned learning cannot account for complex human behavior. The fixed probabilities of finite state grammar do not account for the human ability to generate an infinite variety of sentences, most of which the speaker has never before heard. This ability enables us to construct multiple sentences which all communicate roughly the same idea (e.g., *I'm going to work now* *vs* *I'm off to the lab*). Chomsky claims that finite state grammar only examines the surface structure of language, whereas the underlying meaning of thoughts about objects, events, and ideas lies in the deep structure of language. The thoughts present in deep structure are transformed into surface structure through transformational rules, which gives Chomsky's grammar the name transformational grammar, or phrase structure grammar.

Chomsky further argues against the behaviorist approach with his criticism that describing a grammar in terms of the probability with which words follow one another is
inadequate, since grammar is composed of semantic components as well as syntactic components. By using left-to-right grammar, it is possible to generate many nonsense sentences such as "Colorless green ideas sleep furiously", which follow the probabilistic syntactic rules, but are semantically anomalous.

In order to account for the rapidity and ease with which human infants acquire language, Chomsky argues that there must be some innate components of language processing present, and that these are unique to humans. The *origin of language* question, therefore, should not be "Is language learned through experience or innate mechanisms?", but rather, "What are [the descriptions of] these innate structures in particular domains?" (Chomsky, 1975, p.13).

In order to account for the innate aspect of language learning, Chomsky proposed an LAD, or "language acquisition device" (LAD) (Chomsky, 1965) which has received considerable debate (for reviews, see Golinkoff & Hirsh-Pasek, 1990 and Pinker, 1988). This view maintains that infants acquire language via an innately-specified LAD which must contain the following:

"(i) a universal phonetic theory that defines the notion "possible sentence";
(ii) a definition of "structural description";
(iii) a definition of "generative grammar";
(iv) a method for determining the structural description of a sentence, given a grammar, and;
(v) a way of evaluating alternative proposed grammars."

(Chomsky, 1965, p. 31)

The strong version of Chomsky's "innate hypothesis" states that very little experience with ambient language is required to trigger the LAD and to activate various levels of language processing. This strong version is appealing because it maintains that the ability to use language (specifically, generative grammar) is quintessentially human, setting us apart from other animals on an evolutionary basis. The strong version of the "innate hypothesis", however, does not stand up as a scientific theory that generates testable and falsifiable predictions, since it is impossible to disprove that individuals are born equipped with all the necessary language-processing mechanisms which merely "unfold" with chronological age and maturation. As a result circular debate ensues, and any argument put forth in support of experiential language learning is subject to the nativist criticism that it is not the linguistic experience at all that is responsible for
language learning, but rather the stimulation of certain linguistic conditions that "trigger" the
time-controlled LAD, which then results in abrupt changes in language use. For example, it
might be proposed that phonetic reorganization by infants around 9 months of age (Werker &
Lalonde, 1988) may be a result of infants' experience with their native language. A nativist
could argue against this explanation for phonetic reorganization, however, by claiming that
maturation of the LAD, together with simple triggering from the input, accounts for these
perceptual changes.

A weaker version of the "innate hypothesis" is more readily agreed upon by most
psycholinguists. This version states that some innate structure is in place at birth and even
becomes activated later on in development, but without substantial linguistic stimulation from
the environment these mechanisms will not be able to function. Even Chomsky himself
concedes that environmental stimulation is essential to language learning. He suggests that
"...what we do know, then, or what we come to believe, depends on the specific experiences that
evoke in us some part of the cognitive system that is latent in the mind" (Chomsky, 1975, p. 6).
There is considerable evidence, which will be discussed below, that experience with linguistic
input does have a significant impact on infant language development.

The weaker version of the "innate hypothesis" further states that variations in amount and
quality of ambient language in turn produce wide variation in the speed and accuracy with which
language is acquired. Support for the weaker version is provided by Dunham and Dunham
(1992), who suggest that maternal input accounts for some of the variance in the vocabulary of
infants at thirteen and twenty-four months of age. The Dunhams have shown that, even though
the actual number of words produced by children who receive out-of-home care is similar to that
of children who do not receive out-of-home care, the correlation between maternal and infant
lexicon is significantly higher for those infants receiving full-time care by their mothers.

Psycholinguists leaning heavily on the "nurture" side of the "nature/nurture" debate,
needless to say, have been hard-pressed to offer convincing evidence that experiential input alone
is sufficient for language acquisition because the rules of grammar are so abstract and seemingly
unlearnable in an exclusively experiential manner. The position taken in this research is not that experience alone is sufficient for language acquisition, but rather that certain kinds of experience -- certain forms of input -- might play a facilitative (or inhibitory) role in English language acquisition.

There has been abundant evidence that experience with some characteristics of speech such as intonation and word-stress may facilitate the language-learning process. For example, infant-directed speech is more rhythmic, has longer vowel duration, and has a higher fundamental frequency and more pitch variability than adult-directed speech (Fernald, 1989). Moreover, infants have been shown to prefer this infant-directed speech over adult-directed speech, even in a non-native language (Pegg & Werker, 1993, in preparation; Werker, Pegg, & McLeod, in press).

Aslin (1993) has reported that, in infant-directed speech, words are typically presented within phrases or sentences rather than in isolation, and target words are typically placed in utterance-final position, even if it requires violating strict grammatical rules. One study by Fernald and Mazzie (1991) has shown that English-speaking mothers in the United States stress words in infant-directed speech if they are trying to teach their infants these words as object labels. Thus, target-word placement and word-stress within a syntactic framework may also facilitate lexical acquisition for the infant.

Exposure to a particular language and infants' ability to perceive segmental features of speech also may have a potentially facilitative influence on language development. Mehler, Jusczyk, Lambertz, Halsted, Bertoncini, and Amiel-tison (1988) demonstrated that neonates can discriminate their own, familiar native language from a non-native language, and Moon, Cooper, and Fifer (in press) have further shown that newborns prefer their native language over a non-native language. Jusczyk and colleagues found that 4 month old English-learning infants detect pauses that are incongruent with clause boundaries in both English and Polish, but by 6 months they detect only pauses incongruent with English clause boundaries. Furthermore, by 9 months of age, English-learning infants detect violations to major phrase boundaries in English (Jusczyk,
By nine months of age, infants also show a preference for words that correspond to native language stress patterns (Jusczyk, Cutler, & Redanz, 1993). By the time they are 10 months of age, infants can also discriminate minimal-pair contrasts in their native language with greater ease than they can discriminate non-native minimal-pair contrasts (Werker & Tees, 1984; Polka & Werker, in press). Thus it appears that very young infants are developing a sensitivity to some aspects of the rhythmic, segmental, and possibly syntactic structure of their native language.

These are all examples of how infants are becoming sensitive to highly complex, prosodic, segmental, and phonetic properties of the linguistic structure within the first year of life. It has been argued that this increasing sensitivity to the structure of the native language might facilitate later language development (Werker, Lloyd, Pegg, & Polka, in press). There is as yet, however, little empirical work assessing whether infants use linguistic structure to facilitate word learning. There has been substantial research with children who are already producing speech, but not with infants who are just on the threshold of language acquisition.

Studies with children older than two years of age tend to focus more on comprehension of relational aspects of linguistic structure. For instance, infants are starting to learn hierarchical relations such as object categorization, (Markman, 1989) at this age. Also apparent by this age is acquisition of semantic relations between objects and actions (Pinker, 1988) and syntactic relations among different word classes (Gleitman, 1990).

This leaves students of language acquisition wondering when the transition (if there really is one) from speech perception to language comprehension and eventually production, takes place in the language learning process. At what age do grammatical (syntactic and semantic) aspects of language start to affect lexical acquisition? What is the influence of prosody on early lexical acquisition? Is there a concomitant effect of grammatical structure and prosodic features in language learning, or could it be that grammatical structure does not have any influence until the infant is well into the second year of life and able to use language in a more meaningful, representational manner? The studies in this paper were designed to examine
this bridge from speech perception, when structural but not meaningful properties of language are discriminated, to language comprehension, when speech is understood and used in a meaningful, intentional and communicative way. By examining the role of sentence structure in the development of infants' ability to form word-object associations, the studies discussed here begin to clarify whether syntactic properties of infant-directed speech are related to lexical acquisition for infants at fourteen months of age.

First, an overview describing lexical access research that has been conducted with adults and children will be presented. Next, current "bootstrapping" theories of lexical acquisition will be reviewed, including specific research by Naigles (1990) with 24 month old children on verb comprehension. Third, an explanation on how the present studies differ from previous research will be offered, and the procedure for a pilot study upon which these studies are based will be described. Finally, procedural details and results from the two studies presented here will be documented.

2.0 Overview of Related Research

*Lexical access research with adults and young children.* To date, no research with infants has been undertaken that compares comprehension of a word when the word is presented in isolation versus when it is presented in a sentence context, so I turned to the literature on lexical *access* in adults and school-age children. The effect of sentence structure on lexical access in adults has been studied widely by cognitive scientists who are interested in understanding how knowledge is represented in the mental lexicon (see McClelland & Elman, 1986; Klatt, 1979; and Marslen-Wilson, 1989 for examples of lexical access models). For example, a classic study by Warren and Warren (1970) demonstrated that adults are able to restore the part of a word that had been replaced with white noise based on the overall meaning of the sentence (i.e., The *eel was on the orange). Further, Salasoo and Pisoni (1985) have shown that when all but the initial 150 milliseconds of a word is replaced with a "noise
envelope," adults fail to identify the word when it is presented in isolation, but identify it correctly when it is presented in a normal sentence context.

More pertinent to my work are two studies conducted by Marslen-Wilson and Tyler (1980) and Tyler and Marslen-Wilson (1981). In the first study, adults' speed of response to a target word presented in three different sentential contexts was measured. The sentence contexts were: normal prose, syntactic prose, and random word-order prose. An example of a normal prose sentence is "Some thieves stole most of the lead off the roof," where lead is the target word. A syntactic prose sentence would be syntactically correct, but semantically anomalous, or meaningless: "No buns puzzle some in the lead off the text." The random word-order condition would be syntactically and semantically anomalous, such as "Some the no puzzle buns in lead text the off." Adults' reaction time to the target word was faster in the normal prose condition, slower in the syntactic prose condition, and slowest in the random word-order condition.

The same study was conducted with 5 to 10 year old children, with modification of the sentences to match the children's language ability (Tyler & Marslen-Wilson, 1981). The patterns of response for the children were identical -- response time for the normal prose condition was significantly faster than either the syntactic or random word-order conditions. The two latter conditions did not differ significantly. Thus, like adults, children were fastest at recognizing words presented in normal prose sentences. Unlike adults, children were no faster in the syntactic prose than the random word-order condition.

Although their work with children has not continued, the results obtained by Tyler and Marslen-Wilson are intriguing and point to a significant role played by semantics and syntax in word recognition. Since there is such a strong effect of sentence context on lexical access, this suggests that there could possibly be a similar effect operating in lexical acquisition. Such an effect would be consistent with the notions of syntactic and semantic bootstrapping advanced by Gleitman and Pinker, discussed below, because both bootstrapping hypotheses suggest that semantic and syntactic relations do influence word acquisition, albeit to differing degrees and at different times in linguistic development. Thus the methodology Marslen-Wilson and Tyler
(1980) and Tyler and Marslen-Wilson (1981) used to assess the influence of syntactic context on word recognition in children and adults can be profitably extended to assess the role of semantic and syntactic context on word acquisition in infancy and early childhood. To do so, however, a reliable procedure for assessing word-learning in very young children is required. A detailed description of such a procedure will be discussed in Section 3.0 below.

"Bootstrapping" theories of lexical acquisition. There are two current theories relevant to this research on how children acquire language: the "syntactic bootstrapping hypothesis" proposed by Lila Gleitman, and the "semantic bootstrapping hypothesis" advocated by Steven Pinker. The debate between Gleitman and Pinker concerns how syntactic structure and underlying semantic relations catapult young children from a pre-linguistic state into a state of efficient language use within the first few years of life. Gleitman states that, "...although the [two hypotheses] are distinct, to hold that one of them is implicated in learning is not to deny that the other one is, too. Quite the contrary. It is very likely that they operate in a complementary fashion" (Gleitman, 1990, p. 30). Pinker, similarly, denounces the pointless debate between "semantophiles" and "syntactophiles" "over whether syntax or semantics [is] in some sense more important....[for] even a cursory examination of adult linguistic abilities shows that adult competence involves rules that dictate purely formal, syntactic properties of sentence elements" (Pinker, 1988, pp. 107-108). The interesting theoretical question is not whether semantic or syntactic bootstrapping occurs, but rather how and when each of these processes contribute to the acquisition of language.

The evidence that Pinker offers in support of his "semantic bootstrapping hypothesis" is data collected by Roger Brown in his book A First Language (1973). In this book, Brown characterizes Stage 1, or telegraphic speech, as two-word utterances. An example of telegraphic speech is mommy cookie. He further describes these utterances as expressions of "semantic relations, such as 'agent-object,' 'entity-location,' and 'possessor-possessed' " (Pinker, 1988, p. 107). Pinker suggests that the words representing each of these semantic relations correspond to only one type of grammatical device. Agents of action are expressed as subjects, and patients are
expressed as objects of action. Words that cannot be learned by this "word-to-world" correspondence are henceforth classified through grammatical linking rules based on the position they occupy in phrase structures or inflectional paradigms. An example would be a child's deduction that in Ideas interest Mary; ideas is a noun because it occupies the same syntactic position that dog does in The dog chewed the bone (Pinker, 1989). Thus, further semantic-syntactic relations that are too abstract to learn through direct observation are acquired through Chomsky's proposed "...rich deductive structure": given one fact about an element in a language, many others are either invariably true or have a high probability of being true" (Pinker, 1988, p. 108).

The specific prediction in Pinker's "semantic bootstrapping hypothesis" are that the child's first words should correspond to concrete one-on-one syntactic-semantic correlations assumed to launch the learning process, i.e., first nouns should be names for things; first verbs should refer to actions or changes of state; first subjects should refer to agents of actions; first objects should refer to patients, etc. This process of language acquisition, according to Pinker, explains why "Stage 1 speech would not be a blind alley in the road toward adult mastery of language. Rather, it would be a necessary first step in using innate knowledge to acquire an essentially formal system with circumscribed areas of semantic predictability" (Pinker, 1988, p. 110). Since the semantic bootstrapping hypothesis predicts that one of the earliest linguistic abilities infants develop is to learn nouns as labels of concrete objects, the words presented to the infants in the present two studies are nouns (albeit nonsense) that label accompanying objects. In the first study they are presented alone, and in the second study the same nouns are presented in canonical sentences.

Gleitman, recall, does not dispute that semantic bootstrapping might explain some forms of word-learning. She does, however, argue that many of the scenes children encounter are ambiguous and consistent with multiple interpretations, especially in verb-learning. In these cases syntactic structure is the only way the child can deduce the meaning of verbs. Rather than
word-to-world mappings, Gleitman holds that sentence-to-world mappings are required to account for the full range of meanings acquired in early childhood.

A hypothetical example of a multiply interpretable scene offered by Gleitman is one in which little George pushes his toy truck. Each time he pushes it, he hears his caregiver say "George pushes the truck." However, whenever George pushes the truck, it moves. So how is it that George figures out that "push" means "push" and not "go" (as in "George is making the truck go")? According to Pinker's semantic relations hypothesis, either interpretation would be correct since the agent-object relation is the same irrespective of interpretation. Gleitman claims the evidence is in the syntactic structure of the sentence. (Compare the syntactic structure of the sentences: "George pushes the truck" vs. "George is making the truck go").

These bootstrapping hypotheses are the most well-developed arguments put forth for lexical acquisition in early childhood. The empirical data held up in support of each hypothesis, however, are from research with children two years and older -- on verb-learning in Gleitman's case, and verb- and noun-learning in Pinker's case; and there are more data available from research on production than comprehension of words, because it is relatively easier to collect speech samples from toddlers than to assess comprehension in younger infants. In order to gain a more complete understanding of the initial word-learning process in infancy, then, it is necessary to test the comprehension of infants much younger than two years. It is particularly necessary to test whether there is an effect of sentence context on simple noun acquisition in infancy, since it has been argued that nouns are produced earlier than verbs (Nelson, 1973). Perhaps information provided by sentential structure assists the infant in word-learning much earlier than the evidence supporting the semantic and syntactic bootstrapping theories would have us believe.

One piece of evidence from a comprehension study that provides support for Gleitman's syntactic bootstrapping hypothesis, that syntax is essential to verb-learning, comes from a study conducted by Naigles (1990) in which 24 month old children are shown a video of two people: One person is dressed up as a rabbit and one as a duck. In the video, the rabbit pushes the duck.
back down every time the duck pops up from a squatting position. Simultaneously, the rabbit and duck both make circles in the air with their right arms. One group of subjects hears a voice saying "The rabbit is gorping the duck" and the other group hears "The rabbit and the duck are gorping."

After this training period each child is shown two visual stimuli in a preferential-looking procedure: One where the rabbit is pushing the duck down, but they are not wheeling their arms; and one in which the rabbit and duck are wheeling their arms, but the rabbit is not pushing the duck down. The child is then asked: "Where's gorping now? Find gorping!" The results were conclusively in favor of the children understanding the syntactic meaning. Every child tested looked longer at the screen that matched the syntactic condition in which they were trained than the screen that did not match. This study is supportive of Gleitman's claim that "...if the syntactic structures are truly correlated with the meanings, the range of structures will be informative for deducing which word goes with which concept" (Gleitman, 1990, p. 30).

In order to extend this line of research from verb-learning, the studies reported on here examine the influence of syntactic structure on noun-learning. Even in a scene which is not multiply interpretable, such as a single object moving across a video screen, sentence context may still assist (or interfere) with noun-learning. Since it is known that infants begin to comprehend words much earlier than twenty-four months of age, and since we have developed a procedure which is reliable for fourteen month olds, this is the age group that we chose to test in our research.

3.0 A Reliable Procedure for Testing Lexical Acquisition

In addition to the observational data on word comprehension collected from diary studies mentioned at the beginning of this paper, there have been attempts to assess word comprehension in infants from 10 to 18 months of age using a preferential-looking technique. In this procedure, the infant is typically given a choice of two objects presented on two separate video monitors, and the amount of visual fixation to the object that matches the word presented is compared to
the amount of visual fixation to the object that does not match the word. Oviatt (1980) claims to have developed a reliable preferential-looking procedure to measure comprehension in 10 month olds. In this procedure, two video images are presented side-by-side in front of the infant, who is seated beside his/her parent and one of the experimenters. Then the name of the object is presented, and the amount of time the infant looks at the matching or mis-matching picture is recorded. One criticism of Oviatt's procedure is that the infant's parent presents the speech stimulus, which may introduce external contextual cues and other uncontrolled variables. These external cues may ultimately influence the infants' direction of visual gaze more than the speech stimuli would have if they were presented in a controlled manner (i.e., audio-taped format). A second line of research on infant word comprehension is provided by Reznick (1990), who has developed a preferential-looking procedure assessing word comprehension in 8 to 20 month old infants. Unfortunately, the words presented to the infants in this study were inappropriate for the youngest age-group (i.e., infant, woman, butterfly, purse, etc.), making the results -- that the older infants understood more of the words than the younger infants -- unsurprising. Finally, Golinkoff (1987) has successfully assessed word comprehension using a more controlled preferential-looking procedure, but in our laboratory this procedure has only proven reliable for infants older than 18 months of age (Werker & Pegg, 1992).

A series of preferential-looking and habituation/dishabituation studies conducted by Humphrey and Tees (1979, 1980) revealed that the habituation/dishabituation procedure may be more sensitive than the preferential-looking procedure for assessing infants' ability to detect auditory/visual correspondences. Indeed, there is a substantial history of habituation/dishabituation studies, testing such diverse perceptual abilities in infancy as color perception (Bornstein & Kessen, 1977), sound localization (Zelazo & Weiss, 1989) and object permanence (Baillargeon, 1991).

Younger and Cohen (1989) have adapted the habituation/dishabituation procedure from a technique used to assess infants' ability to discriminate different exemplars of a single perceptual domain to one that investigates infants' ability to learn correlations among several features of an
exemplar within a domain. They used this modified procedure to conduct a series of visual categorization studies with which they tested infants' ability to correlate several visual features of a single object. A further adaptation by Lloyd, Werker and Cohen (1993) of the habituation/dishabituation procedure tests infants' ability to detect correlations across modalities -- in this case, between words and objects. This procedure uses controlled auditory-visual stimuli and is reliable in assessing word-object associations in infants as young as 14 months of age.

In the experimental procedure used in the word-object association study by Lloyd, Werker, and Cohen (1993), infants were repeatedly shown a video tape of two familiar, attractive toys -- a truck and a dog -- that moved horizontally or vertically across the video monitor, respectively. One object was paired with the nonsense word "lif" (i.e., truck/"lif") and the other with the nonsense word "neem" (i.e., dog/"neem"). Following this familiarization phase, infants were shown two test trials presented in counterbalanced order: One maintained the familiar word-object combination (i.e., truck/"lif"), and the second presented a new word-object association (i.e., dog/"lif"). The critical question was whether the infants would look longer at the new, "switched" word-object combination than at the familiar, "same" combination. If they did, it would indicate they had formed an association between a specific nonsense word and a familiar object.

Ninety-six infants were tested; 32 at each of three ages, 8, 10 to 12, and 14 months. Boys and girls were represented approximately equally in each age group. Half of the subjects in each age group were presented with the "switch" test trial first, and the other half were shown the "same" test trial first. The infants were presented the familiarization events until their fixation time had dropped by a set criterion, or until they had received a total of 20 14-sec trials. An analysis of the familiarization data indicated approximately half the infants at each age and of each gender reached the habituation criterion. Thus habituation status also was entered as a factor in the analysis.

The results revealed an interesting developmental pattern. Infants at 8- and 10 to 12-months of age showed no evidence of dishabituating to the "switched" word-object association.
Even those who reached habituation criterion did not look significantly longer at the "switch" than at the "same" test trial. Thus the habituators at these earlier ages had apparently learned the individual word and object features during the familiarization phase, rather than the word-object pairings.

As might be expected, infants at any age who failed to habituate did not look significantly longer at the new word-object combination. To control for the possibility that the infants who did not dishabituate to the "switch" trial had not merely become fatigued by the end of the study, a completely novel word-object pairing was presented at the beginning and end of the testing session. Visual fixation to these pre- and post-test trials was compared, and found to not be significantly different1.

At 14 months of age, however, infants who had habituated to criterion looked significantly longer at the "switched" word-object combination than at the "same" pairings, showing clear evidence of having learned the word-object associations $t(14) = 2.267$, $p<.05$ (one-tailed). Upon closer scrutiny of the data, it appeared that almost all of the female 14-month old infants had dishabituated to the "switch" test trial, and almost all of the male 14-month old infants had not. With gender entered as a between-group variable, it became clear that the females were responsible for the significant difference between the last block of trials in the habituation phase and the "switch" trial in the test phase, $t(7)=4.613$, $p<.002$ (two-tailed), whereas the same comparison for the males did not yield a significant difference, $t(6)=.173$, $p>.05$ (two-tailed). Furthermore, the girls also looked significantly longer at the "switch" than "same" test trials, $t(7)=5.922$, $p<.001$ (two-tailed) (see Figure 1).

1. The results from this habituation/dishabituation study do not preclude the possibility that word-object associations may be made at earlier ages in other testing procedures (for example, in situations where the infant is given the opportunity to play with and act on the object).
Similar gender differences have been found in the literature on language comprehension in infancy (Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Oviatt, 1985; Reznick, 1990; Reznick & Goldfield, 1992) and in production (Nelson, 1973). Often, however, the same researchers only find gender differences in some, but not all of the experiments conducted (Oviatt, 1980; Reznick, 1990; Reznick & Goldfield, 1992). Still other reports on early language comprehension indicate no differences at all in language comprehension and production (Benedict, 1979; Goldfield & Reznick, 1990; Oviatt, 1982; Snyder, Bates & Bretherton, 1981).

At least one comparison study on gender differences in linguistic performance indicates girls are more precocious than boys in language production before 2 years of age, after which time the difference disappears (Maccoby & Jacklin, 1974), but much data have been collected since the time of the analysis, and it is clear that more meta-analytical studies are required before any substantive conclusion can be made about gender differences in early language acquisition. A meta-analysis conducted by Hyde and Linn (1988) claims that any gender differences reported
by Maccoby and Jacklin (1974) have now disappeared. Even though there is considerable controversy over how prevalent and large gender differences are in early language acquisition, when a gender difference is reported, it is almost always the case that girls are shown to be more precocious than boys. It is for this reason that the gender difference found in Lloyd, Werker, and Cohen (1993) was taken seriously, and that an attempt to replicate these findings was undertaken in Experiment 1.

The results from the Lloyd, Werker, and Cohen (1993) study provided clear evidence that girls at 14 months of age can discriminate novel from familiar word-object pairings. They also showed that this ability changes across age. Hence, their procedure seemed particularly useful for testing whether carrier phrases facilitate, inhibit, or have no effect whatsoever on word-object mapping in infancy.

4.0 The Experiments

The research described here extends that of the Lloyd, Werker, and Cohen (1993) study in several ways. First, controls are introduced for object novelty. The truck and dog shown along with the audio stimuli in the Lloyd, Werker, and Cohen (1993) study were objects with which the infants may have had some familiarity. Even if they did not have experience with the particular objects used, the infants may have had experience with other exemplars of the objects, and word-categories to which these objects belong (i.e., doggy; car-car). Thus some infants may already have had category labels for the objects and, according to Markman’s (1989) mutual exclusivity principal, after one label is learned for an object, further labels will be assumed by the infant to refer to a feature of the object, such as color or shape. Thus, mutual exclusivity may have interfered with the infants' learning a second label for the object in the Lloyd, Werker, and Cohen (1993) study. Second, the direction in which the objects move across the video screen is controlled in the present experiments. The objects used in the Lloyd, Werker, and Cohen (1993) study moved in different directions across the screen: The truck moved horizontally and the dog moved back-and-forth toward the viewer. Thus the infants may have dishabituated to the
"switch" trial in the word-object pairing based on the association between the word and direction of movement rather than the association of the word with the object itself. In the present studies, the objects were novel, and they both moved in the same direction -- horizontally across the video screen.

By using a strategy similar to that developed by Marslen-Wilson and Tyler (1980), infants' ability to associate objects with words presented in isolation was compared to their ability to form such associations when the words were presented in a normal prose sentential condition. Since infants comprehend an average of fifty words at 14 months (Benedict, 1979), and 14-month old girls have the ability to make word-object pairings when the words are presented in isolation, whereas 8-, 10- and 12-month olds do not (Lloyd, Werker & Cohen, 1993), 14-month old infants were tested in this set of experiments. It was reasoned that it is important to first establish whether 14-month old infants, particularly girls, are influenced by sentence structure while making word-object associations before going on to examine whether sentence structure influences infants at younger ages.

In summary, two separate experiments were conducted. The first tested lexical acquisition of nonsense words presented in isolation (with novelty of object and direction of movement controlled), thus providing a replication and extension of Lloyd, Werker, and Cohen (1993); and the second tested acquisition with a new group of infants when the same nonsense words were presented in phrase-final position within a set of normal prose carrier phrases.

4.1 Experiment 1

The purpose of Experiment 1 was to replicate our previous results showing that 14-month old girls can make associations between isolated nonsense words and objects, but with novel rather than familiar objects used as the visual stimuli, and with the direction of motion controlled. The infants learned a pair of word-object combinations by viewing them on a videotape monitor. They were subsequently tested on whether they detected a violation of one of the original word-object combinations. The infants' visual fixation to the habituation and test trials
were recorded as the dependent measure. Completely novel visual stimuli were used, and each object moved in a horizontally across the video screen. The speech stimuli remained the same as in the Lloyd, Werker, and Cohen (1993) study.

**Method**

**Subjects.** Sixteen 14-month old infants (± 3 weeks) were required for the first study, with females and males represented equally. Their gestational age at birth ranged from 37 to 43 weeks, and their ambient language environment was composed of a minimum of 80% English. Eight girls and 8 boys successfully completed the study and habituated to criterion in Experiment 1; one boy and one girl were tested in each order. The data collected from 14 infants were not included in the analysis: 3 girls and 4 boys due to fussiness; 1 girl whose mother pointed during the test trials; and, 3 girls and 3 boys due to non-habituation. Overall attrition rate was forty seven percent.

The infants were recruited mainly by visiting new mothers at Grace Hospital in Vancouver, but also through community service announcements in local newspapers and on radio and television programs. Permission to contact the parents by phone when their infants were the appropriate age was obtained, and the parents were given details of the experimental procedure at the time they were selected for participation. Those who eventually took part in the experiment were given an infant scientist t-shirt and an infant scientist degree in appreciation for their participation.

**Stimuli.** The audio stimuli were seven exemplars of each of two nonsense consonant-vowel-consonant (CVC) words: "neem" and "lif" for the habituation and test phase trials. An additional word, "pok", was also recorded for the pre-test and post-test trials (see Chart 1 and Table 1). These exemplars were chosen because they differ in vowel category and the consonantal dimensions of nasality, voicing and place dimensions (Ladefoged, 1975). Maximally different nonsense words were used to ensure optimal discrimination.
The infant-directed CVC speech exemplars were identical to those used in the Lloyd, Werker, and Cohen (1993) study. These tokens were recorded in a sound-proof booth by a female speaker who is fluent in English. While recording this speech, the speaker was instructed to imagine that she was speaking to a 14-month old infant to ensure appropriate infant-directed speech and prosodic contours. Each of the seven isolated word exemplars was approximately .7-seconds in duration, with a 1.5-second interval between words. This produces audio files that are each 14 seconds in duration.2

The visual stimuli were three novel objects video-taped against a black background and transferred to laser-disc format. Two of the objects, made from modeling clay (FIMORég.TM), were used for the habituation and test phase trials and the other object, a commercially manufactured plastic water wheel, was used for the pre- and post-test trials (see Appendix 1). To control for brightness, size, and color, and to ensure that one figure was not inherently more attractive than the other, the clay objects were composed of equal amounts of each of three colors -- red, blue, and yellow. These bright, primary-colored novel objects occupied approximately 13.5° vertical and 13° horizontal visual angle. The duration of each video file was s so that they synchronized with the digitized audio files.

**Apparatus.** The testing session took place inside a small, quiet, and dimly lit lab room (2.3 m x 2.7 m) in the Department of Psychology at the University of British Columbia. The infant sat on the parent’s lap facing a Mitsubishi HC 3905, 45cm video monitor with 640 dot horizontal by 480 line vertical resolution (see Appendix 2). A Bose 101 speaker was located directly below the monitor, through which the audio stimulus was played at approximately 70dB.

During testing, the video image was approximately 70cm from the infant’s eyes and the video monitor was surrounded by black draping from floor to ceiling, with a 6cm hole centered
above the monitor behind which was placed a Panasonic PV-S770K closed circuit camera. The closed circuit system was used to monitor the infant's visual responses on-line and to record the session on video tape for the purpose of reliability coding. The parent listened to female vocal music over a pair of Koss Pro/4AA headsets connected to a Panasonic RX-C5700 portable stereo in an adjacent room. The purpose of the music was to mask the audio stimuli (a female's voice) presented to the infant.

The experiment was controlled by a Macintosh IIfx computer interfaced with a Sony LDP-1550 laser disc player. The video segment for each visual image from the laser disc player was synchronized with a digitized audio file by the computer and the signals were transmitted to the monitor and speaker, respectively.

The experimenter monitored the infant's visual gaze on a NEC PM-1271A monitor in the observation room and recorded the duration of gaze by depressing a pre-programmed key on the computer keyboard when the infant was looking at the visual stimulus and releasing it when the infant looked away. The experimenter was blind to the audio stimuli presented and whether the trial was an habituation or test trial, but monitored the visual stimuli presented to the infant, since this was not recorded on the video tape. After each 14-second trial, the program switched the stimuli to a flashing red light without sound. Once the infant was looking at the flashing light, the experimenter depressed a second key to initiate the next trial. Visual fixations were stored by the computer, and both trial-by-trial scores and a block mean summary sheet were automatically computed for each infant.

Procedure. The infants were tested in a modified habituation paradigm identical to that used by Lloyd, Werker, and Cohen (1993). In this procedure, during the habituation phase the infant was shown two word-object combinations presented alternately (i.e., Image 1/"lif", Image 2/"neem") and in semi-random order until looking time decreased to a set criterion (.65 of the first block of four trials), or a maximum number of 20 trials were completed. During the testing phase, two test trials were presented: One maintained the word-object pairing used in the
habituation phase (i.e., Image 1/"lif") and the other was a new word-object combination (i.e., Image 1/"neem"). The dependent variable was the amount of time the infant looked at the stimuli. As a control for whether the infant was disinterested in the test stimuli, or had become fatigued, a novel word-object pairing was presented before and after the experimental stimuli. The infant was seated on the parent's lap in front of the television monitor and audio speaker. During testing, the parent was made blind to the visual and audio stimuli by wearing a cap with a visor attached that covered her/his eyes and a pair of headsets through which female vocal music was played.

Two infants were assigned to each of eight orders in the experimental condition (Table 1). Recall that each session began and ended with a 14-second pre-test trial of a novel object (a plastic water wheel) paired with the nonsense word "pok". Next, a minimum of 2 and a maximum of 5 blocks of four 14-second trials were presented. Each block consisted of two word-object pairings, each presented twice, and randomly ordered by the computer program. A red, flashing light without sound was presented between trials to recapture the infant's attention.

In reminder, habituation was established if visual fixation time on the third or fourth block of trials was less than 65% of that for the first block of four trials. If the infant had reached habituation criterion after the third or fourth block of trials, the test phase began. If the infant had not reached habituation criterion, a fifth and final habituation block of four trials was presented, then the test phase began. The test phase was composed of two trials: One word-object pairing was the same, and one was switched. The order of same and switched trials was counterbalanced across infants, providing a within subject control group. The total testing time was approximately five minutes.

**Coding Criteria.** For on-line coding, the experimenter depressed a pre-programmed computer key when the infant was looking at the video image, and released it when the infant looked away. The computer was programmed such that timing was accurate to within .25 seconds. A maximum score of 14 seconds was possible for each trial.
**Reliability coding.** A second coder scored twenty percent of the infants' video-taped responses to the experimental stimuli, again with girls and boys equally represented. A Pearson product-moment pairwise correlation of on-line and off-line trial scores had to equal or exceed 95% for the data to be considered reliable. This level of agreement was achieved in all instances.

**Experimental Design.** Each testing session began with a pre-test, followed immediately by a maximum of 20 habituation trials. Next, two test trials were presented, and the session ended with a post-test.

**CHART 1**

Sequence of Stimuli Presentation

<table>
<thead>
<tr>
<th>Habituation Phase</th>
<th>Test Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trials</td>
<td></td>
</tr>
<tr>
<td>Pre-Test</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20</td>
</tr>
<tr>
<td>Block 1</td>
<td>Block 2</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In reminder, the speech stimulus for the pre- and post-test was the word "pok". Audio1 file consisted of seven different exemplars of the word "lif" and Audio2 consisted of seven different exemplars of the word "neem". The 8 stimulus orders are presented in Table 1, below. Recall that two infants, one girl and one boy, were tested in each order, rather than four subjects per order as in Lloyd, Werker, and Cohen (1993), since almost all of the infants in this study reached habituation criterion.
TABLE 1
Experiment 1: Design

<table>
<thead>
<tr>
<th>Order</th>
<th>Habituation Phase</th>
<th>Test Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Same</td>
<td>Switch</td>
</tr>
<tr>
<td>1</td>
<td>Image1/lif</td>
<td>Image2/neem</td>
</tr>
<tr>
<td>2</td>
<td>Image1/lif</td>
<td>Image2/neem</td>
</tr>
<tr>
<td>3</td>
<td>Image1/lif</td>
<td>Image2/neem</td>
</tr>
<tr>
<td>4</td>
<td>Image1/lif</td>
<td>Image2/neem</td>
</tr>
<tr>
<td>5</td>
<td>Image2/lif</td>
<td>Image1/neem</td>
</tr>
<tr>
<td>6</td>
<td>Image2/lif</td>
<td>Image1/neem</td>
</tr>
<tr>
<td>7</td>
<td>Image2/lif</td>
<td>Image1/neem</td>
</tr>
<tr>
<td>8</td>
<td>Image2/lif</td>
<td>Image1/neem</td>
</tr>
</tbody>
</table>

Results and discussion

Isolated word condition. A one-way repeated-measures analysis of variance (ANOVA) was conducted on the data collected from the 8 girls and 8 boys who completed the study, and reached habituation criterion. Gender was entered as a between-groups factor, and duration of visual fixation to the "final block" of habituation trials, "switch" test trial and "same" test trial was then compared. There was a significant interaction between gender and trials, $F(2,14) = 5.724, p< .01$. On the basis of the previous study (Lloyd, Werker & Cohen, 1993), the girls were expected to look significantly longer at the "switch" test trial than the "same" test trial and "final block" of habituation trials, but were not expected to look significantly longer to the "same" test trial compared to the "final block" of trials. Indeed, when the girls' data were analyzed separately, looking time to the "switch" test trial was significantly higher than the "same" test trial, $t(7) = 6.66, p<.001$ (one-tailed), and looking time to the "switch" test trial was significantly higher than the "last block" of habituation trials, $t(7) = 2.287, p <.03$ (one-tailed). The difference in looking time between the "last block" of habituation trials and the "same" test trial was not significantly different (see Figure 2).
As expected, the boys did not look significantly longer to the "switch" test trial compared to the "same" test trial or to the "final block" of habituation trials compared to the "switch" test trial. In addition, to test whether those who did not dishabituate to the "switch" test trial had not merely become tired or disinterested in the study, a correlated t-test comparison was done between the pre- and post-test and found to be non-significant. Furthermore, it had been decided a priori to eliminate the data from those infants who looked at the pre- and post-test trials for less than half the trial duration, but all the infants in this study exceeded the 50% criterion.

**Experiment 1: Target Words**
**Presented in Isolation**

![Graph](image)

*Figure 2*: Results from Experiment 1 showing dishabituation to the switch in word-object pairing by 14-month old females when object novelty and direction of movement is controlled.

The above results confirm the results of the Lloyd, Werker, and Cohen (1993) study, and establish that 14-month old girls are able to make word-object associations in a short training period, even with novel objects and even when direction of movement is controlled. Thus the procedural basis for Experiment 2, which would test infants' ability to learn word-object associations when the word is presented in a set of carrier phrases, was firmly established.
As in the Lloyd, Werker, and Cohen (1993) study, only the female subjects in Experiment 1 showed an indication of associating the word and object. This justifies conducting a time-lag cross-sectional study as a follow-up to Experiment 1 to investigate the validity of a gender difference, which will be completed as a separate project to this thesis. Using this strategy, the 14-month old females and males who participated in Experiment 1 will be re-tested at 16 months of age in the same condition as they were tested in at 14 months of age. The purpose of this study will be to ensure that the girls maintain the ability to make the word-object associations, and determine whether the boys are yet able to make the associations. A new group of 16-month olds will also be tested to confirm the reliability of the procedure, and to control for any test-retest confounds.

In summary, the results from Experiment 1 replicate the Lloyd, Werker, & Cohen (1993) study, and extend the finding, that 14-month old girls are able to learn word-object associations in a controlled experimental setting, to include novel objects that move in the same direction.

### 4.2 EXPERIMENT 2

With the results of Experiment 1, we were in a position to ask the next question: "What role does sentence structure play in the association of words with objects in infancy?"

Experiment 2 was designed to test this question using the same methods as in Experiment 1, except the audio stimuli were a sequences of carrier phrases that each ended with the target word rather than a series of target words presented in isolation.

#### Method

**Subjects.** A new sample of eighteen 14-month old infants (± 3 weeks) were tested with females and males represented equally. Eight girls and 8 boys successfully completed and habituated to criterion in Experiment 2; 1 boy and 1 girl were tested in each order, as well as 1 additional girl and boy tested in randomly selected orders. The data collected from 9 infants

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3 Two additional infants were tested, and their data included in the analyses, because their appointments had already been scheduled at the time of study completion
was not included in the analysis: 4 boys due to infant fussiness; 1 boy due to a technical error, and 4 boys due to non-habituation. Overall attrition rate was thirty-three percent.

**Stimuli.** The visual stimuli were the same as in Experiment 1, except the trial duration was increased to 19 seconds to accommodate the longer audio files. The auditory stimuli varied in that the target word was embedded in a set of three carrier phrases each repeated twice per trial. Each trial was now 19 seconds in duration to accommodate the addition of carrier phrases. Stress was consistently sentence final in all cases and prosody was controlled across carrier phrases.

**Apparatus, procedure, coding criteria, and reliability:** Same as in Experiment 1 above.

**Experimental Design.** In Experiment 2 the target words were embedded in syntactically and semantically correct carrier phrases, which were:

Audio 1: *Look at the līf*. Do you see the līf? What a nice līf!

Audio 2: *Look at the neem*. Do you see the neem? What a nice neem!

* word stress is shown in bold.

As in Experiment 1, 8 combinations of habituation and test trials were presented, with "same" and "switch" trials counterbalanced in the test phase:
TABLE 2

Experiment 2: Design

<table>
<thead>
<tr>
<th>Order</th>
<th>Habituation Phase</th>
<th>Test Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Same</td>
<td>Switch</td>
</tr>
<tr>
<td>1</td>
<td>Image1/Audio1</td>
<td>Image1/Audio1</td>
</tr>
<tr>
<td>2</td>
<td>Image1/Audio1</td>
<td>Image2/Audio2</td>
</tr>
<tr>
<td>3</td>
<td>Image1/Audio1</td>
<td>Image2/Audio2</td>
</tr>
<tr>
<td>4</td>
<td>Image1/Audio1</td>
<td>Image1/Audio1</td>
</tr>
<tr>
<td>5</td>
<td>Image2/Audio1</td>
<td>Image2/Audio1</td>
</tr>
<tr>
<td>6</td>
<td>Image2/Audio1</td>
<td>Image1/Audio1</td>
</tr>
<tr>
<td>7</td>
<td>Image2/Audio1</td>
<td>Image2/Audio2</td>
</tr>
<tr>
<td>8</td>
<td>Image2/Audio1</td>
<td>Image1/Audio1</td>
</tr>
</tbody>
</table>

Results and discussion

**Carrier phrases condition.** As in Experiment 1, a one-way repeated-measures analysis of variance (ANOVA) was conducted on the data collected from the 9 girls and 9 boys who completed the study and reached habituation criterion. Gender was entered as a between-groups factor, and duration of visual fixation to the "final block", "switch" and "same" trials was then compared. There was no significant interaction between gender and test trials, $F(2,16) = .433, p> .05$. On the basis of the previous study (Lloyd, Werker, & Cohen, 1993), the girls were expected to look significantly longer at the "switch" test trial than the "same" test trial and "final block" of habituation trials, but were not expected to look significantly longer at the "same" test trial compared to the "final block" of habituation trials. Therefore, an analysis of the girls' data was conducted separately, which compared looking time to the "switch" test trial with looking time to the "same" test trial. There was not a significant difference between "switch" and "same" test trials, $t(8) = 1.224^4, p>.05$, nor were any of the other comparisons of looking time significantly different for the girls' or the boys' data (see Figure 3).

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4 Although the comparison between "switch" and "same" test trials for the girls' data was not significantly different, seven of nine girls looked longer at the "same" than the "switch" trial, regardless of order in which the test trials were presented. This pattern of results is intriguing, and may warrant further attention.
Again, to test whether those who did not dishabituate to the "switch" test trial had not merely become tired or disinterested in the study, a correlated t-test comparison was conducted between the pre- and post-test trial looking times and found to be non-significant. All of the infants in this study also exceeded the 50% criterion set a priori for the duration of the pre- and post-test trial looking times.

**Experiment 2: Target Words Presented in a Set of Carrier Phrases**

![Graph](image)

**Figure 3:** Results of Experiment 2 showing that neither 14-month old girls nor boys dishabituated to the switch in word-object association when the target words were presented in a set of carrier phrases.

In consideration of the above results, it was concluded that the carrier phrases in Experiment 2 did not facilitate infants' ability to make word-object associations at 14 months of age. Further support for this conclusion comes from additional analyses of the data: a one-way between-groups ANOVA comparing proportion of looking time to trial duration for the "switch" test trial between Experiments 1 and 2 revealed no significant difference in dishabituation; a chi-square analysis showed that the number of infants that habituated to criterion was not significantly different for the two experiments; and, a chi-square analysis comparing the number
of infants that habituated by the third block of trials revealed no significant difference between Experiments 1 and 2. In fact, the overall pattern of habituation was remarkably similar among the infants who participated in these two experiments.

5.0 General Discussion

Results from the studies presented here enrich our understanding of the role sentence structure plays in first language acquisition. Two studies have been conducted. The first tested 14-month old infants' ability to associate isolated nonsense words with novel objects, and has provided additional evidence that at 14 months of age, girls, but not boys, are able to make these word-object pairings. The second study was identical, except the target words were embedded in the context of a set of carrier phrases. Results from the second study indicated that neither 14-month old boys nor girls were able to make word-object pairings in this more complex condition.

There was no difference in overall patterns of habituation between the two studies; the only difference found was that the girls dishabituated to the switched word-object pairing in the first but not the second experiment. There was a difference, however, between the pattern of habituation in Experiments 1 and 2, and the pattern of habituation in the Lloyd, Werker, and Cohen (1993) study. Most of the infants in Experiments 1 and 2 habituated to the novel objects, (73 and 83 percent, respectively) whereas only half of the infants in each age-group in the Lloyd, Werker, and Cohen (1993) study habituated to the familiar objects. This indicates that perhaps mutual exclusivity was playing a role in the Lloyd, Werker, and Cohen (1993) study -- the younger infants, and the 14-month old boys may have been in the process of learning labels for the familiar objects, which may have interfered with their learning of new object labels.

Further research is required to address several issues unearthed by Experiments 1 and 2. First, it is important to establish the validity of a gender difference in word-learning at this age. Even though the finding of a gender difference first reported in Lloyd, Werker, and Cohen (1993) has been replicated with Experiment 1, the extent of the gender difference and the possibility that confounding variables were responsible for the results needs to be examined in
further research. Specifically, a follow-up time-lag sequential study will provide us with more information about the reliability of a gender difference in word-learning.

Second, it is important to investigate whether the 14-month old girls' ability to learn word-object pairings in Experiment 1 is, in fact, linguistic. Perhaps the girls were simply responding to a sound-object association, and the fact that the sound was linguistic was not an important factor in their performance. An important subsequent study would be to present the same objects to girls of this age, except this time the objects would be paired with arbitrary, non-linguistic sounds rather than speech sounds. If the results of such a study are significantly different from those in Experiment 1 in either the speed of habituation, the number of girls who habituate, or the degree of dishabituation, this would provide a stronger indication that the results of Experiment 1 do, indeed, reflect object-labeling rather than the construction of simple object-sound associations.

Third, it is important to modify the speech stimuli in Experiment 2 to determine whether the infants failed to dishabituate to the switched word-object pairing because the target words were embedded in carrier phrases, or because the particular carrier phrases used in this experiment made the task demands too high for 14-month old infants. For example, there were three different types of carrier phrases in the speech stimuli in Experiment 2: Imperative: "Look at the neem"; Interrogative: "Do you see the neem?"; and, Exclamatory: "What a nice neem!" Perhaps the memory requirements imposed by the variety of carrier phrases in the second study was more responsible for the null results of Experiment 2 than the sentential context itself. A further study, in which only one type of carrier phrase is repeated several times per trial would lessen the memory load on the infants and have more construct validity in addressing the question of whether sentence structure influences word-learning in infancy.

There are a few things to be said regarding the bootstrapping hypotheses discussed in the introduction to this paper. According to Pinker's semantic bootstrapping hypothesis, infants learn their first nouns through word-to-world semantic operations, starting with simple subject-object relations. The results from Experiment 1 and 2 appear, upon first glance, to support
Pinker's position that the relationship between word class and the object is more important than sentence structure to word-learning. A more direct test of Pinker's semantic bootstrapping hypothesis would be to teach infants object labels when the objects are in semantic relations, such as agent-patient relations. After they have learned the word-object pairings, the word-object pairings could be switched and the infants' response to this change measured to determine whether semantic relations influence infants' ability to make word-object associations.

According to Gleitman's syntactic bootstrapping hypothesis, infants learn their first words by means of sentence-to-world mappings. Although the experiments discussed in this paper did not test this hypothesis directly, the results from Experiment 2 provide no evidence that infants at 14 months of age are taking advantage of sentence structure to learn object labels. To be fair to Gleitman's position, however, these studies did not assess word acquisition when the target word is presented in one type of sentential condition compared to when the target word is presented in another type of sentential condition (e.g., classifying the target word as a noun vs. verb). To test Gleitman's syntactic bootstrapping hypothesis directly, a comparison between two types of sentences applied to a multiply interpretable scene, such as in Naigles (1990) would be required.

In summary, the results provided strong evidence that 14-month old girls are able to learn word-object associations in a controlled, experimental setting. The results of the Lloyd, Werker, and Cohen (1993) study, that 14-month old girls, but not boys, are able to learn word-object associations in a controlled experimental procedure were replicated in Experiment 1. These findings are consistent with similar findings of gender differences in the literature on early language acquisition with older infants. Thus the development of a reliable procedure to test word-learning in infants as young as 14 months of age is a useful methodological contribution.

The results from Experiment 2 indicated that the particular set of carrier phrases used did not facilitate word-learning in 14-month old infants, but rather inhibited the girls' ability to detect changes in word-object pairings. It is too early, however, to abandon the notion that carrier phrases, under some circumstances and for infants of certain ages, might facilitate word-learning. The results from these studies provide a strong foundation for designing further studies in early
language comprehension. We are now in a better position to examine when, and under what specific conditions, young infants are able to decide when a "neem" is, or is not, a "neem".
REFERENCES


Appendix 1: Objects shown during Pre/Post-test (water wheel), and Habituation/Dishabituation phases (modelling clay figures).
Appendix 2: Apparatus configuration for Experiments 1 and 2.