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**An examination of the factors underlying the facilitative
effect of word phrases on object categorization in
9-month-old infants**

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*When you notice infants in profound meditation,
The reason, I tell you, is always the same:
Their minds are engaged in a rapt contemplation
Of the thought, of the thought, of a thing and its name...*

- adapted from *The Naming of Cats*, T.S. Eliot (1939)

Eliot's notion that "The naming of cats is a difficult matter" (1939, p. 2), suggests the developmental corollary that, for infants, the naming of *categories* is a difficult matter. This paper describes our recent and ongoing endeavors to understand the early relation between language and conceptual organization. The series of studies described here was motivated by the discovery that novel words facilitate categorization in 12-month-old infants (Waxman and Markow, 1995). Such findings imply that the relation between words and object categories may be manifest in prelinguistic infants. Our goal was to extend these studies to a younger age and ascertain whether novel words could assist 9-month-old infants as they encounter the challenge of mapping words to meanings.

The age of nine months seems an ideal time to investigate linkages between words and categories, because infants at about this age discriminate familiar from unfamiliar words in speech segments (Jusczyk & Aslin, 1995; Newsome & Jusczyk, 1994) and may demonstrate comprehension of some initial word-to-meaning connections. Moreover, by nine months, infants demonstrate the ability to categorize objects that are perceptually similar (e.g., Colombo, McCollam, Coldren, Mitchell, & Rash, 1990; Kemler Nelson, 1984; Roberts & Horowitz, 1986; Younger & Cohen, 1986).

Recently, we conducted a series of studies addressing the question, "Do words facilitate object categorization in 9-month-old infants?" (Balaban & Waxman, in press). We begin here by presenting analyses that consolidate the data from three studies and reveal an affirmative answer to this question: Words can facilitate object categorization at nine months. We consider converging evidence from recent studies that extend these findings (a) to content-filtered words, (b) to nonsense words and (c) to novel words presented in speech segments. We discuss factors that might contribute to the facilitative influence of words on infants' object categorization.

Demonstration that words enhance infants' attention to object categories is necessary, but not sufficient, to support a language-based enhancement of

categorization. We also need to determine whether any facilitatory effect of words might simply be due to the generalized alerting effects of auditory stimulation (cf. Baldwin & Markman, 1989; for evidence of alerting effects in young infants, see Kaplan, Fox, Scheuneman, & Jenkins, 1991; Mendelson & Haith, 1976). Our initial studies compared the influence of word phrases to the influence of another type of auditory stimulus, namely, a tone sequence.

We examined 9-month-old infants' attention to object categories in a slide-viewing familiarization/novelty preference task. The results from three experiments are combined here. For separate analyses of each study or further details, see Balaban and Waxman (in press). Subjects included female and male infants tested at 37 - 41 weeks of age.

In Experiment 1, infants were familiarized to slides of pigs or rabbits; in Experiments 2 and 3 the object categories were birds and dinosaurs. Experiments 1 and 2 consisted of 12 subjects in each condition (Word and Tone) and in Experiment 3 there were 16 subjects in each condition. Thus, the combined analyses include 40 infants tested in Word conditions and 40 in Tone conditions. In addition, Experiment 3 included 16 infants tested in a Content-filtered Word condition; data for this condition are summarized after presentation of the combined analyses for Word and Tone conditions.

The experiments consisted of a 9-trial familiarization phase and a 2-trial test phase. Infants were familiarized to color slides of drawings of animals from one object category, that is, either pigs or rabbits in Experiment 1 and either birds or dinosaurs in Experiments 2 and 3. During the familiarization phase, a different exemplar of the object category was presented on each of nine successive 10-s trials. Colors varied across slides, but each animal was a single color, outlined in black, presented on a white background.

Infants were randomly assigned to either the Word or the Tone condition in each experiment. Word phrases ("a pig" and "a rabbit" for Experiment 1 and "a dinosaur" and "a bird" for Experiments 2 and 3), spoken in infant-directed speech by an adult female, were computer-digitized, matched for durations of words and pauses, and recorded on audiotape for presentation during the studies. A sequence of two 400 Hz tones, matched in duration and loudness to the word phrases, was the auditory stimulus in the Tone (control) conditions. The spectral compositions of these auditory stimuli are depicted in Figure 1. Sounds were presented from a speaker located just below the slide screen.

An auditory stimulus (word phrase or tone sequence) occurred once during the slide presentation on six of the nine familiarization trials. The other three familiarization trials were presented in silence. The dependent measure during familiarization was the infants' accumulated looking time on each trial. Infants' visual fixation was determined by an observer, seated behind the slide screen, who used a button to indicate to the computer whether or not the infant was looking at the slide.

The test phase examined infants' preferences for familiar or novel object

categories. Each of the two test trials paired a new member of the familiar category (e.g., bird) with an animal from the novel category (e.g., dinosaur). The novel animal was presented to the left side of the slide on one test trial and to the right side on the other test trial. Test trials were presented in silence. The dependent measure during the test phase was based on the observer's forced choice of whether the infant was looking to the left or the right side of the slide during the time that the infant viewed each of the two test slides.

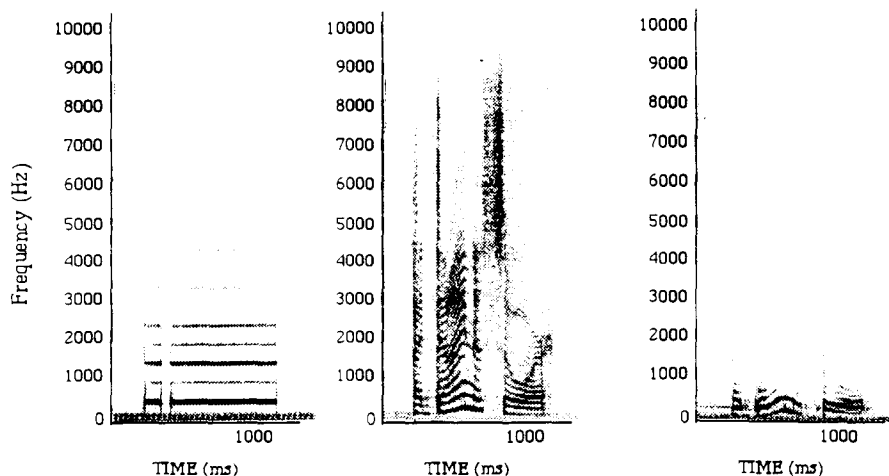


Figure 1. Frequency spectrograms of audiotaped tone sequence (left), word phrase “a dinosaur” (center) and content-filtered word phrase “a dinosaur” (right). Analysis courtesy of Amy Wisniewski and Timothy Gentner.

First, we describe the results for the familiarization phase of the combined analyses of Word versus Tone conditions in the three experiments. Analysis of infants' looking times during the familiarization phase addressed two questions. We asked whether presentation of an auditory stimulus would facilitate infants' visual attention; this was done by comparing looking times on trials that included presentation of a word phrase or tone sequence to looking times on silent trials. In addition, we wondered whether infants' visual attention would habituate across the familiarization phase. Regarding both of these questions, it was also important to determine whether infants in the Word condition responded differently than infants in the Tone conditions during the familiarization phase.

The nine familiarization trials were separated into three trial blocks, with one silent and two auditory trials in each block (Block 1 = trials 1, 2, 3; Block 2 = trials 4, 5, 6; Block 3 = trials 7, 8, 9). The analysis included Experiment (1, 2, or 3), Condition (Word or Tone), and Category (pig or rabbit for Experiment 1 and bird or dinosaur for Experiments 2 and 3) as between-subjects variables and

Trial Type (auditory and silent) and Trial Block (1, 2, and 3) as within-subjects variables. For trial block, linear and quadratic trends were analyzed in lieu of the omnibus test.

As predicted, infants looked longer on trials when slides were presented with an auditory stimulus ($M = 6.95$ s) than on trials when slides were presented in silence ($M = 6.05$ s), and this effect was robust, $F(1,68) = 27.6$, $p < .0001$. There were no significant interactions. The magnitude of the auditory-silent difference was comparable for infants in the Word and Tone conditions. In addition, there was no significant difference in the total amount of looking time accumulated over the familiarization phase for infants in the Word (60.2 s) and Tone (56.9 s) conditions. Thus, the answer to our first question is that, across these three studies, auditory signals had a nonspecific facilitatory influence on infants' visual attention.

Our second question was whether infants' looking times would change over the course of the familiarization phase. There was no evidence of habituation. Instead, the significant linear trend for trial block, $F_{lin}(1, 68) = 14.59$, $p < .0004$, indicated an increase in looking time across trial blocks during familiarization (Figure 2A). There were no significant interactions with this linear trend for trial blocks. There was one significant effect for the quadratic trend, and that was the interaction with auditory condition, $F(1, 68) = 4.87$, $p < .05$. Follow-up analyses confirmed the pattern evident in Figure 2A: For infants in the Word conditions, looking time showed significant linear and quadratic changes over trial blocks, $F_{lin}(1,34) = 6.61$, $p < .02$ and $F_{quad}(1,34) = 6.43$, $p < .02$. Infants in the Tone conditions showed a significant linear increase, $F_{lin}(1,34) = 8.41$, $p < .007$, but no quadratic trend ($F < 1$).

The general picture that emerges is that 9-month-olds do not habituate during this familiarization procedure. It is possible that the stimulus variation across trials and the relatively brief familiarization period precluded habituation. However, it is also likely that potential decrements in visual attentiveness across trials were offset to some extent as the infants became accustomed to the procedure and adjusted to the test room, the rhythm of the trials, etc.

In previous studies using a hands-on object manipulation paradigm, habituation was more evident for 12-month-old infants who heard novel words during a familiarization procedure than for those who did not hear novel words (Waxman & Markow, 1995). Waxman and Markow explained that this result was consistent with the finding that those infants who heard novel words showed greater attention, relative to those infants who did not hear novel words, to objects from a novel category in a subsequent test phase. Both effects indicate a facilitative influence of novel words on object categorization in 12-month-olds.

In the 9-month studies using slide presentation, infants in Word and Tone conditions showed similar increases in visual attention across the familiarization phase. The only hint of a difference between conditions was the significant quadratic trend over trial blocks for infants in the Word condition.

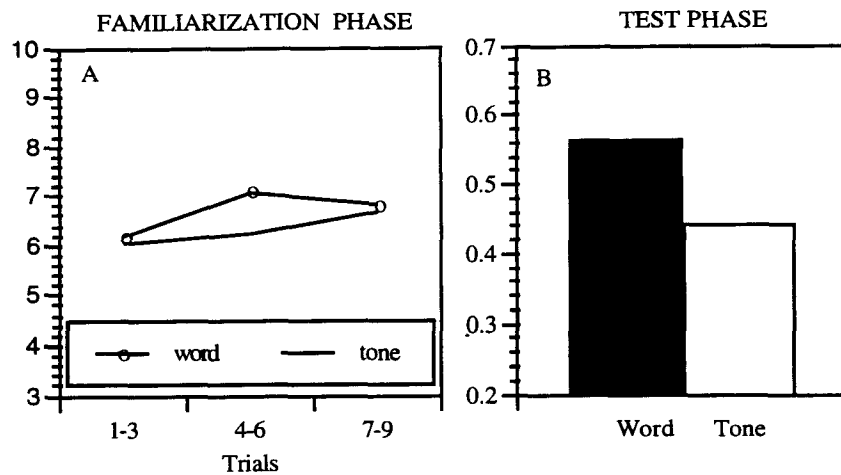


Figure 2. A. Looking times (s) over blocks during the familiarization phase for infants in Word and Tone conditions. Data are averaged across auditory and silent trials for Experiments 1, 2, and 3. B. Novelty preference scores during the test phase for infants in Word and Tone conditions for Experiments 1, 2, and 3.

The familiarization period allowed the infants time to view different exemplars of one object category. It was not necessary that the infants habituate to the category in order for us to study their subsequent preferences for objects in the novel or familiar categories. Previous categorization studies found novelty preferences in circumstances where habituation to the familiar category was not evident (Reznick & Kagan, 1983). In our studies, the familiarization period was kept relatively brief in order to avoid ceiling effects, that is, the test trials probed the infants at a time when categorization processes might be ongoing, rather than completed.

Next, we consider the results from the test phases of the three experiments. Novelty preference scores were calculated from the mean looking times to animals from the novel and familiar categories during the two test trials. If infants attended relatively more to the novel animal than the familiar animal, preference scores would be greater than .50. If infants attended less to the novel than the familiar animal, preference scores would be less than .50 and would indicate a familiarity preference. The preference scores were analyzed with Experiment (1, 2, or 3), Condition (Word or Tone) and Category (pig or rabbit for Experiment 1 and bird or dinosaur for Experiments 2 and 3) as between-subjects variables.

Infants in Word conditions showed greater attention to novelty than infants in Tone conditions (Figure 2B), supporting the hypothesis that words facilitate categorization in infants as young as nine months of age. This difference

between Word and Tone conditions was statistically significant, $F(1,68) = 13.83, p < .0005$, for the main effect of condition. A significant main effect of experiment indicated that novelty preference scores were relatively higher in Experiment 3 than in the other experiments; there were no significant interactions. Follow-up tests indicated that the novelty preference exhibited by infants in the Word conditions ($M = .56$) was significantly greater than $.50, t(39) = 3.08, p < .004$ and that the familiarity preference exhibited by infants in the Tone conditions ($M = .45$) was significantly less than $.50, t(39) = 2.16, p < .04$. In a descriptive analysis of individual infant performance, 27 of the 40 infants in Word conditions and only 10 of the 40 infants in the Tone conditions showed preferences greater than $.50$.

These results indicate that the pattern of relatively greater attention to novelty at test for infants in the Word conditions, relative to infants in the Tone conditions, was robust overall. The direction of this difference was consistent across each of the three experiments (Balaban & Waxman, in press). We interpret this effect as evidence for a facilitatory influence of words on categorization at 9 months. Infants in the Tone conditions demonstrated a familiarity preference, suggesting that they did not accrue sufficient familiarity with the object category, per se, to promote a novelty preference at test. Some information-processing models of infant novelty preferences describe a switch from familiarity preferences to novelty preferences with increasing familiarization time (e.g., Colombo, 1993; Hunter & Ames, 1988). We suggest that, for infants in the Word conditions, the salience of the object category was enhanced by the repeated presentations of the word phrase during familiarization. Therefore, infants in Word conditions devoted greater attention to the member of the novel category at test because it was more discrepant from their working model of the familiar object category.

In summary, this set of studies provides two main findings. A nonspecific facilitation of infants' attention occurred during familiarization, such that words and tones enhanced visual attention, relative to trials without auditory signals. This effect could stem from an alerting effect of auditory stimulation on visual attention (Posner, 1975). Infants also tended to orient toward the sound source when an auditory signal occurred, and this may have helped direct their attention to the centrally-presented slide. Despite the generally comparable influences of words and tones on looking times during the familiarization phase, a specific facilitation of infants' categorization was evident at test. Those infants who had heard a consistent word paired with several exemplars of an object category during familiarization attended more to the novel category at test than did infants who had heard a tone sequence during familiarization. We doubted that the enhanced categorization in the Word, relative to the Tone, conditions was due to infants' comprehension of the particular words. In fact, parental reports confirmed that 9-month-old infants are unlikely to understand the words *pig*, *rabbit*, *bird*, and *dinosaur* as referents to specific object categories.

We explored this idea further by including a Content-filtered Word condition in Experiment 3. Infants in the Content-filtered Word condition heard filtered versions of the word phrases (“a bird” and “a dinosaur”) that were presented to the Word group in Experiment 3 (see Rogers, Scherer, & Rosenthal, 1971, for filter description). Content filtering removed high frequencies (see Figure 1) and drastically reduced intelligibility of the word phrases for adult listeners (Balaban & Waxman, in press). During the familiarization phase, infants in the Content-filtered Word condition demonstrated significant facilitation of visual attention on trials with auditory stimulation compared to silent trials, $F(1, 14) = 10.0$, $p < .007$. This confirms the nonspecific facilitation effect seen for infants in Word and Tone conditions. There was no habituation across trial blocks during familiarization; mean looking times increased across blocks. During the test phase, infants in the Content-filtered Word condition showed a preference for the novel category ($M = .55$) that was significantly greater than .50, $t(15) = 2.86$, $p < .02$. Comparisons with the other conditions in Experiment 3 indicated (a) a tendency toward greater attention to novelty for infants in the Content-filtered Word condition than for infants in the Tone condition, $F(1, 42) = 3.67$, $p < .07$, and (b) no significant difference between infants in the Content-filtered Word and Word conditions, $F(1, 42) < 1$. Inspection of individual subjects indicated that, of the 16 infants in each of the Content-filtered Word, Word, and Tone conditions, the numbers of infants showing preferences for novelty greater than 0.50 were 12, 12, and 7, respectively.

Infants in the Content-filtered Word condition responded similarly to infants in the Word conditions, suggesting that the facilitative effect of words on object categorization at nine months is not due to infants’ knowledge of particular words that label object categories. We suggested that word phrases and content-filtered word phrases enhanced infants categorization because of the interactive influence of novel words and infant-directed speech (Balaban & Waxman, in press).

Infant-directed speech has potent influences on attentional state, even in young infants (Fernald, 1992; Kaplan, Goldstein, Huckleby, Owren, & Cooper, 1995). Moreover, by the age of nine months, infants can use infant-directed speech in segment-parsing and in discriminating familiar from unfamiliar words in speech segments (Kemler Nelson, Hirsh-Pasek, Jusczyk, & Cassidy, 1989; Jusczyk, Hirsh-Pasek, Kemler Nelson, Kennedy, Woodward, & Piwoz, 1992; Jusczyk & Aslin, 1995). Kemler Nelson and colleagues concluded that “Motherese... is not only attention-getting, but it also can be instructive in revealing perceptual units that relate to the building blocks of grammar” (1989, p. 66). At the inception of language comprehension, infants may take advantage of the cues provided by infant-directed speech in order to distinguish words. In our studies, we suggest that the consistent word phrases, presented in infant-directed speech, enabled infants to attend to the object category as they viewed the exemplars.

Two different types of follow-up studies provide converging evidence for a linguistic influence on categorization at nine months. The first study was a variant of the slide task described in Experiments 1-3; this work was initiated in a thesis by Wall (1993)¹. There were two primary objectives of this study. First, in order to demonstrate that prior knowledge of the word phrase or the object category is not required for the facilitative effect of words on categorization, Wall employed a nonsense word phrase ("a biv"), and contrived two animal-like object categories. The second objective was to test the effect of a melody phrase that, in essence, added contour to the tone sequence. Our question was whether object categorization, as indexed by novelty preferences, would be more evident for infants who heard the word phrase than for infants who heard the melody. If so, this would corroborate our argument for a language-based facilitation of categorization in 9-month-old infants. On the other hand, Roberts and Jacobs (1991) found a nonspecific facilitatory influence of words and instrumental music on categorization at the superordinate level in 15-month-old infants. There were numerous differences between their procedure and our slide task (see Balaban & Waxman, in press). However, a plausible alternative to our language-based hypothesis is that categorization is facilitated by the attention-engaging contours present in both infant-directed speech and in a melody.

The melodic phrase was a four-note sequence, with salient contour changes, that was matched in duration to the word phrase. The stimulus categories were make-believe creatures whose shapes were penguin-like or lion-like. Subjects included 24 9-month-old infants. The design and procedure were similar to that described above for Experiments 1 - 3. As predicted, looking times during the familiarization phase were significantly longer for trials with auditory stimulation (word phrases or melodies) than for silent trials. During the test phase, infants in the Word condition demonstrated greater attention to the novel category than did infants in the Melody condition.

These data replicate and extend our studies of Word, Content-filtered Word, and Tone conditions in several ways: (1) The fact that these findings were obtained with make-believe stimulus categories suggests that words can facilitate categorization when object categories are based on new perceptual input, rather than previous knowledge. (2) Extending the results to categories named with a nonsense word confirms the idea that prior comprehension of the word is not required. (3) Relative to infant-directed speech, the presence of changing contours in the melody did not have a comparable facilitatory effect on categorization. Thus, to date, several studies using a familiarization/novelty slide task point to a linguistic influence on basic-level categorization at nine months.

We have additional support for a facilitative influence of novel words on basic level categorization at nine months from a different experimental approach (Waxman & Balaban, 1996), namely, a familiarization-novelty object manipulation task used for 12-month-old infants by Waxman and Markow

(1995). In this task, the 9-month-old infants were tested individually while sitting in a highchair, facing an experimenter. During the familiarization phase for each object set, the experimenter showed the infant a toy from an object category (e.g., a cat) by holding it up at midline and then placing the object on the highchair tray. A different exemplar from the object category was presented on each of the five familiarization trials. Infants were allowed to manipulate the toy for the duration of the trial; the experimenter retrieved the toy at the end of each trial. This procedure was followed by one 20-s test trial in which the experimenter showed the infant a pair of objects, one from the familiar category (e.g., another cat) and one from a novel category (e.g., a bear). The experimenter held the toys up in front of the infant, one to the right and one to the left of midline, and then placed them on the highchair tray.

Infants ($N = 44$) were assigned to either a Novel Word or a Control condition. These conditions differed only during the familiarization phase. Each trial began with the infant's name, indicated as a blank in the following table:

Trial	Novel Word condition	Control condition
1	___, see the <i>feline</i> ?... Do you like the <i>feline</i> ?	___, see here?... Do you like that?
2	___, see the <i>feline</i> ?... Do you like the <i>feline</i> ?	___, see here?... Do you like that?
3	___, see the <i>feline</i> ?... Do you like the <i>feline</i> ?	___, see here?... Do you like that?
4	___, see what I have?	___, see what I have?
5	___, see the <i>feline</i> ?... Do you like the <i>feline</i> ?	___, see here?... Do you like that?
Test	___, see what I have?	___, see what I have?

Table 1. Description of experimenter's comments during presentation of objects to infants in Novel Word and Control conditions (Waxman & Balaban, 1996).

In the Novel Word condition, the experimenter labelled the objects with a consistent, unfamiliar word, which was presented and repeated on four of the five familiarization trials. Each infant was tested with two object sets, cats versus bears and horses versus whales. The corresponding unfamiliar labels were *feline*, *ursine*, *pinto*, and *orca*. The toys that were paired on the test trials were similar

in size and color, and the side of presentation (left or right) of the novel object was counterbalanced across sets to eliminate confounds due to infants' handedness or side preferences.

This procedure provided a strong test of the hypothesis that novel words facilitate categorization at nine months. Infants in the Novel Word and the Control conditions all heard several phrases in infant-directed speech on each trial, but only infants in the Novel Word condition heard a specific novel word presented in conjunction with different exemplars from a basic-level object category.

Naive observers, coding from videotape, scored the duration of time the infant attended to each toy during familiarization and test trials. This measure of general attention included looking, mouthing, and/or touching behaviors. Observers coded the tapes with sound removed in order to ensure that they remained unaware of whether the subject was tested in the Novel Word or in the Control condition.

Despite the fact that infants in the Novel Word and the Control conditions did not differ in their general attention/manipulation of objects during the familiarization phase, the predicted difference occurred during the test phase. Infants in the Novel Word condition devoted more attention to the toy object from the novel category than to the toy object from the familiar category, thus demonstrating a novelty preference that differed reliably from a preference score of .50 ($M = .62$). Infants in the Control condition did not exhibit a reliable preference ($M = .52$). This difference between conditions suggests that it is not merely the occurrence of infant-directed speech, but rather the introduction of a particular word across multiple exemplars, that supports categorization. Current studies further explore this phenomenon and extend the task to superordinate categories, such as *animal* and *vehicle*.

Results from the object manipulation task broaden and bolster the evidence that words can facilitate basic-level object categorization in 9-month-old infants. In conclusion, this report documents a precursor to the finding that novel words focus attention on object categories in 12-month-old infants (especially at the superordinate level, see Waxman & Markow, 1995) and that novel nouns in particular have this effect during the preschool years (Markman & Hutchinson, 1984; Waxman, 1991; Waxman & Hall, 1993)

Returning to our opening refrain on relating objects and names, and with appreciation to T.S. Eliot, we suggest that the early linkage between language and conceptual abilities is integral for rapid development of object categorization and the acquisition of word meanings:

*And so in time you reach your aim,
And finally call it by its name.*

- adapted from *The Ad-dressing of Cats*, T. S. Eliot (1939)

Endnotes

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¹ The acceptance criteria in this thesis were more lenient than those in Balaban & Waxman (in press); we currently are collecting additional data for this study.

References

- Balaban, M. T., & Waxman, S. R. (in press). Do words facilitate object categorization in 9-month-old infants? *Journal of Experimental Child Psychology*.
- Baldwin, D. A., & Markman, E. M. (1989). Establishing word-object relations: A first step. *Child Development, 60*, 381-398.
- Colombo, J. (1993). *Infant cognition: Predicting later intellectual functioning*. Newbury Park, CA: Sage.
- Colombo, J., McCollam, K., Coldren, J. T., Mitchell, D. W., & Rash, S. J. (1990). Form categorization in 10-month-olds. *Journal of Experimental Child Psychology, 49*, 173-188.
- Eliot, T. S. (1939). *Old Possum's book of practical cats*. London: Faber and Faber.
- Fernald, A. (1992). Human maternal vocalizations to infants as biologically relevant signals: An evolutionary perspective. In J. H. Barlow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind* (pp. 391-428). Oxford: Oxford University Press.
- Hunter, M. A., & Ames, E. W. (1988). A multifactor model of infant preferences for novel and familiar stimuli. *Advances in Infancy Research, 5*, 69-95.
- Jusczyk, P. W., & Aslin, R. N. (1995). Infants' detection of the sound patterns of words in fluent speech. *Cognitive Psychology, 29*, 1-23.
- Kaplan, P., Fox, K., Scheuneman, D., & Jenkins, L. (1991). Cross-modal facilitation of infant visual fixation: Temporal and intensity effects. *Infant Behavior and Development, 14*, 83-109.
- Kaplan, P. S., Goldstein, M. H., Huckeby, E. R., Owren, M. J., & Cooper, R. P. (1995). Dishabituation of visual attention by infant- versus adult-directed speech: Effects of frequency modulation and spectral composition. *Infant*

- Behavior and Development*, 18, 209-223.
- Kemler Nelson, D. G. (1984). The effect of intention on what concepts are acquired. *Journal of Verbal Learning and Verbal Behavior*, 23, 734-759.
- Kemler Nelson, D. G. K., Hirsh-Pasek, K., Jusczyk, P. W., & Cassidy, K. W. (1989). How the prosodic cues in motherese might assist language learning. *Journal of Child Language*, 16, 55-68.
- Markman, E. M., & Hutchinson, J. E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic vs thematic relations. *Cognitive Psychology*, 16, 1-27.
- Mendelson, M. J., & Haith, M. M. (1976). The relation between audition and vision in the human newborn. *Monoographs of the Society for Research in Child Development*, 41 (No. 4, Serial No. 167).
- Newsome, M. & Jusczyk, P. (1994, June). *Infants' ability to learn and parse words*. Paper presented at the 127th meeting of the Acoustical Society of America. Cambridge, MA.
- Posner, M. (1975). *Chronometric explorations of mind*. Hillsdale, NJ: Erlbaum.
- Reznick, J. S., & Kagan, J. (1983). Category detection in infancy. *Advances in Infancy*, 2, 79- 111.
- Roberts, K., & Horowitz, F. D. (1986). Basic level categorization in seven- and nine-month-old infants. *Journal of Child Language*, 13, 191-208.
- Roberts, K., & Jacob, M. (1991). Linguistic vs attentional influences on nonlinguistic categorization in 15-month-old infants. *Cognitive Development*, 6, 355-375.
- Rogers, P. L., Scherer, K. R., & Rosenthal, R. (1971). Content filtering human speech: A simple electronic system. *Behavioral Research Methods and Instrumentation*, 3, 16-18.
- Wall, K. M. (1993). *Basic level categorization at six and nine months: A comparison of the effects of linguistic and nonlinguistic input*. Unpublished honors thesis, Harvard University.
- Waxman, S. R. (1994). The development of an appreciation of specific linkages between linguistic and conceptual organization. *Lingua*, 92, 229-257.
- Waxman, S. R. & Balaban, M. T. (1996, April). *Ursines and felines: Novel words support object categorization in 9-month-old infants*. Paper presented at the International Conference on Infant Studies, Providence, RI.
- Waxman, S. R., & Hall, D. G. (1993). The development of a linkage between count nouns and object categories: Evidence from 15 to 21 month old infants. *Child Development*, 64, 1224-1241.
- Waxman, S. R., & Markow, D. B. (1995). Words as invitations to form categories: Evidence from 12- to 13-month-old infants. *Cognitive Psychology*, 29, 257-302.
- Younger, B. A., & Cohen, L. B. (1986). Developmental change in infants' perception of correlations among attributes. *Child Development*, 57, 803-815.