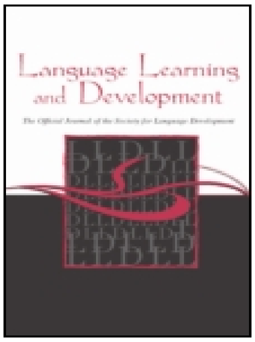


Language Learning and Development

ISSN: 1547-5441 (Print) 1547-3341 (Online) Journal homepage: http://www.tandfonline.com/loi/hlld20

# Word Learning in Infant- and Adult-Directed Speech

**Weiyi Ma , Roberta Michnick Golinkoff , Derek M. Houston & Kathy Hirsh-Pasek**

*Language Learning and Development*, 7: 185–201, 2011

ISSN: 1547-5441 print / 1547-3341 online
DOI: 10.1080/15475441.2011.579839

Psychology Press
Taylor & Francis Group



# Word Learning in Infant- and Adult-Directed Speech

Weiyi Ma
*School of Foreign Languages, Key Laboratory for NeuroInformation of Ministry of Education, School of Life Science and Technology, University of Electronic Science and Technology of China*

Roberta Michnick Golinkoff
*School of Education, and Departments of Psychology and Linguistic and Cognitive Science, University of Delaware*

Derek M. Houston
*Department of Otolaryngology, Indiana University*

Kathy Hirsh-Pasek
*Department of Psychology, Temple University*

Infant-directed speech (IDS), compared with adult-directed speech (ADS), is characterized by a slower rate, a higher fundamental frequency, greater pitch variations, longer pauses, repetitive intonational structures, and shorter sentences. Despite studies on the properties of IDS, there is no direct demonstration of its effects for word learning in infants. This study examined whether 21- and 27-month-old children learned novel words better in IDS than in ADS. Two major findings emerged. First, 21-month-olds reliably learned words only in the IDS condition, although children with relatively larger vocabulary than their peers learned in the ADS condition as well. Second, 27-month-olds reliably learned the words in the ADS condition. These results support the implicitly held assumption that IDS does in fact facilitate word mapping at the start of lexical acquisition and that its influence wanes as language development proceeds.

Interactions with infants often involve a style of speaking referred to as infant-directed speech (IDS) (e.g., Snow, 1977; Phillips, 1973). Compared with adult-directed speech (ADS), IDS is characterized by a slower rate, greater variations in fundamental frequency (e.g., McRoberts & Best, 1997; Papousek, Papousek, & Symmes, 1991; van de Weijer, 1997), longer vowels and pauses (e.g., Albin & Echols, 1996; Andruski & Kuhl, 1996; Bernstein Ratner & Luberoff, 1984), a high proportion of questions (e.g., Newport, Gleitman, & Gleitman, 1977; Soderstrom, Blossom, Foygel, & Morgan, 2008), and increased repetition (e.g., Fernald & Simon, 1984). People use IDS to gain an infants' attention and elicit smiles, and developmental scientists have

Correspondence should be addressed to Roberta Michnick Golinkoff, School of Education, University of Delaware, Newark, DE 19716. E-mail: roberta@udel.edu

long suspected that IDS also facilitates language acquisition. However, as Singh, Nestor, Parikh, and Yull (2009) recently pointed out: “Although there has been substantial discussion of the possible causal effects of ‘motherese’ . . . on language acquisition in infants . . . very few studies have systematically and empirically compared learners’ capacities to analyze language presented in IDS versus ADS” (p. 655).

Much of the speculation that IDS facilitates language acquisition is tied to the possibility that IDS is an acoustically easier input to segment into words and grammatical phrases. Compared with ADS, newly mentioned words in IDS tend to be pronounced on frequency peaks (e.g., Fernald & Mazzie, 1991), undergo wider pitch changes (e.g., Fisher & Tokura, 1996), appear in utterance-final position (Fernald & Mazzie, 1991; Fisher & Tokura, 1996), and are accompanied by exaggerated syllable lengthening (e.g., Church, Bernhardt, Pichora-Fuller, & Shi, 2005; Koponen & Lacerde, 2003). Some of these features may facilitate speech processing (Soderstrom, 2007).

There is also speculation that IDS encourages language acquisition by drawing infants’ attention to speech (Soderstrom, 2007). Investigations of infants’ attention to IDS have shown that infants prefer listening to IDS in both their native language (e.g., Cooper & Aslin, 1990; Fernald, 1985; Papousek, Bornstein, Nuzzo, Papousek, & Symmes, 1990) as well as foreign languages (e.g., Fernald & Morikawa, 1993; Werker, Pegg, & McLeod, 1994), and this preference is manifested within two days of birth (e.g., Cooper & Aslin, 1990). IDS also elicits increased neural activity in 6- and 13-month-old infants (Zangl & Mills, 2007) compared to ADS. Findings that IDS may be easier to process and promote attention to speech suggest that IDS *can* facilitate language learning. These findings do not, however, constitute evidence that IDS *does* facilitate language learning. This is the goal of the present research.

Some work has investigated links between IDS use and language acquisition through correlational analyses (Liu & Tsao, 2008; Rowe, 2008). For example, maternal use of IDS at 7 to 11 months of age correlates with children’s language development at 5 years of age (Liu & Tsao, 2008). However, as with any correlational design, it is impossible to know the causal direction of the effect. It is quite possible, for instance, that infants who are naturally more socially interactive learn language better *and* elicit more IDS from adults.

To date, there have been only a few studies that have empirically tested the effects of IDS on language learning in infants and toddlers. Recent evidence suggests that IDS prosody facilitates infants’ word segmentation (Thiessen, Hill, & Saffran, 2005), speech discrimination (e.g., Liu, Kuhl, & Tsao, 2003; Karzon, 1985; Trainor & Desjardins, 2002), phoneme categorization (e.g., Kuhl et al., 1997; Werker et al., 2007), separation of speech from background noise (Barker & Newman, 2004; Colombo, Frick, Ryther, Coldren, & Mitchell, 1995; Newman & Hussain, 2006), phrasal boundary detection (Jusczyk et al., 1992), locating linguistic units (Shady & Gerken, 1999), and word recognition (Singh et al., 2009). These perceptual abilities are likely to be important for the earliest stages of language acquisition. However, it is not known what role IDS may play in later linguistic skills, such as the ability to learn novel words.

There are two sets of findings that suggest that IDS may facilitate word learning in infants. Kaplan, Jung, Ryther, and Zarlengo-Strouse (1996) showed that 4-month-old infants learned an association between a voice and a face under an IDS but not an ADS condition. Because word learning also involves cross-modal associative learning, it is possible that there would be a similar benefit for IDS. However, in Kaplan et al.’s study, they found learning only under some facial expressions (happy or sad) and not others (angry or fearful) suggesting that the associations may not have been arbitrary. Perhaps infants associated something in the exaggerated IDS prosody with the emotional expression of the faces. Word learning requires learning an arbitrary association between a string of phonemes and a referent.

The second set of findings investigated English-speaking *adults'* ability to learn Chinese words under IDS and ADS conditions. Golinkoff and Alioto (1995) found that participants learned novel words best when words were presented in IDS and were located in sentence-final (compared to sentence-medial) position. Although these results are suggestive, they do not bear directly on the question of whether IDS facilitates word learning in *infants*, as adults can use explicit strategies in laboratory tasks. Research has not directly compared infants' word learning in IDS and ADS under experimental conditions.[1]

To investigate the role of IDS in early word learning and vocabulary development, this study examines two questions. First, does IDS facilitate word learning? Second, does the effect, if any, of IDS on word learning change across development? We predicted that older children and children with larger vocabularies rely on IDS in word learning less than younger children, since children's preference for IDS generally decreases across development (e.g., Cooper & Aslin, 1994; Hirsh-Pasek, Treiman, & Schneiderman, 1984). This prediction is also consistent with the *Emergent Coalition Model* (ECM), which proposes that children first rely primarily on perceptual cues (in this case, exaggerated prosodic cues), followed by social cues, and finally linguistic cues to learn novel words (Brandone, Pence, Golinkoff, & Hirsh-Pasek, 2007; Golinkoff & Hirsh-Pasek, 2006; Hollich, Hirsh-Pasek, & Golinkoff, 2000; Nurmsoo & Bloom, 2008). Thus, older children and developmentally advanced children with larger vocabularies are predicted to rely less on the exaggerated IDS prosodic cues as they have already shifted to the use of social and linguistic cues.

To answer the question of whether IDS facilitates word learning, we tested 21-month-olds using a word-learning task and compared their learning under IDS and ADS conditions. To control factors other than prosody (e.g., syntax, word choice), the same sentence structure was used in both conditions. We predicted that IDS prosody would facilitate children's ability to learning novel words and that the mechanism here might be attentional. That is, we also predicted that children would watch the IDS stimuli longer than the ADS stimuli. To answer the question of when reliance on IDS wanes, Experiment 2 tested 27-month-olds' novel word learning with ADS, and we examined the relationship between vocabulary size and word learning with ADS.

## EXPERIMENT 1

Experiment 1 used a modified version of the Intermodal Preferential Looking Paradigm (IPLP) (Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987; Hirsh-Pasek & Golinkoff, 1996), which relies on a response already in children's repertoire, namely, visual fixation to interesting events. The

[1]An unpublished study also suggests that IDS facilitates word learning under experimental conditions (see the footnote 1 in Graf Estes, Evans, Alibali, & Saffran, 2007). In addition to discussing unpublished work that supports the idea that IDS facilitates word learning, that footnote also stated that Thiessen et al. (2005) showed that IDS facilitated infants' word learning. Actually, Thiessen et al. (2005) only examined infants' word segmentation. Although word segmentation is important for word learning, it is not word learning per se.

IPLP has been successfully used to assess children's comprehension of various lexical and syntactic contrasts (e.g., Golinkoff & Hirsh-Pasek, 2007) and their ability to learn novel words (e.g., Hollich et al., 2000; Imai et al., 2008; Maguire, Hirsh-Pasek, Golinkoff, & Brandone, 2008; Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006). In the IPLP, children are presented with novel word-object pairs during a training phase and then presented with two objects side-by-side and one of the words during testing. Word learning is indicated by longer looking times to the object associated with the word (the target object) than to the other object. Often it is difficult to know with the IPLP exactly what children have encoded about the relationships between the novel words and novel objects. However, in two recent studies of word learning using a three-dimensional version of the IPLP, Hollich et al. (2000) and Pruden et al. (2006) found that 10- and 12-months-olds associated novel words to novel objects rather than to the location of the objects. Infants also demonstrated an early use of the principle of "mutual exclusivity" (Markman, 1989), providing evidence that the IPLP assesses some type of word learning rather than pure associative learning.

The present study used an infant-controlled IPLP. During the interstimulus interval, a giggling baby appeared in the center of the screen. The trial did not start until the child looked at the baby. The children's task was to learn the names of the two novel objects. An earlier study (Houston, Stewart, Moberly, Hollich, & Miyamoto, 2010) using the exact same methodology and stimuli (IDS only) found that normal-hearing 21-month-olds demonstrated word learning in this task but younger infants did not. Moreover, at 21 months of age most children are still novices at rapid word learning (Bloom, 2000) and may benefit from IDS. For these reasons 21-month-olds were tested for this experiment.



## METHOD

### Participants

Forty-eight 21-month-old full-term, healthy, monolingual English-learning children were randomly assigned to either the IDS ($M = 21.00$ months, range: 20.23–22.07; 12 girls) or the ADS ($M = 21.07$ months, range: 20.00–22.03; 12 girls) condition. An additional 17 children were eliminated because of crying (12), parental interference (3), and experimental error (2). Children's productive vocabulary, measured using the short form of the Communicative Development Inventory (CDI) (Fenson et al., 2000), did not differ between the IDS ($M = 36.33$, $SD = 20.36$) and ADS conditions ($M = 38.42$, $SD = 25.55$).

### Apparatus and Stimuli

Children sat on a caregiver's lap facing a large monitor at a distance of 37 inches from the center of the screen. The visual stimuli were shown as left and right split-screen displays at infants' eye level; the auditory stimuli were presented through the TV monitor. A hidden camera recorded children's visual fixation to the display. Parents were instructed to close their eyes once the movie started. If a parent did not close their eyes throughout the testing session, all data from that child were discarded.

### *Visual Stimuli*

The two familiar objects (i.e., apple and book) and the two novel objects were designed using Macromedia's Extreme 3D program. For the training phase, the novel objects were animated using Macromedia Director Software Package. The novel object first dropped from the top of the screen to the bottom of the screen, bounced three times, then appeared to move toward and then away from the viewer, turned twice in a circle, jumped to the right, then, jumped to the left out of screen, then immediately jumped back into the center of the screen and stayed there statically. In all other phases, the objects were static, except for a bounce of the target during the last second of each test trial (see Table 1 for stimuli).

### *Speech Stimuli*

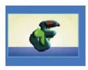
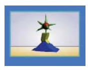
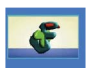
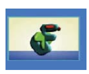
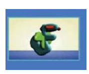
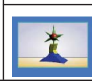
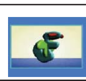
A female speaker, who was the mother of a young child, was asked to record sentences containing the two target words (e.g., *It's a modi/blick! See the modi/blick. That's the modi/blick*). During recording, she was asked to imagine that she was talking to an infant (for the IDS) and to an adult (for the ADS). The recording process involved multiple attempts with feedback to ensure that the IDS stimuli possessed IDS characteristics. Our subjective impressions were then verified with acoustic analyses. Based on the average of *all* the words used in training and test, the IDS audio ($M = 330$ Hz, $SD = 65$ Hz, range: 203–463 Hz) had a higher fundamental frequency (F0) and a wider frequency range than the ADS audio ($M = 219$ Hz, $SD = 31$ Hz, range: 167–291 Hz) ($p$'s $< .001$) (Figure 1). These IDS values are consistent with those reported by previous research (Fernald, 1989; Thiessen et al., 2005). When all the *sentences* containing the target words were analyzed, a chi-square test showed that the target words appeared on frequency peaks in IDS (51%) and in ADS (45%) about the same percent of the time ($p = .29$).

To maintain the naturalness of the speech types being contrasted, word length was *not* controlled between conditions. Sentence duration was longer in IDS ($M = 1.16$ s, $SD = .47$) than in ADS ($M = .95$ s, $SD = .36$) ($t(70) = 2.18$, $p < .05$). Because sentence duration was shorter in ADS than in IDS, longer pauses were inserted between sentences in ADS than in IDS in order to equalize the durations of the trials in the two conditions.

## Procedure

Testing consisted of five phases. Between each trial children saw a giggling baby in the center of the screen. The experimenter waited until the child looked at the baby to establish that each trial started with a neutral look to the center. A digital video camera recorded children's looking behavior, and fed the recording to an experimenter in an adjacent area. That experimenter watched two televisions: One showed the movie that the child was watching, and the other showed the child watching the video. The experimenter started a trial once a child looked at the baby. During the *task familiarization phase,* infants were presented with images of a ball and a book side-by-side and were directed to look at the ball in one trial, and the book in the other (counterbalanced for order of presentation). During the *salience phase* (one trial), infants were shown the two novel objects side-by-side without animation or accompanying auditory stimuli.

TABLE 1
Visual and Linguistic Stimuli Used to Teach Two Novel Words in Either IDS or ADS

| | *Left Side* | *Right Side* | *Audio* |
|---|---|---|---|
| **Task familiarization phase** |  |  | *Book! Look for the book! Can you find the book? That's the book.* |
| |  |  | *Ball! Look for the ball! Can you find the ball? That's the ball.* |
| **Salience** |  |  | No audio |
| **Training** Animations of objects (4 trials: 24 seconds each) The 2 trials (modi & blick) repeat. |  | | *Look here! It's a modi! See the modi. That's the modi. Look what the modi is doing? Now the modi is going over here. Where's the modi going? Where's the modi? Modi! There's the modi!* |
| | |  | *Look here! It's a blick! See the blick. That's the blick. Look what the blick is doing? Now the blick is going over here. Where's the blick going? Where's the blick? Blick! There's the blick!* |
| **Test block 1** (4 trials: 2 for each word; 7 seconds each test) |  |  | *Modi! Where's the modi? Look at the modi! There's the modi.* |
| |  |  | *Blick! Where's the blick? Look at the blick! There's the blick.* |
| **Reminder 1** (2 trials: 7 seconds each |  | | *Modi! That's the modi. See the modi. It's a modi!* |
| | |  | *Blick! That's the blick. See the blick. It's a blick!* |
| **Test block 2** (4 trials: 2 for each word; 7 seconds each test) |  |  | *Modi! Where's the modi? Look at the modi! There's the modi.* |
| |  |  | *Blick! Where's the blick? Look at the blick! There's the blick.* |

*Note*: An empty cell means one side (left or right) of the monitor is blank. The name assignment (*modi* and *blick*) and the side of presentation of the two novel objects are counterbalanced in four conditions in IDS and ADS, respectively. Color table available online.

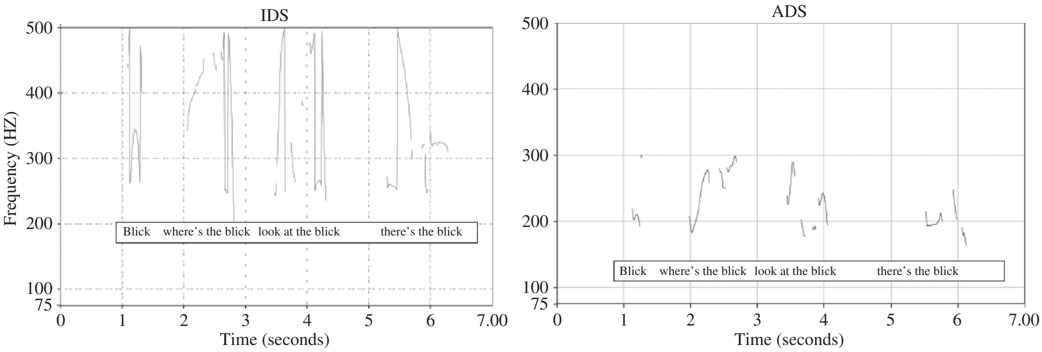



FIGURE 1 Spectrogram of the sentence "Blick! Where's the blick? Look at the blick! There's the blick" as presented in IDS and ADS.



During the *training phase* (four trials, 24 seconds each), infants were presented with the animated videos of the same two novel objects as during the salience phase, each paired with one of the two training sentences, twice each in alternating order (Table 1). The left-right position of the two objects was consistent across phases for each infant. The name assignments (*blick* or *modi*) and left-right positioning of the objects were counterbalanced across infants.

The two blocks of test trials were separated by a *reminder phase* (two trials) that allowed infants additional opportunities to learn the pairings of the novel objects and words. During each trial, infants were presented with one of the novel objects and the corresponding reminder phase passage. The order of the *blick* and *modi* reminder trials was randomized for each infant.

During the *test phase* (two blocks of four trials separated by the reminder phase), infants were presented with the static version of the two novel objects side-by-side and were directed to look at one of them (e.g., "*Modi. Where's the modi . . .*"). There were two trials for each object/label pair. The order of the four, seven-second test trials was randomized for each infant. During the last second of each test trial, the "target" (i.e., the named object) bounced to reinforce—or encourage—looking to the target.

## Coding and Data Analysis

Visual fixation was coded frame-by-frame to the thirtieth of a second with the audio turned off so that the coder was blind to condition. Recoding of 20% of the subjects by another coder yielded an intercoder agreement of .98. The dependent variable was single *longest look* at the target and the nontarget in each test trial, which has been found to be a more sensitive measure than total looking time, especially when children's attention decreases over the course of a test (e.g., Schafer & Plunkett, 1998; Bailey & Plunkett, 2002).[2]

[2]The data on longest looks were highly correlated with the data on total looking time and the proportion of looking time at the target, as is consistent with previous research employing these measures (e.g., Schafer & Plunkett, 1998; Bailey & Plunkett, 2002).

## Vocabulary Assessment

Caregivers completed the short-form version of the MacArthur communicative development inventories (MCDI)—words and sentences (Fenson et al., 2000)—while the child became acclimated to the testing room.

# RESULTS AND DISCUSSION

## Did IDS Facilitate Word Learning?

Figure 2 displays infants' mean longest looks to the target and nontarget across blocks for each condition. The duration of children's mean longest looks at the target and the nontarget in each test block were subjected to a 2 (condition: IDS, ADS) $\times$ 2 (stimulus type: target vs. nontarget) $\times$ 2 (test block: 1, 2) repeated-measures ANOVA. A significant interaction of condition (IDS, ADS) and stimulus type (target, nontarget) suggested that children performed differently with IDS and ADS ($F$ (1,46) = 4.23, $p < .05$, $\eta_p^2 = .08$). Planned t-tests revealed that infants in the IDS condition looked significantly longer to the target than to the nontarget in block 1 ($t(23) = 4.14$, $p < .001$, Cohen's d = .86) and in block 2 ($t(23) = 2.84$, $p < .01$, Cohen's d = .60). Infants in the ADS condition, however, did not look significantly longer to the target than to the nontarget in either block 1 ($t(23) = 0.00$, $p = 1$) or block 2 ($t(23) = 1.31$, $p = .20$, Cohen's d = .27). These results suggest that children learned the words in IDS, but not in ADS. This pattern of results is displayed in Figure 2.

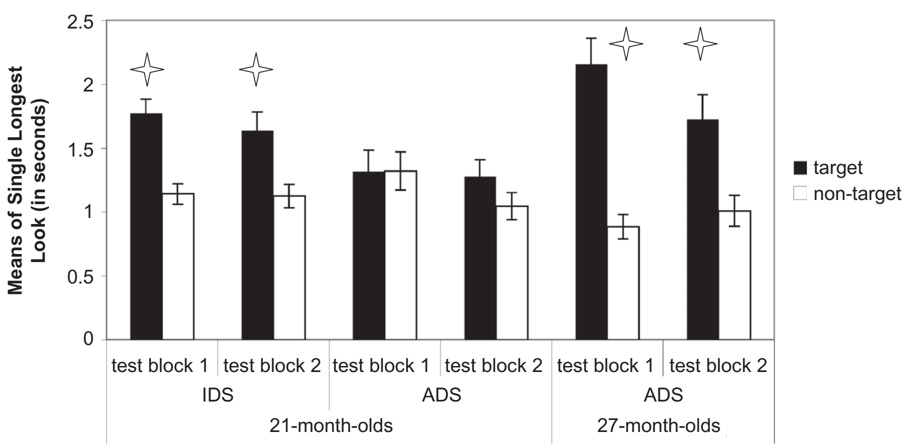



FIGURE 2 Means of single longest look at the target and non-target in test blocks 1 and 2 for 21-month-olds under IDS and ADS and under ADS for 27-month-olds.

## Was There a Relationship Between Children's Performance and Vocabulary Size?

To examine the effect of vocabulary size and word learning performance, we first calculated a word-learning performance score for each child by subtracting the mean longest look to the non-target from the mean longest look to the target. We then correlated the children's word-learning performance scores with the number of words mothers reported they produced on the MCDI. A statistically significant correlation ($r = .32$, $p < .05$) suggested that children with larger vocabularies tended to perform better on the word-learning task than children with smaller vocabularies.

To further investigate the relationship between vocabulary level and performance, children were divided into two groups within each condition (IDS, ADS): high vocabulary (HV) and low vocabulary (LV), based on a median split of MCDI scores in the IDS ($Mdn = 28$) and ADS conditions ($Mdn = 23$), respectively. Figure 3 displays the mean longest looks to the target and nontarget for each of the four groups across the two blocks of trials. Paired-samples *t*-tests were used to compared the mean of children's longest looks at the target and nontarget in each test block. In IDS, HV children's longest look at the target was longer than that at the nontarget in test block 1 and 2. LV children's single longest look favored the target over the nontarget only in test block 1 ($p$'s $< .05$). In ADS, HV children's single longest look favored the target over the nontarget in test block 2 ($p < .05$), but LV children did not show evidence of word learning in either test block (Figure 3).

## Did IDS Maintain Children's Attention More Than ADS?

To examine whether children paid more attention in the IDS condition than in the ADS condition in different phases of the experiment, analyses were conducted on mean looking times to the TV monitor. During the training phase, there were no significant differences in looking times between conditions (M IDS = 21.41 s, SEM = .71 s; M ADS = 21.16 s, SEM = .60 s). During the test phase, however, children showed greater overall attention (i.e., combining the looking times to

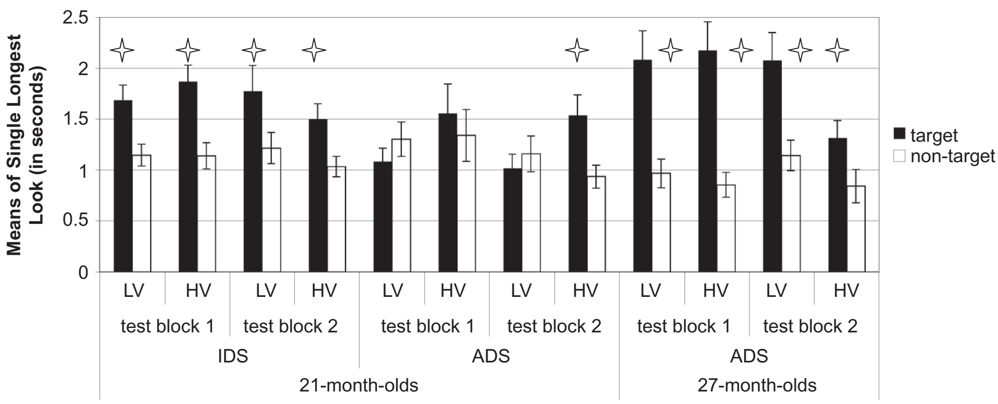



FIGURE 3 Means of single longest look at the target and non-target in test blocks 1 and 2 for 21-month-olds under IDS and ADS and under ADS for 27-month-olds by vocabulary level.

the target and nontarget) in the IDS (M = 3.88 s, SEM = .14 s) than in the ADS condition (M = 3.27 s, SEM = .14 s) (t(46) = 2.68, p = .01, Cohen's d = .75). To explore the nature of the overall looking time difference, we conducted separate analyses for the target and nontarget. Children in the IDS condition looked more at the target (M = 2.22 s, SEM = .13 s) than children in the ADS condition (M = 1.70 s, SEM = .15 s) (t(46) = 2.6, p = .01, Cohen's d = .73), but children in the IDS condition looked for almost the same amount of time at the nontarget (M = 1.60 s, SEM = .09 s) as did children in the ADS condition (M = 1.56 s, SEM = .12 s). These results suggest that IDS maintained children's attention more than ADS because they were better able to recognize words in IDS than in ADS.

The findings in Experiment 1 suggest that IDS facilitates word learning, especially in children who have smaller vocabularies. Eventually, however, children must be able to learn words presented in ADS. It is possible that as children learn more words, word learning under ADS improves. That possibility was tested in Experiment 2.



## EXPERIMENT 2

The results of Experiment 1 suggest that IDS facilitates word learning in 21-month-olds. These findings raise the question of whether more advanced word learners are as reliant on IDS to learn novel words. Thus, Experiment 2 tested 27-month-olds in the ADS condition only.

## METHOD

### Participants

Sixteen 27-month-old full-term, healthy, monolingual English-learning children (M = 27.98 months; range = 26.57–28.65; 9 girls) participated. Another two children were eliminated because of crying (one), and failure to complete at least two test blocks (one). The mean of children's productive vocabulary, measured using the short CDI, was 75.38 (range = 8–100). Fewer children were tested in this experiment than in Experiment 1 because this experiment included only one condition—ADS. Moreover, it was expected that older children would show more consistent learning.

### Procedure and Stimuli

Experiment 2 was identical to the ADS condition in Experiment 1.

## RESULTS AND DISCUSSION

### Did Older Children Learn the Words in ADS?

A 2 (stimulus type: target vs. non-target) × 2 (test block: 1, 2) repeated measures ANOVA showed that children's longest look at the target ($M = 1.93$ s, $SEM = .16$) was greater than their longest look at the nontarget ($M = .95$ s, $SEM = .09$) ($F(1, 14) = 26.58$, $p < .001$, $\eta_p^2 = .64$).

Separate paired-samples *t* tests compared the mean of children's single longest looks at the target and the nontarget in each test block – Block 1: $t(15) = 4.82$, $p < .001$, Cohen's d = 1.23; Block 2: $t(15) = 3.23$, $p < .01$, Cohen's d = .83). The results suggest that 27-month-olds were able to learn words with ADS unlike their 21-month-old peers. To compare performance with younger children, data from the 27-month-olds and from the 21-month-olds in the ADS condition were subjected to a 2 (stimulus type) × 2 (test block) × 2 (age group) repeated-measures ANOVA. The interaction between age group and stimulus type was significant ($F(1, 38) = 9.97$, $p < .01$, $\eta_p^2 = .21$), reflecting a greater looking preference for the target in the older children than in the younger children.

## Was Children's Vocabulary Size Correlated With Their Performance?

Children were divided into two groups (LV and HV children) based on the vocabulary median (*Mdn* = 80). A repeated-measures ANOVA with stimulus type (target, nontarget) as the repeated-measures variable and vocabulary level (LV, HV) as the between-subjects variable revealed a main effect of stimulus type ($F(1, 14) = 25.00$, $p < .001$, $\eta_p^2 = .64$) but no interaction with vocabulary level ($F < 1$), suggesting that the two groups did not differ significantly in their performance on the task. Paired-samples *t* tests indicated that both HV and LV 27-month-olds had longer looks to the target than to the non-target in test block 1 (LV: $t(7) = 2.90$, $p < .05$, Cohen's d = 1.03; HV: $t(7) = 3.77$, $p < .01$, Cohen's d = 1.37), test block 2 (LV: $t(7) = 2.41$, $p < .05$, Cohen's d = .86; HV: $t(7) = 2.41$, $p < .05$, Cohen's d = .85), and overall (LV: $t(7) = 2.93$, $p < .05$, Cohen's d = 1.05; HV: $t(7) = 5.60$, $p < .01$, Cohen's d = 2.18). Thus, 27-month-olds learned the novel words regardless of the size of their productive vocabularies. Moreover, the correlation between performance on the task and vocabulary did not approach statistical significance (r = .15).

## Did ADS Maintain Older Children's Attention?

To compare younger and older children's attention to ADS, analyses were performed on mean looking time data collected from the 27-month-olds and the 21-month-olds in the ADS condition. During the training period, older children (M = 22.47 s, SEM = .34 s) did not look significantly longer than younger children (M = 21.16 s, SEM = .60 s) ($t(38) = 1.67$, $p > .1$, Cohen's d = .67). During the test period, analyses revealed an effect of age group that approached significance ($t(38) = 1.96$, $p = .06$, Cohen's d = .61), reflecting greater overall attention (i.e., combining the looking times to the target and nontarget) to the ADS in older children (M = 3.74 s, SEM = .18 s) than younger children (M = 3.26 s, SEM = .16 s). To examine if older children attended more to both the target and nontarget than did younger children, we conducted separate analyses for these event types. Analyses revealed that older children looked longer at the target (M = 2.43 s, SEM = .14 s) than younger children (M = 1.70 s, SEM = .15 s) (t(38) = 3.34, p = .002, Cohen's d = 1.05), but looking at the nontarget did not differ significantly between the age groups (M older = 1.31 s, SEM = .12 s; M younger = 1.56 s, SEM = .12 s). The pattern of results suggests that the stimulus type by age group interaction (reported above) was carried by the older children's increased looking time to the target and not by differences in looking time to the nontarget. This finding parallels the finding reported in Experiment 1 in which 21-month-olds in the IDS condition looked longer at the target than children in the ADS condition but that the two groups did not differ in their looking times to the nontarget. Both findings suggest that differences in attention (as measured by looking time) were driven by recognition of the target items.

## GENERAL DISCUSSION

Two key findings emerged. First, the 21-month-olds learned associations between the novel words and novel objects when they heard IDS but not when they heard ADS. Second, when using the ADS materials, the 27-month-olds demonstrated word learning in both test blocks, and high-vocabulary 21-month-olds also showed word learning in test block 2. Thus, IDS seemed to have its greatest effect in the younger group when children have relatively small vocabularies. The present findings do not imply that toddlers can never learn novel words in ADS. Indeed, when words were presented in ADS in isolation, 15-month-olds (Schafer & Plunkett, 1998) showed word learning. Nor do the present findings imply that children cannot learn novel words in IDS at even earlier ages. For example, using the IPLP, Houston-Price, Plunkett, and Harris (2005) found word learning performance in IDS with 18-month-olds. Differences in the age at which children show learning across studies are likely due to methodological differences. The aim of this study was not to determine *when* infants are able to learn words; rather, it was to test the possibility that IDS facilitates word learning by pitting IDS against ADS with novel words and unfamiliar objects. No prior study of which we are aware has put this possibility to the test.

### Why Does IDS Prosody Facilitate Word Learning?

There are several possible reasons why IDS may facilitate word learning. The most obvious perhaps has to do with familiarity; when children are addressed directly, it is more frequently in IDS than in ADS. Infants may also be accustomed to segmenting IDS, and IDS prosody may make segmentation easier (e.g., Kemler Nelson, Hirsh-Pasek, Jusczyk, & Cassidy, 1989), thus facilitating the process of encoding a novel word into memory. Work by Amanda Seidl and her colleagues suggests that prosodic cues such as pausing, preboundary lengthening, and intonation are important for speech segmentation in 4- to 6-month-old English-learning infants (Johnson & Seidl, 2008; Seidl, 2007; Seidl & Cristiá, 2008). Relatedly, perhaps children can more readily encode phonological information from IDS than from ADS, possibly because IDS involves an expanded vowel space (Kuhl et al., 1997).

IDS prosody may also facilitate novel word learning for the simple reason that it elicits more attention in infants than ADS. Consistent with that possibility, children in the IDS condition looked more at the monitor than those in the ADS condition during the test phase. However, a closer look at these results raise the possibility that children looked longer in the IDS condition because they learned and recognized the word-object associations in the IDS condition and not because the IDS elicited more attention than the ADS condition. The children in the IDS condition showed more looking only for the target and not for the nontarget. Moreover, looking times did not differ by condition in the training phase. If IDS elicited more attention than ADS, we would have expected longer looking times for the IDS condition throughout the experiment.[3] Instead, longer looking times were observed only for looking at the target during the test phase, which may have been an outcome of having learned the words.

## Role of IDS in Children's Word Learning Journey

One theory suggests that at the start of word learning children may utilize multiple, overlapping cues (perceptual, social, and linguistic) to learn new words. The Emergent Coalition Model (ECM) (Hollich et al., 2000) would explain the sequence above as a shift from relying on primarily perceptual cues for word learning to relying mainly on linguistic cues. Synchronous movement and sound (Gogate & Bahrick, 2001), object motion (Werker, Cohen, Lloyd, Casasola, & Stager, 1998), and object salience (Pruden et al., 2006; Hollich et al., 2000) are ways to perceptually highlight a word's referent and may be key to early word learning in just the same way that the exaggerated contours of IDS contribute to word learning. Then, as vocabulary is slowly amassed, children begin to free themselves from the use of perceptual cues such as object salience (Golinkoff & Hirsh-Pasek, 2006) or the prosodic exaggerations of IDS. Finally, children will be able to learn words even from overheard speech (Akhtar, Jipson, & Callanan, 2001), and with referents that they do not find particularly salient or attractive (Hollich et al., 2000; Brandone et al., 2007).

By 27 months of age in the present study, children can learn two new words in a speech register that is more often used with adults than children. Bolstering this perspective is the finding that when the younger group in Experiment 1 was divided at the median by the size of their vocabularies as assessed by parental report on the MacArthur Communicative Development Inventory (Fenson et al., 1994), only the children *above* the median showed learning under IDS. Thus, it is not age *per se* that is associated with reliance on IDS for word learning. Rather, children of the same age who are more skilled at word learning reduce their dependence on IDS sooner than those with fewer words in their lexicons. By 27 months, there is no link between vocabulary size and word learning, as seen in Experiment 2. By that time, and regardless of their lexical size, children could learn words easily under ADS. Perhaps this occurred because the older group had 6 months more of language input and is more familiar with ADS than the 21-month-olds. Or perhaps we are observing a "learning to learn" phenomenon: Having learned more words, the 27-month-olds may have improved their word learning skills (Smith, 2000). The ECM perspective then, suggests that lexical acquisition may not only be influenced by the frequency (e.g., Hart & Risley, 1995) and diversity of the words children hear (Tabors, Roach, & Snow, 2001) but also by the acoustic nature of that input.

Although our participants were squarely in the age where word learning is underway, we had no long-term follow-up or transfer test and thus did not have a stringent test of word learning. Nonetheless, it is reasonable to conclude that these children were learning the names of the novel objects. Novel word learning has, in fact, been reported with younger infants using other methodologies (Schafer & Plunkett, 1998; Werker, Cohen, Lloyd, Casasola, & Stager, 1998;

[3]It should be noted that the relationship between visual fixation and attention is complex – infants and young children can be in different states of attention while looking (Richards, 1997; Richards & Casey, 1992). However, it is well established that infants increase their looking time to visual displays when presented with novel or interesting auditory stimuli than when presented with auditory stimuli that is less interesting or not novel (Horowitz, 1975).

Woodward, Markman, & Fitzsimmons, 1994). For example, Werker et al. (1998) found that 14-month-olds demonstrated word learning using a "Switch task," whereby infants are habituated to two novel word-object pairs and then presented with switched pairs. In that task, isolated words are used instead of utterances, which may be why word learning is demonstrated in that task at a younger age than it is in our task.

The fact that we used unusual novel objects (see Figure 1) and presented them on television may be another reason why we obtained results at 21 months and not before (in pilot testing). As numerous papers have by now shown (e.g., Roseberry, Hirsh-Pasek, Golinkoff, 2009; Troseth & DeLoache, 1998), young children suffer from a "video deficit" (Anderson & Pempek, 2005) and often have difficulty learning new words from televised displays. In any event, these results clearly show an advantage for IDS in children learning novel words during a period of development in which they are not yet advanced word learners.

In conclusion, this is the first study to experimentally demonstrate that IDS facilitates novel word learning in children who are already learning words. It also suggests that reliance on IDS declines with age. While prior research suggested that IDS played a role in lexical acquisition (e.g., Golinkoff & Alioto, 1995; Masur, 1981; Tomasello, 1988), the present study is the first to demonstrate an advantage for IDS in early word learning. Since other research has indicated that in cultures where IDS is minimized children still learn language (e.g., Scheiffelin & Ochs, 1983), we do not suggest that IDS is necessary for word learning. Nonetheless, it appears that early in word learning, IDS, among other perceptual enhancers such as object motion and object salience, facilitates the learning of new words.



## ACKNOWLEDGMENTS

We thank our laboratory coordinators Zeke Strober, Aimee Stahl, and Kabreea York for their assistance in conducting this study; George Hollich and Jessica Stewart for making the stimuli; and all the children and parents who participated. This research was funded by joint grants to the second and fourth authors (NSF, SBR9615391 and NIH, RO1HD050199). The third author was funded by a grant from NIH, R01DC006235. The first author was funded by grants from Chinese Natural Science Funding (NSFC 60736029), Chinese National University Basic Research Funding (ZYGX2010J137), and Sichuan Provincial Research Funding (CXSL-01002014), issued by the Sichuan Applied Psychological Research Center, Chengdu Medical University.

## REFERENCES

Akhtar, N., Jipson, J. L., & Callanan, M. A. (2001). Learning words through overhearing. *Child Development*, *72*, 416–430.

Albin, D. D., & Echols, C. H. (1996). Stressed and word-final syllables in infant-directed speech. *Infant Behavior and Development*, *19*, 401–418.

Anderson, D. R., & Pempek, T. A. (2005). Television and very young children. *The American Behavioral Scientist*, *48*, 505–522.

Andruski, J., & Kuhl, P. K. (1997, April). The acoustic structure of vowels in speech. Paper presented at the Biannual infant- and adult-directed Meeting of the Society for Research in Child Development, Washington, DC.

Bailey, T., & Plunkett, K. (2002). Phonological specificity in early words. *Cognitive Development*, *17*, 1267–1284.
Barker, B. A., & Newman, R. S. (2004). Listen to your mother! The role of talker familiarity in infant streaming. *Cognition*, *94*, B45–53.
Bernstein Ratner, N., & Luberoff, A. (1984). Cues to post-vocalic voicing in mother-child speech. *Journal of Phonetics*, *12*, 285–289.
Bloom, P. (2000). *How children learn the meaning of words*. Cambridge, MA: The MIT Press.
Brandone, A., Pence, K., Golinkoff, R. M., & Hirsh-Pasek, K. (2007). Action speaks louder than words: Young children differentially weight perceptual, social, and linguistic cues to learn verbs. *Child Development*, *78*, 1342–1343.
Church, R., Bernhardt, B., Pichora-Fuller, K., & Shi, R. (2005). Infant-directed speech: Final syllable lengthening and rate of speech. *Canadian Acoustics Journal*, *33*, 13–20.
Colombo, J., Frick, J. E., Ryther, J. S., Coldren, J. T., & Mitchell, D. W. (1995). Infants' detection of analogs of "motherese" in noise. *Merrill-Palmer Quarterly*, *41*, 104–113.
Cooper, R. P., & Aslin, R. N. (1990). Preference for infant-directed speech in the first month after birth. *Child Development*, *61*, 1584–1595.
Cooper, R. P., & Aslin, R. N. (1994). Developmental differences in infant attention to the spectral properties of infant-directed speech. *Child Development*, *65*, 1663–1677.
Fenson, L., Pethick, S., Renda, C., Cox, J. L., Dale, P. S., & Reznick, J. S. (2000). Short-form versions of the MacArthur communicative development inventories. *Applied Psycholinguistics*, *21*, 95–116.
Fernald, A. (1985). Four-month-olds prefer to listen to motherese. *Infant Behavior and Development*, *8*, 181–195.
Fernald, A. (1989). Intonation and communicative intention mothers' speech to infants: Is the melody the message? *Child Development*, *60*, 1497–1510.
Fernald, A., & Kuhl, P. (1987). Acoustic determinants of infant preference for motherese speech. *Infant Behavior and Development*, *10*, 279–293.
Fernald, A., & Mazzie, C. (1991). Prosody and focus in speech to infants and adults. *Developmental Psychology*, *27*, 209–221.
Fernald, A., & Morikawa, H. (1993). Common themes and cultural variations in Japanese and American mothers' speech to infants. *Child Development*, *64*, 637–656.
Fernald, A., & Simon, T. (1984). Expanded intonation contours in mothers' speech to newborns. *Developmental Psychology*, *20*, 104–113.
Fisher, C., & Tokura, H. (1996). Acoustic cues to grammatical structure in infant-directed speech: Cross-linguistic evidence. *Child Development*, *67*, 3192–3218.
Gogate, L. J., & Bahrick, L. E. (2001). Intersensory redundancy and 7-month-old infants' memory for arbitrary syllable-object relations. *Infancy*, *2*, 219–231.
Golinkoff, R. M., & Alioto, A. (1995). Infant-directed speech facilitates lexical learning in adults hearing Chinese: Implications for language acquisition. *Journal of Child Language*, *22*, 703–726.
Golinkoff, R. M., & Hirsh-Pasek, K. (2006). Baby wordsmith: From associationist to social sophisticate. *Current Directions in Psychological Science*, *15*, 30–33.
Golinkoff, R. M., & Hirsh-Pasek, K. (2007). Language development: The view from the radical middle [Keynote address]. In H. Caunt-Nulton, S. Kulatilake, & I. Woo (Eds.), *Proceedings of the 31st Annual Boston University Conference on Language Development* (pp. 1–25). Somerville, MA: Cascadilla Press.
Golinkoff, R. M., Hirsh-Pasek, K., Cauley, K. M., & Gordon, L. (1987). The eyes have it: Lexical and syntactic comprehension in a new paradigm. *Journal of Child Language*, *14*, 23–45.
Graf Estes, K., Evans, J. L., Alibali, M., & Saffran, J. R. (2007). Can infants map meaning to newly segmented words? Statistical segmentation and word learning. *Psychological Science*, *18*, 254–260.
Hart, B., & Risley, T. (1995). *Meaningful differences in everyday experience of young American children*. Baltimore, MD: Paul Brookes Publishing Co.
Hirsh-Pasek, K., & Golinkoff, R. M. (1996). The preferential looking paradigm reveals emerging language comprehension. In D. McDaniel, C. McKee, & H. Cairns (Eds.), *Methods for assessing children's syntax* (pp. 105–124). Cambridge, MA: MIT Press.
Hirsh-Pasek, K., Treiman, R. & Schneiderman, M. (1984) Brown & Hanlon revisited: Mothers' sensitivity to ungrammatical forms. *Journal of Child Language*, *11*, 81–89.
Hollich, G. J., Hirsh-Pasek, K., Golinkoff, R. M. (With Hennon, E., Chung, H. L., Rocroi, C., Brand, R. J., & Brown, E.). (2000). Breaking the language barrier: An emergentist coalition model for the origins of word learning. *Monographs of the Society for Research in Child Development*, *65* (3, Serial No. 262).

Horowitz, F. D. (1975). Visual attention, auditory stimulation, and language discrimination in young infants. *Monographs of the Society for Research in Child Development*, *39*(5–6), 1–140.

Houston, D. M., Stewart, J., Moberly, A., Hollich, G., & Miyamoto, R. T. (2010). *Word learning in deaf children with cochlear implants: Effects of early auditory experience*. Manuscript submitted for publication.

Houston-Price, C., Plunkett, K., & Harris, P. L. (2005). Word learning "Wizardry" at 1;6. *Journal of Child Language*, *32*, 175–189.

Imai, M., Li, L., Haryu, E., Okada, H., Hirsh-Pasek, K., Golinkoff, R. M. & Shigematsu, J. (2008). Novel noun and verb learning in Chinese-, English-, and Japanese-speaking children. *Child Development*, *79*, 979–1000.

Johnson, E. K., & Seidl, A. (2008). Clause segmentation by 6-month-old infants: A crosslinguistic perspective. *Infancy*, *13*(5), 440–455.

Jusczyk, P. W., Hirsh-Pasek, K., Kemler Nelson, D. G., Kennedy, L., Woodward, A., & Piwoz, J. (1992). Perception of acoustic correlates of major phrasal units by young infants. *Cognitive Psychology*, *24*, 252–293.

Kaplan, P. S., Jung, P. C., Ryther, J. S., & Zarlengo-Strouse, P. (1996). Infant-directed vs. adult-directed speech as a signal for faces. *Developmental Psychology*, *32*, 880–891.

Karzon, R. G. (1985). Discrimination of polysyllabic sequences by one- to four-month-old infants. *Journal of Experimental Child Psychology*, *39*, 326–342.

Kemler Nelson, D. G., 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*(1), 55–68.

Koponen, E., & Lacerda, F. (2003). Final lengthening in infant directed speech may function as a cue to phrase constituents. *PHONUM*, *9*, 9–12.

Kuhl, P. K., Andruski, J. E., Chistovich, I. A., Chistovich, L. A., Kozhevnikova, E. V., Ryskina, V. L., . . . Lacerda, F. (1997). Cross-language analysis of phonetic units in language addressed to infants. *Science*, *277*, 684–686.

Liu, H., Kuhl, P. K., & Tsao, F. (2003). An association between mothers' speech clarity and infants' speech discrimination skills. *Developmental Science*, *6*, F1–10.

Liu, H., & Tsao, F. (2008, March). *The association between maternal speech input and child language development.* Poster presented at the International Conference on Infant Studies, Vancouver, Canada.

Maguire, M. J., Hirsh-Pasek, K., Golinkoff, R. M., & Brandone, A. C. (2008). Focusing on the relation: Fewer exemplars facilitate children's initial verb learning and extension. *Developmental Science*, *11*, 628–634.

Markman, E. M. (1989). *Categorization and naming in children: Problems of induction*. Cambridge, MA: MIT Press.

Masur, E. F. (1981). Mothers' responses to infants' object-related gestures: Influences on lexical development. *Journal of Child Language*, *9*, 23–30.

McRoberts, G. W., & Best, C. T. (1997). Accommodation in mean f0 during mother-infant and father-infant vocal interactions: A longitudinal case study. *Journal of Child Language*, *24*, 719–736.

Newman, R. S., & Hussain, I. (2006). Changes in infant preference for infant-directed speech in low and moderate noise by 4.5- to 13-month-olds. *Infancy*, *10*, 61–76.

Newport, E. L., Gleitman, H., & Gleitman, L. R. (1977). Mother, I'd rather do it myself: Some effects and non-effects of maternal speech style. In C. E. Snow & C. A. Ferguson (Eds.), *Talking to children* (pp. 109–149). Cambridge, England: Cambridge University Press.

Nurmsoo, E., & Bloom, P. (2008). Preschoolers' perspective-taking in word learning: Do they blindly follow eye gaze? *Psychological Science*, *19*, 211–215.

Papousek, M., Bornstein, M. H., Nuzzo, C., Papousek, H., & Symmes, D. (1990). Infant responses to prototypical melodic contours in parental speech. *Infant Behavior and Development*, *13*, 539–545.

Papousek, M., Papousek, H., & Symmes, D. (1991). The meanings of melodies in motherese in tone and stress languages. *Infant Behavior and Development*, *14*, 415–440.

Phillips, J. R. (1973). Syntax and vocabulary of mothers' speech to young children: Age and sex comparisons. *Child Development*, *44*, 182–185.

Pruden, S. M., Hirsh-Pasek, K., Golinkoff, R., & Hennon, E. A. (2006). The birth of words: Ten-month-olds learn words through perceptual salience. *Child Development*, *77*, 266–280.

Richards, J. E. (1997). Effects of attention on infants' preference for briefly exposed visual stimuli in the paired-comparison recognition-memory paradigm. *Developmental Psychology*, *33*(1), 22–31.

Richards, J. E., & Casey, B. J. (1992). Development of sustained visual attention in the human infant. In B. A. Campbell, H. Hayne, & R. Richardson (Eds.), *Attention and information processing in infants and adults: Perspectives from human and animal research* (pp. 30–60). Hillsdale, NJ: Lawrence Erlbaum Associates.

Roseberry, S., Hirsh-Pasek, K., Parish-Morris, J., & Golinkoff, R. M. (2009). Live action: Can young children learn verbs from video? *Child Development*, *80*, 1360–1375.

Rowe, M. (2008). Child-directed speech: Relation to socioeconomic status, knowledge of child development and child vocabulary skill. *Journal of Child Language*, *35*, 185–205.

Schafer, G., & Plunkett, K. (1998). Rapid word learning by 15-month-olds under tightly controlled conditions. *Child Development*, *69*, 309–320.

Schieffelin, B. B., & Ochs, E. (1983). A cultural perspective on the transition from pre-linguistic to linguistic communication. In R. M. Golinkoff (Ed.), *The transition from pre-linguistic to linguistic communication* (pp.115–131). Hillsdale, NJ: Lawrence Erlbaum Associates.

Seidl, A. (2007). Infants' use and weighting of prosodic cues in clause segmentation. *Journal of Memory and Language*, *57*(1), 24–48.

Seidl, A., & Cristià, A. (2008). Developmental changes in the weighting of prosodic cues. *Developmental Science*, *11*(4), 596–606.

Shady, M., & Gerken, L. (1999). Grammatical and caregiver cues in early sentence comprehension. *Journal of Child Language*, *26*, 163–175.

Singh, L., Nestor, S., Parikh, C., & Yull, A. (2009). Influences of infant-directed speech on early word recognition. *Infancy*, *14*, 654–666.

Smith, L. B. (2000). Avoiding association when it's behaviorism you really hate. In R. M. Golinkoff & K. Hirsh-Pasek (Eds.), *Breaking the word learning barrier* (pp. 169–174). Oxford, England: Oxford University Press.

Snow, C. E. (1977). Mothers' speech research: From input to interaction. In C. E. Snow & C. A. Ferguson (Eds.), *Talking to children: Language input and acquisition*. Cambridge, England: Cambridge University Press.

Soderstrom, M. (2007). Beyond babytalk: Re-evaluating the nature and content of speech input to preverbal infants. *Developmental Review*, *27*, 501–532.

Soderstrom, M., Blossom, M., Foygel, I., & Morgan, J. L. (2008). Acoustical cues and grammatical units in speech to two preverbal infants. *Journal of Child Language*, *35*, 869–902.

Sullivan, J. W., & Horowitz, F. D. (1983). The effects of intonation on infant attention: The role of rising contour. *Journal of Child Language*, *10*, 521–534.

Tabors, P., Roach, K., & Snow, C. (2001). Home language and literacy environment: Final results. In D. Dickinson, & P. Tabors (Eds.), *Beginning literacy with language: Young children learning at home and school* (pp. 111–138). Baltimore, MD: Paul H. Brookes Publishing.

Thiessen, E. D., Hill, E. A., & Saffran, J. R. (2005). Infant-directed speech facilitates word segmentation. *Infancy*, *7*, 53–71.

Tomasello, M. (1988). The role of joint attentional process in early language development. *Language Sciences*, *10*, 69–88.

Trainor, L. J., & Desjardins, R. N. (2002). Pitch characteristics of infant-directed speech affect infants' ability to discriminate vowels. *Psychonomic Bulletin and Review*, *9*, 335–340.

Troseth, G. L., & DeLoache, J. S. (1998). The medium can obscure the message: Young children's understanding of video. *Child Development*, *69*, 950–965.

van de Weijer, J. (1997). Language input to a prelingual infant. In A. Sorace, C. Heycock, & R. Shillcock (Eds.), *Proceedings of the GALA 97 Conference on Language Acquisition* (pp. 290–293). Edinburgh, Scotland.

Werker, J. F., Cohen, L. B., Lloyd, V. L., Casasola, M., & Stager, C. L. (1998). Acquisition of word-object associations by 14-month old infants. *Developmental Psychology, 34*, 1289–1309.

Werker, J. F., Pegg, J. E., & McLeod, P. (1994). A cross-language comparison of infant preference for infant-directed speech: English and Cantonese. *Infant Behavior and Development*, *17*, 321–331.

Werker, J. F., Pons, F., Dietrich, C., Kajikawa, S., Fias, L., & Shigeaki, A. (2007). Infant-directed speech supports phonetic category learning in English and Japanese. *Cognition*, *103*, 147–162.

Woodward, A. L., Markman, E. M., & Fitzsimmons, C. M. (1994). Rapid word learning in 13 and 18-month-olds. *Developmental Psychology*, *30*, 553–566.

Zangl, R., & Mills, D. (2007). Increased brain activity to infant-directed speech in 6- and 13-month-old infants. *Infancy*, *11*, 31–62.