Infancy, *14*(2), 162–194, 2009

ISSN: 1525-0008 print / 1532-7078 online
DOI: 10.1080/15250000802707062

Psychology Press
Taylor & Francis Group

The Role of Verbal Repetition in the Development of Infant Speech Preferences From 4 to 14 Months of Age

Gerald W. McRoberts
Haskins Laboratories
New Haven, CT

Colleen McDonough
Department of Psychology
Neumann College

Laura Lakusta
Department of Psychology
Montclair State University

Four experiments investigated infants' preferences for age-appropriate and age-inappropriate infant-directed speech (IDS) over adult-directed speech (ADS). Two initial experiments showed that 6-, 10-, and 14-month-olds preferred IDS directed toward younger infants, and 4-, 8-, 10-, and 14-month-olds, but not 6-month-olds, preferred IDS directed toward older infants. In Experiment 3, 6-month-olds preferred IDS directed toward older infants when the frequency of repeated utterances matched IDS to younger infants. In Experiment 4, 6-month-olds preferred repeated IDS utterances over the same IDS utterances organized without repetition. Attention to repeated utterances precedes word segmentation and sensitivity to statistical cues in continuous speech, and might play a role in the discovery of these and other aspects of linguistic structure.

Infants' preference to listen to infant-directed speech (IDS) over adult-directed speech (ADS) has been the focus of numerous studies. These studies have consis-

Correspondence should be addressed to Gerald W. McRoberts, Haskins Laboratories, 300 George Street, New Haven, CT 06511. E-mail: mcroberts@haskins.yale.edu

tently shown that young infants (e.g., up to about 6 months of age) demonstrate a preference for IDS, either by choosing it more often (Fernald, 1985) or listening to it longer than ADS (e.g., Cooper & Aslin, 1994; Pegg, Werker, & McLeod, 1992; Werker & McLeod, 1989). However, the question of whether infants continue to prefer IDS after the middle of the first year has received less attention and results have been contradictory. There are reports of IDS preferences at 8 months (Werker & McLeod, 1989), 9 months (Glenn & Cunningham, 1983; Werker, Pegg, & McLeod, 1994), and 21 months (Glenn & Cunningham, 1983), but there are also reports of failures to find IDS preferences between 7 and 13 months (Hayashi, Tamekawa, & Kiritani, 2001; Newman & Hussain, 2006). One potential explanation for this conflicting pattern of results involves the particular IDS stimuli used in these studies. In general, researchers have tended to treat all IDS as equal. Thus, some studies of older infants used IDS stimuli that were directed to infants of the same age as the infants being tested, whereas other studies used IDS directed to infants who were notably younger or older than the infants being studied. Still other studies have used non-IDS utterances spoken with IDS-like prosody. However, this undifferentiated approach ignores the fact that IDS changes over the course of the first 2 years as infants' cognitive and linguistic skills improve. For example, IDS to infants who are beginning to talk and understand some words (e.g., 12 to 14 months) differs in important ways from IDS to younger infants who are not yet demonstrating these linguistic abilities (e.g., 4 to 6 months). IDS directed toward older infants is less redundant, has an increased type/token ratio, and contains utterances that are both longer and more structurally complex (e.g., Broen, 1972; Snow, 1972). As a result, IDS to infants at one age might not be optimal for infants at other ages. This raises the question of whether infants treat all IDS as equal, or whether they only have a preference for IDS that is directed to their age or developmental peers. This study addresses these questions by testing both older and younger infants for IDS preferences using speech directed to both younger and older infants.

YOUNG INFANTS' PREFERENCES FOR IDS

Studies of IDS preferences have taken different approaches to stimulus generation. Some studies used actual audio clips of mothers interacting with their infants (natural IDS) or an adult (natural ADS). Other studies took mothers' natural speech and modified it in some way such as low-pass filtering (modified IDS or modified ADS). In other studies, a nonmother (typically a female research assistant) was recorded while reciting passages in IDS or ADS prosody (simulated IDS or simulated ADS). Typically, stimuli were audio only, although a few studies used audiovisual stimuli, in which infants could both see and hear the person speaking. Although some of the audiovisual studies are included here, there are potential

problems with generalization, as previous studies suggest that intersensory redundancy (such as that provided by the combined audio and visual information) might scaffold learning in infancy (e.g., Bahrick & Lickliter, 2000). Further, facial expressions could differ across IDS and ADS, potentially influencing infants' attention.

The first demonstration of a listening preference for IDS over ADS in young infants was reported by Fernald (1985). In that study, 4-month-old infants were tested using a head-turn preference procedure on natural IDS directed to 4-month-old infants versus natural ADS. Cooper and Aslin (1990) adapted an infant-controlled procedure (e.g., Columbo & Bundy, 1981; Miller, 1983), and found that neonates (2 days old) and 1-month-old infants preferred simulated IDS over simulated ADS. Finally, two recent studies provide additional evidence that young infants show a preference for IDS. Hayashi et al. (2001) reported that infants between 4 and 6 months of age had a preference for natural IDS over natural ADS, and Newman and Hussain (2006) found that 4.5-month-old infants preferred simulated speech with IDS prosodic characteristics over simulated speech with ADS prosodic style. However, neither Hayashi et al. (2001) nor Newman and Hussain (2006) used IDS stimuli that were explicitly intended for young infants. In Hayashi et al. (2001), the IDS stimuli were excerpts from a mother interacting with her 11-month-old. Newman and Hussain (2006) used IDS stimuli that consisted of passages from a story that were read in IDS and ADS prosodic styles.

Werker and her colleagues (Pegg et al., 1992; Werker & McLeod, 1989; Werker et al., 1994) studied infants' preferences using simulated audiovisual presentations of IDS and ADS. Werker and McLeod (1989) reported a preference by 4.5- to 5.5-month-old infants for (audiovisual) IDS from speakers of both genders. In a later study using the same stimuli (Pegg et al., 1992), 7-week-old infants also preferred the IDS audio-video stimuli over the ADS stimuli. Werker et al. (1994) presented natural audio-video clips of a female Cantonese speaker interacting with her 4-month-old and with an adult, and found that both Cantonese- and English-learning 4.5-month-old infants listened longer to the IDS stimuli. Although these studies are consistent with other results showing that young infants prefer IDS, they cannot be considered conclusive because potential differences in dynamic facial information in the IDS and ADS videos (e.g., smiling, eye widening) could have influenced infants' attention.

Several studies have addressed the basis of young infants' attention to IDS. Fernald and Kuhl (1987) tested infants on sine-wave analogs of IDS and ADS intonation contours, amplitude contours, and temporal patterns. They concluded that the pitch modulation, especially the expanded intonation contours of IDS, was responsible for infants' attentional responses to IDS. On the other hand, Cooper (1993) reported that although very young infants preferred natural IDS over ADS, they did not have a preference when both were low-pass filtered to approximate the sine-wave analogs used by Fernald and Kuhl (1987). Cooper suggested that the full

spectral range of acoustic energy was necessary for very young infants to show a preference, but that by 4 months the intonation contour alone might be sufficient. More recently, Kitamura and Burnham (1998) and Singh, Morgan, and Best (2002) challenged the assumption that the pitch modifications of IDS are what underlie infants' preferences. These studies reported that 6-month-old infants do not show a preference for natural (Kitamura & Burnham, 1998) or simulated (Singh et al., 2002) IDS over ADS when the two speech styles are equated for affective quality. Indeed, infants preferred ADS with positive affect over IDS, even when the IDS had higher F_0 and wider F_0 range than the ADS (Singh et al., 2002). This result led the authors to conclude that 6-month-old infants' preferences were based on the affective quality of speech, although in natural speech the prosodic characteristics of IDS (higher F_0, wider F_0 range, etc.) are likely to be highly correlated with the expression of positive affect.

In summary, infants from 2 days to about 6 months have consistently shown a listening preference for natural and simulated IDS over ADS. Sometimes the IDS stimuli were specifically addressed to young infants, and sometimes they were not. Despite this variation in stimulus preparation, young infants showed a preference for IDS in nearly every study. The basis for young infants' preference for IDS appears to be related to the expression of positive affect, especially in the form of IDS prosodic patterns. However, some results suggest that the basis of the IDS preference might change over the first half-year of life (i.e., Cooper, 1993).

INVESTIGATIONS OF OLDER INFANTS' SPEECH PREFERENCES

Investigations of older infants' preference for IDS have been both less common and less conclusive than studies of younger infants' preferences. Two early studies showed that older infants preferred highly inflected speech over other auditory signals including instrumental music, but did not test IDS versus ADS per se (Friedlander, 1968; Glenn, Cunningham, & Joyce, 1981). The first direct evidence of an IDS preference in older infants was reported by Glenn and Cunningham (1983), who showed that both infants with Down syndrome (12 and 24 months of age) and typically developing infants (9 and 21 months of age) preferred their own mother's IDS over ADS. Although suggestive of a preference for IDS in older infants, the use of IDS and ADS from the infants' own mothers opens the possibility that familiarity with the maternal voice could have played a role in their findings. The studies by Werker and her colleagues (described earlier) also found IDS preferences by 8-month-old (Werker & McLeod, 1989) and 9-month-old infants (Werker et al., 1994), but there are potential issues with the generalizations from the audiovisual stimuli.

Two recent studies cast doubt on the conclusion that infants continue to prefer IDS after 6 months of age. Hayashi et al. (2001) studied Japanese-learning infants' preference for Japanese IDS versus ADS in two experiments. The results of a small longitudinal study and a cross-sectional follow-up study demonstrated a U-shaped function, in which infants preferred IDS over ADS at both younger (4–6 months) and older ages (10–14 months), but had no preference at intermediate ages (7–9 months). Newman and Hussain (2006) reported that 4.5-month-olds prefer simulated IDS over ADS, but 9- and 13-month-olds do not. The results of these two studies stand in contrast to previous studies showing IDS preferences in older infants. Although their results are not in complete agreement about infants' preferences after 10 months, at a minimum they suggest that infants older than 6 months do not always show an IDS preference. The question of whether older infants have a preference for IDS remains unresolved.

Given the consistent findings that younger infants typically prefer listening to IDS over ADS, why wouldn't older infants also show a preference? Hayashi et al. (2001) suggested that infant preferences for IDS develop through three stages. They suggested that infants' preferences for IDS are initially based on an "innate emotional attachment to the melodic and rhythmic qualities of maternal speech" (Hayashi et al., 2001, p. 1196). This is similar to Fernald's (1992) idea that the acoustic properties of IDS are a "prepotent stimulus" (p. 20) that serves to elicit and maintain attention, as well as to engage the infant emotionally. It would also seem consistent with the conclusions of Kitamura and Burnham (1998) and Singh et al. (2002) that by 6 months of age, infants' IDS preferences are driven by positive affect. Hayashi et al. (2001) posited a second stage of preference for IDS at intermediate ages, during which infants' emotional attachment to IDS decreases, resulting in a decline in preference. Finally, in a third stage, the preference returns because of developments in infants' speech perception abilities, such as sensitivity to native language phonetic contrasts, phonotactic and rhythmic patterns, and segmentation of words from continuous speech. Echoing Hayashi et al.'s idea that older infants' speech preferences might be driven by their linguistic development, Newman and Hussain (2006) suggested that by the time infants are segmenting the speech stream and acquiring vocabulary they "may attend more to content than to prosody" (p. 72). If this is the case, they noted, then older infants might have a preference for some types of IDS, but not necessarily the same types of IDS that younger infants prefer.

AGE-RELATED CHANGES IN IDS AND INFANT DEVELOPMENT

Hayashi et al. (2001), and to some degree Newman and Hussain (2006), focused on developmental changes in infants' cognitive and linguistic abilities as the deter-

mining factor in whether they will have a preference for IDS or not. Thus, Hayashi et al. (2001) suggested that infants' responses to IDS shift from an affective basis for younger infants to a linguistic basis by 10 months. However, they failed to take into account the fact that IDS changes in important ways over the course of the first 2 years of life. It should come as no surprise that the speech directed to older infants is not the same as the speech directed to younger infants. Just as the prosodic, linguistic, and discourse structure of IDS differs from ADS, speech to younger infants and older infants, toddlers, and young children differs along these same dimensions as IDS slowly merges with ADS. For example, Stern, Spieker, Barnett, and MacKain (1983) reported that prosodic modifications of F_0 and pause durations are greater in speech to newborns and 4-month-olds than in speech to infants at 12 or 24 months. Garnica's (1977) seminal work on child-directed speech suggested that the prosody of speech to toddlers (22–30 months) differed from that to adults, but the prosody of speech to young children (61–68 months) was essentially the same as that to adults. Similarly, studies of redundancy in IDS show that verbal repetition (e.g., repeated utterances) in IDS is at its peak at around 4 to 6 months (e.g., Fernald & Morikawa, 1993; Stern et al., 1983), and declines to approximately adult levels by 24 months of age (e.g., Kaye, 1980; Snow, 1972). In contrast, utterance length (e.g., the number of words per utterance) and mean length of utterance (MLU, the number of morphemes per utterance) in maternal speech increases over the second year (Stern et al., 1983). Speech to young infants typically contains fewer than 3 words per utterance (Kaye, 1980; Papousek, Papousek, & Haekel, 1987), whereas speech to 24- to 30-month olds-contains between 3.7 and 5.0 words per utterance (e.g., Kaye, 1980; Newport, Gleitman, & Gleitman, 1977; Snow, 1972). Thus, IDS to young infants is maximally different from ADS in terms of prosodic modifications, MLU, utterance length, and redundancy, but becomes more adult-like during the second year. These changes in IDS likely reflect the fact that communication between mothers and infants in the second year of life is increasingly based on the linguistic content of speech.[1]

In view of the evidence of adjustments in maternal IDS as infants become more cognitively and linguistically competent, we find it implausible that infants would fail to attend preferentially to IDS directed to their age or developmental cohort over ADS. We assume that infant speech preferences will occur where the intersection of infants' developing perceptual, cognitive, and linguistic abilities and the structure of the IDS stimuli optimally engage and sustain infants' attention. Furthermore, we note that the second half-year of life is a period in which infants' linguistic abilities are showing rapid development. Relevant examples are evidence that the ability to segment words from continuous speech appears to emerge be-

[1]This is not to say that the prosodic and affective components of IDS are no longer important, but rather that they might be becoming secondary to the linguistic message as infants' language abilities become more sophisticated.

tween 6 and 7.5 months of age (e.g., Jusczyk & Aslin, 1995), and sensitivity to statistical regularities in prosodically unmarked speech emerge between 6.5 and 8 months (Saffran, Aslin, & Newport, 1996; Thiessen, Hill, & Saffran, 2005). However, to the degree that the changes in the structure of IDS are related to infant development, speech directed to infants at one age might not be optimal for sustaining infants' attention at another age. This suggests that failures to find IDS preferences (e.g., Hayashi et al., 2001; Newman & Hussain, 2006) might be related to mismatches between infants' developing capabilities and the structure of the IDS stimuli.

One kind of mismatch between IDS stimuli and infants' capabilities can occur when speech that was not intended for infants is used as an IDS stimulus. An example of this is seen in the study by Newman and Hussain (2006). Although the simulated IDS stimuli used in this study were spoken with IDS-like prosody, the linguistic characteristics of the utterances differed from typical speech to infants in several ways. First, the passages consisted of sentences averaging 15.4 syllables (12.4 words) per utterance, much longer than speech typically directed toward infants (e.g., Kaye, 1980). Second, the speech rate of the stimuli was adjusted to equate the duration of the IDS and ADS samples. As a result, the IDS was spoken faster than typical IDS, whereas the ADS was spoken slower than normal ADS. Finally, although IDS commonly contains repeated utterances, these stimuli contained no repeated utterances. Thus, the linguistic characteristics of Newman and Hussain's (2006) IDS stimuli were more like ADS than typical IDS. The fact that the 4.5-month-olds in this study showed a preference is consistent with previous work showing that the attention of infants this age is engaged by the prosodic and affective aspects of IDS. Evidence suggests that by 10 months or so, infants are actively engaged in segmenting speech and acquiring words. If this is a major focus of their attention to speech at this age, the lack of a preference by infants between 9 and 13 months of age could be due to the fact that the linguistic structure of the IDS stimuli was too complex for their emerging capabilities. Thus, there was a mismatch between the abilities of these older infants and the IDS stimuli.

Just as the complexity of ADS is a mismatch with older infants' capabilities, IDS directed to older, more linguistically competent infants is more complex than IDS to younger infants, and might result in a mismatch. An example of this can be seen in the study by Hayashi et al. (2001), who described their IDS stimuli as excerpts from a mother interacting with her 11-month-old infant. Two of their groups of infants, one 4 to 6 months old and one 10 to 14 months of age, had a preference for this natural IDS, but a group of 7- to 9-month-old infants did not. Because the stimuli were natural IDS directed to an 11-month-old infant, the properties typical of IDS to infants around the end of their first year were present, thus accounting for the preference by the 10- to 14-month-olds. Furthermore, based on studies suggesting that the prosodic and affective components of IDS underlie the preferences of younger infants (e.g., Fernald & Kuhl, 1987; Kitamura & Burnham, 1998;

Singh et al., 2002), it seems reasonable to assume that these characteristics were present in sufficient form to attract and maintain the attention of their youngest group of infants.

The failure of the 7- to 9-month-old group to show a preference suggests two things. First, prosody is not enough to elicit the attention of older infants, further confirming earlier reports (e.g., Kitamura & Burnham, 1998; Singh et al., 2002). Second, the IDS stimuli (directed toward an 11-month-old) lacks some critical property necessary to sustain sufficient attention in 7- to 9-month-olds, but not necessary for the older 10- to 14-month-olds. The question is this: What aspect of IDS changes over the course of the second half of the first year that might be especially salient to infants in the early part of that period, but not critical to 10- to 14-month-olds? One possibility is the amount of verbal repetition in the form of exactly repeated utterances. Several studies show that the presence of repeated utterances in IDS reaches a maximum at around 4 to 6 months of age and declines to adult levels (i.e., essentially none) by 24 months (Fernald & Morikawa, 1993; Kaye, 1980; Snow, 1972; Stern et al., 1983). Infants between 7 and 9 months of age are beginning to attend to the linguistic structure in speech, as shown by their ability to segment familiarized words (Jusczyk & Aslin, 1995) and demonstrate sensitivity to cooccurrence probabilities in speech (Saffran et al., 1996). During this critical transition into language, repeated utterances can act as an important scaffold, providing an opportunity to perceptually explore the transient speech signal. Therefore, it would not be surprising if infants' attention and interest in speech that contains repetition is at a maximum during this transition, but that infants even a few months older no longer need this support.

In summary, the preference to listen to IDS over ADS has been well established for young infants. However, results for older infants have been inconsistent. We hypothesize that infants should have a preference for IDS that is directed to infants of roughly the same age or level of cognitive and language development, but that speech to more linguistically sophisticated infants might not be optimal for less advanced infants, especially during the transition into lexical segmentation around 6 to 8 months of age. Experiment 1 was designed to address this hypothesis by testing infants at 6, 10, and 14 months on natural IDS directed to both younger infants (4–6 months) and older infants (12–14 months) versus natural ADS by the same speakers.

EXPERIMENT 1

Some studies have failed to find a preference for IDS by older infants. We hypothesized that these results could be due to the use of IDS that was not directed to the age cohort tested, and therefore was not optimal to engage their attention. To test our hypothesis, we assessed the preferences of infants at 6, 10, and 14 months with

IDS addressed to younger infants (4–6 months) and IDS addressed to older infants (12–14 months). For each age cohort we tested two groups of infants. One group was tested with IDS directed to young infants compared to ADS from the same speakers, and one group was tested with IDS directed to older infants and ADS from the same speakers.

We predicted that the older and younger infants would have a preference for IDS addressed to their age peers. Thus, we predicted that 6-month-olds would have a preference for IDS to 4- to 6-month-olds, and 14-month-olds would prefer IDS to 12- to 14-month-olds. We further expected IDS to young infants to be engaging to infants of all ages because of its tendency to have reduced complexity (e.g., shorter utterance length and lower MLU), increased redundancy, higher F_0, and wider F_0 range. Therefore, we also predicted that infants at all three ages would have a preference for IDS to younger infants. Finally, our analysis of studies that have reported failures to find IDS preferences led us to hypothesize that speech that is directed to an older or more advanced cohort might not be optimal for engaging infants at some younger ages. This suggests that IDS directed to older infants (12–14 months) in this experiment might not be optimal for either 6- or 10-month-olds. Therefore, we predicted that infants at these two ages might not have a preference for the IDS to older infants.

Method

Participants. The participants for this experiment were 144 infants, 48 at each of three ages: 6 months (M = 189.4 days), 10 months (M = 309.7 days), and 14 months (M = 440.2 days). At each age, half of the infants were male. An additional 42 infants participated, but were dropped from the final analysis due to fussiness or inattentiveness (n = 30), experimenter error or equipment failure (n = 8), or interference by the parent (n = 4).

Stimuli. The IDS stimuli were excerpts from natural recordings of three mothers interacting with their 4- to 6-month-old infants (younger IDS, or YIDS) and three mothers interacting with their 12- to 14-month-old infants (older IDS, or OIDS). The ADS stimuli were natural samples of the same mothers talking with a female research assistant (i.e., YADS and OADS, respectively). The recording sessions lasted between 20 and 30 min and were made in a sound-isolated room. The mothers were encouraged to play with their infants as they normally would at home. The younger infants were in a bouncy seat on a table and their mothers were seated or stood facing them. The older infants were mobile, so their mothers were seated on the floor. Both sets of mothers interacted with their infants with familiar toys brought from home. During recording, the mothers wore a unidirectional, wireless, head-mounted microphone (Optimus 33-0312) that transmitted to an

audiocassette recorder (Denon DRM-740). The recordings were digitized at 44 Khz and 16 bits of resolution and saved on a Macintosh G3 computer.

Selection of stimulus utterances involved eliminating utterances that contained both participants vocalizing simultaneously, crying or fussing, breathing noises, or other extraneous noises. From the remaining utterances, selection was based on overall quality of the recordings, and the presence of intonationally complete phrase groups. Whenever possible, multiple contiguous utterances were selected. IDS and ADS utterances from each mother then were arranged into four groups (two IDS, two ADS) of approximately 17 sec duration, with 750 msec between utterances. This resulted in six sets (3 speakers × 2 groups) of IDS utterances and six groups of ADS utterances for mothers of both older and younger infants. These sets of utterances became the trials for the two preference tests.

Acoustic analysis of the stimulus utterances was performed using the pitch extraction routines in Praat (Boersma, 2001). Each utterance within each sound file (trial) was analyzed for F_0 maximum, minimum, mean, and range, and averaged across utterances for each speaker in each IDS and ADS condition (see Table 1). These analyses demonstrated that both the YIDS and OIDS had the typical prosodic characteristics of IDS (e.g., Fernald et al., 1989), with significantly higher mean minimum F_0, mean maximum F_0, overall mean F_0, and F_0 range than their respective ADS samples ($p <$ .05 in all cases; see Table 1). Also, consistent with existing literature on prosodic changes in IDS with infant age (e.g., Stern et al. 1983), the F_0 characteristics of the YIDS were more extreme than the OIDS, although these differences were not significant. Analysis of the prosodic characteristics of the ADS samples showed that they were very similar in mean F_0 and mean minimum F_0. However, the mean maximum F_0 and mean F_0 range of the OADS sample were about 100 Hz higher than the YADS sample ($p < .05$; see Table 1), reflecting differences between mothers' voices used for the YIDS/YADS and OIDS/OADS speech samples. However, prosodic characteristics of the OIDS clearly differentiated it from the OADS.

TABLE 1
Prosodic Characteristics of Speech Stimuli in Experiments 1 Through 3

Addressee	*M* F_0[a]	*M Max* F_0	*M Min* F_0	*M* F_0 *Range*	*Duration*[b]
Younger Infants					
YID speech	371.3*	526.0*	251.5*	274.5*	17.1
YAD speech	178.5	275.3	142.0	133.3	17.2
Older infants					
OID speech	299.9*	484.2*	221.0*	263.2*	18.2
OAD speech	196.3	383.8**	141.3	242.5**	17.9

Note. YID = younger infant directed; YAD = younger adult directed; OID = older infant directed; OAD = older adult directed.

[a]In Hz. [b]Trial duration in seconds.

*Differs from related ADS value, $p < .05$. **Differs from related YADS value, $p < .05$.

Measures of utterance complexity and redundancy are shown in Table 2 for each speech style. Measures of complexity include the mean type/token ratio (the number of differently spelled words divided by the total number of words), MLU, and the mean number of words per utterance. Measures of redundancy are the percentage of exactly and partially repeated utterances, and the percentage of total verbal repetition (e.g., Kaye, 1980; Snow, 1972). Except for partial repetition in the OIDS/OADS, IDS samples differ on each measure from their respective ADS samples ($p < .05$), demonstrating overall greater complexity and less redundancy in the YADS and OADS stimuli than in the YIDS or OIDS stimuli (see Table 2). IDS to younger and older infants is similar on all of these measures except verbal repetition. Consistent with previous reports (Fernald & Morikawa, 1993; Stern et al., 1983) that verbal repetition is greater to infants at around 4 to 6 months than to older infants, mean exact and total repetition were greater for YIDS stimuli than for the OIDS stimuli (17.4 vs. 12.4 and 42.0 vs. 33.8, respectively), but the differences were not statistically significant.

Design. At each age, half the infants, including equal numbers of boys and girls, were tested on the YIDS/YADS stimuli and half were tested on the OIDS/OADS stimuli. Each infant was presented with 12 trials, 6 IDS and 6 ADS. Trials alternated between IDS and ADS. Trial order was counterbalanced, with half the infants at each age and in each IDS condition beginning on an IDS trial and half beginning on an ADS trial.

Apparatus. Testing was conducted in a sound-isolated laboratory room that was acoustically isolated from an adjoining control room. The infant testing booth

TABLE 2
Linguistic and Discourse Characteristics of Speech Stimuli in Experiments 1 Through 3

	Repetition					
Addressee	*Exact*	*Partial*	*Total*	*TT/Ratio*[a]	*MLU*[b]	*Length*[c]
Younger infants						
YID speech	17.4%**	24.6%*	42.0%*	0.40	4.5*	4.1*
YAD speech	0.0%	13.6%	13.6%	0.51	7.8	7.3
Older infants						
OID speech	12.4%*	21.4%	33.8%**	0.39	4.2*	3.9*
OAD speech	0.0%	16.3%	16.3%	0.47	6.9	6.7

Note. YID = younger infant directed; YAD = younger adult directed; OID = older infant directed; OAD = older adult directed.

[a]Type/token ratio across all utterances in each speech sample.[b]Mean number of morphemes per utterance. [c]Mean words per utterance.

*Differs from related ADS, $p < .05$. **Differs from related ADS, $p < .01$.

consisted of black felt-covered walls measuring approximately 1.5 × 2 m on two sides and the front. The top half of the front panel consisted of clear Plexiglas that was covered with black felt except for a 0.3 × 0.3 m opening to allow viewing of a computer monitor. The bottom half of the front panel consisted of pegboard, which was covered with black felt. The inside of the booth was lit from above with two 15-watt incandescent light bulbs with red filters to reduce the illumination level. The fourth side of the booth was open.

A computer monitor (Sony 200SF) was mounted on a shelf behind the center of the front panel. A video camera (Sony TRV37) was focused on the infant's face through an aperture in the front panel. A single audio speaker (Optimus Pro X7) sat on the floor behind the pegboard portion of the front panel, directly below the computer monitor and video camera. Audio output from the computer was routed through a small audio amplifier (Radio Shack SA150) to the speaker. The camera was connected to a video recorder (Sony SLV-R1000) and monitor (Panasonic CT2084) in the control room, where the observer monitored the infant's eye movements and the test session was recorded.

Procedure. The parent and infant were escorted to the testing room for a 10-min acclimation period. The procedure was described to the parent and consent was obtained. The infant was then seated on the parent's lap in the open end of the testing booth, facing the computer monitor. Parents wore headphones through which music was played to provide competing auditory stimulation to keep the parents, as much as possible, from having knowledge about which type of stimulus was being presented on any given trial.

Specially designed software recorded observer key presses, controlled the onset and offset of trials, and controlled sound presentation (Pinto, 1994). At the beginning of each trial, a checkerboard appeared on the computer monitor and flashed to engage the infant's attention. When the infant fixated the checkerboard, the observer pressed a "looking" key on a computer keyboard that signaled the computer to stop the checkerboard flashing, begin playing the speech stimulus for the first trial, and begin accumulating looking time. As long as the infant maintained fixation on the checkerboard, the observer continued to press the looking key. When the infant looked away from the checkerboard, the observer released the looking key and the computer stopped accumulating looking time. If the observer pressed the looking key again within 1 sec, indicating that the infant had returned fixation to the checkerboard, the trial continued and additional looking time was accumulated. If the infant failed to return gaze to the checkerboard within 1 sec, the trial ended, the sound stopped, and the checkerboard disappeared. If infants continued to look without a greater than 1-sec look away, trials automatically terminated when the sound file had played twice (trials were capped at approximately 34 sec). After a 3-sec intertrial interval, the checkerboard reappeared and flashed to signal the beginning of a new trial. The procedure continued for 12 trials, or until the in-

fant became fussy. Infants who failed to complete all 12 trials were not included in the analysis.

Offline reliability and error coding. All sessions were video-recorded. Approximately 10% of the sessions were recoded offline in slow motion (frame by frame) for two types of observer errors: (a) *extension errors,* in which the online observer failed to terminate a trial when the infant looked away for more than 1.1 sec; and (b) *termination errors,* in which the online observer terminated a trial when the infant had not looked away for more than 1.1 sec. The error rate of the online observers was between 10% and 15% across the four experiments. More important, however, the distribution of errors did not differ between trial types, indicating no observer bias (see Pinto, Fernald, McRoberts, & Cole, 1998). Data from all trials and sessions, including those with the two types of errors, were included in the final analysis. Because only a subset of sessions were coded for errors, removing those trials with errors would be inappropriate without offline coding of all of the sessions. The point of the offline coding analysis was simply to determine whether there was observer bias, which there was not.

Results

Looking times were entered into a 3 (age) × 2 (age of addressee) × 2 (speech type) analysis of variance (ANOVA), with speech type treated as a repeated measure. This analysis revealed a significant main effect for speech type (IDS vs. ADS), $F(1, 129) = 57.487$, $p = .0001$ ($\eta^2 = .31$[2]), indicating longer looking time for IDS than for ADS overall. There was also a significant Age × Age of Addressee× Speech Type interaction, $F(2, 129) = 3.71$, $p = .0275$ ($\eta^2 = .06$). See Figure 1.

To clarify interpretation of the significant three-way interaction, two-way ANOVAs (Age × Speech Type, with speech type treated as a repeated measure) were performed separately on looking times to the YIDS/YADS and OIDS/OADS stimuli. For the YIDS/YADS stimuli, the analysis indicated that only the main effect of speech type was significant, $F(1, 69) = 47.76$, $p = .0001$ ($\eta^2 = .335$). The Age × Speech Type interaction was not significant, $F(2, 69) = 1.18$, $p = .314$. Effect sizes were computed using Cohen's *d* statistic (Cohen, 1988). At 6 months, $d = .70$ (a medium to large effect), at 10 months, $d = .39$ (a small to medium effect), and at 14 months, $d = 1.11$ (a large effect).

[2]Effect sizes for factors and interactions in ANOVAs were computed using the eta squared (η^2) statistic. Cohen (1988) suggests that η^2 values of .02 reflect small effects, .13 reflect medium effects, and .21 are large effects. Effect sizes for IDS–ADS looking and listening times were computed using *d.* For the *d* statistic, Cohen (1988) suggested values of .2, .5, and .8 for small, medium, and large effects, respectively.

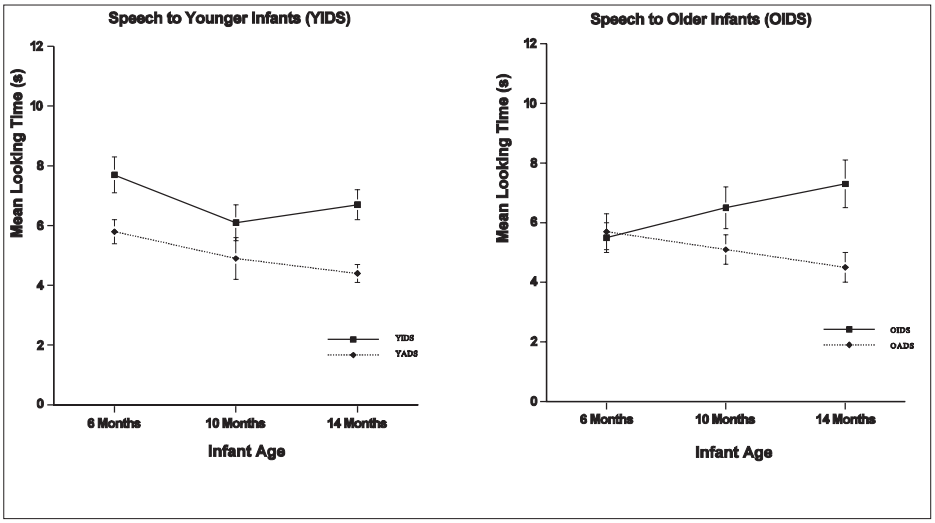

FIGURE 1 Mean looking times for 6-, 10-, and 14-month-old infants for younger infant-directed speech (YIDS) and adult-directed speech (YADS; left), and older infant-directed speech (OIDS) and OADS (right).

For the OIDS/OADS stimuli, the analysis indicated a main effect of speech type, $F(1, 69) = 18.188$, $p = .0001$ ($\eta^2 = .177$). However, there was also a significant Age × Speech Type interaction, $F(2, 69) = 7.445$, $p = .001$ ($\eta^2 = .145$). Separate repeated measures ANOVAs on the looking times at each age indicated significantly higher looking and listening times for the OIDS by both 10-month-olds, $F(1, 23) = 5.007$, $p = .035$ ($d = .50$, a medium effect), and 14-month-olds, $F(1, 23) = 26.874$, $p = .0001$ ($d = .83$, a large effect). However, at 6 months, there was no difference between looking and listening to the OIDS and OADS, $F(1, 23) = .181$, $p = .674$ ($d = –0.07$, a near zero effect).

Discussion

The goals of this experiment were twofold. First, we wanted to investigate reports in the literature that infants older than 6 months failed to show a preference for IDS. We predicted that both 6- and 14-month-old infants would have a preference for IDS directed to their age peers. Indeed, infants at both 6 and 14 months of age had a significant preference for IDS over ADS when the IDS was directed to their age peers. Furthermore, our 10-month-olds also had a significant preference for the IDS to older infants. This is consistent with the report by Hayashi et al. (2001) that 10- to 14-month-olds preferred IDS directed to an 11-month-old. The preference of younger infants for IDS directed to younger infants is consistent with the

results of several previous studies (e.g., Cooper, 1993; Cooper & Aslin, 1990; Fernald, 1985), and thus comes as no surprise. However, the preference by 10- and 14-month-olds for IDS directed to older infants helps to clarify mixed results in the literature regarding older infants' IDS preferences. This result is consistent with earlier results reported by Glenn and Cunningham (1983), in which both typically developing 9- and 21-month-old infants and 12- and 24-month-old infants with Down syndrome preferred the IDS of their mothers over her ADS. It is also consistent with Hayashi et al. (2001), who reported that 10- to 14-month-olds preferred IDS to an 11-month-old infant. Thus, we conclude that older infants, like younger infants, have a preference for IDS under at least some conditions.

Our second goal was to test whether infants treat all IDS as equal, or whether some forms of IDS are more optimal for infants at some ages, such as IDS to their age or developmental peers. In previous studies of both younger (e.g., Cooper, 1993; Cooper & Aslin, 1990; Fernald, 1984) and older infants (e.g., Werker & McLeod, 1989; Werker et al., 1994), IDS preferences were found when the IDS stimuli consisted of speech intended for or directed toward younger infants. This led us to hypothesize that speech to younger infants would be engaging to infants across a wide age range, and we predicted that infants in all age groups in Experiment 1 would show a preference for the IDS to younger infants. Our results confirmed our prediction. All three age groups of infants in Experiment 1 had significant preferences for the IDS to younger infants.

In the introduction we argued that two recent failures to find IDS preferences in infants between 7 and 13 months of age might be attributed to the use of IDS that was directed to infants older than the test participants (Hayashi et al., 2001), or speech that was much more complex than typical IDS (Newman & Hussain, 2006). We hypothesized that at some ages, infants might fail to show a preference for IDS directed to older infants. Therefore, we predicted that our 6- and 10-month-olds might not show a preference for the IDS to older infants. Consistent with our prediction, the 6-month-olds in Experiment 1 did not have a preference for the IDS to 12- to 14-month-olds, although the 10-month-olds did have a significant preference. Indeed, the 6-month-olds failed to show even a trend toward a preference for the IDS stimuli directed to older infants (OIDS $M = 5.55$ sec; OADS $M = 5.73$ sec; 10 of 24 listened longer to OIDS stimuli), although another group of 6-month-olds demonstrated a robust preference for the IDS directed to younger infants (YIDS $M = 7.67$ sec; YADS $M = 5.82$ sec; 21 of 24 infants listened longer to YIDS stimuli).

Together, these results provide evidence of continuity in infant preferences for IDS. Infants have a preference for IDS directed to their age peers, and infants across a wide age range prefer IDS directed to young infants. However, the failure of the 6-month-olds to prefer IDS directed to older infants over ADS, in conjunction with similar results by Hayashi et al. (2001) and Newman and Hussain (2006) with even older infants, suggests that under some circumstances infants fail to show a preference for IDS that is directed to an older cohort, although they still

prefer speech directed to their own peers or to a younger cohort. There would seem to be two possible explanations for these results. One explanation is that the prosodic or affective component of IDS to infants in older cohorts is reduced to a degree that it does not sufficiently engage the attention of infants from younger cohorts. A second explanation is that the problem involves more structural linguistic properties of IDS to older infants, such as the reduced redundancy. Both of these would result in IDS that is more ADS-like than younger infants typically hear, and therefore might result in speech that fails to attract and maintain the attention of infants from younger cohorts, or is insufficiently different from ADS to present a compelling contrast. Experiment 2 tests the first of these possibilities.

EXPERIMENT 2

The goals of Experiment 2 were to confirm the results with the 6-month-olds in Experiment 1, to determine whether the failure to prefer IDS to older infants was due to prosodic differences between the speech to older versus younger infants, and to investigate the responses of an older cohort, between the 6- and 10-month-olds studied in Experiment 1; we did this by testing 8-month-olds in Experiment 2. As we noted previously, the prosodic characteristics of IDS change over the course of infancy. Consistent with this, the mean F_0 and F_0 range of the OIDS stimuli in Experiment 1, although clearly in the IDS range, were less extreme than in the YIDS stimuli. In addition, the mean F_0 in the OADS stimuli was somewhat higher than in the YADS stimuli. It is possible that the combination of these factors resulted in a contrast between OIDS and OADS that was not sufficiently compelling to result in an IDS preference by the 6-month-olds. One way to evaluate this possibility is to test 4-month-old infants, whose speech preferences appear to be based primarily on the prosodic or affective aspects of IDS (Fernald & Kuhl, 1987; Singh et al., 2002). If 4-month-olds prefer the OIDS over the OADS it would seem unlikely that the prosodic or affective aspects of the speech are insufficient for 6-month-olds. Thus, in addition to a new sample of 6-month-olds, we also tested 4-month-olds on the OIDS and OADS stimuli from Experiment 1. We expected the new sample of 6-month-olds to fail to show a preference for the OIDS, replicating the results of Experiment 1. However, previous research suggests that 4-month-olds respond to the prosodic and affective characteristics of IDS. Therefore, we expected the 4-month-olds in this experiment to show a clear preference for OIDS over the OADS.

Another goal of Experiment 2 was to further investigate infants' responses to IDS directed to an older cohort. Hayashi et al. (2001) reported that 7- to 9-month-olds failed to prefer IDS directed to an 11-month-old. Newman and Hussain (2006) also reported that 9- and 13-month-olds failed to prefer IDS that had some

prosodic features of IDS (high F_0, wide F_0 range), but had a faster speech rate than typical IDS. The 10-month-olds in Experiment 1 preferred IDS to older infants, but the 6-month-olds did not. Therefore, to clarify the development of IDS preferences for speech to older infants, we will test an intermediate age, 8-month-old infants, on the OIDS and OADS stimuli from Experiment 1. Based on Hayashi et al. (2001) and Newman and Hussain (2006), we might predict that the 8-month-olds will fail to show a preference for the OIDS. However, the 10-month-olds in Experiment 1 had a significant preference despite the findings of Hayashi et al. and Newman and Hussain. Recent research shows that by 8 months of age, infants are able to segment speech into word and word-like units (e.g., Jusczyk & Aslin, 1995; Saffran et al., 1996), but 6-month-olds apparently are not (Jusczyk & Aslin, 1995). Therefore, 8-month-olds might respond more like the 10-month-olds in Experiment 1 than like 6-month-olds, and also have a preference for the OIDS. In either case, we expect 4-month-olds to have a clear preference for OIDS, and we expect 6-month-olds to fail to show a preference. Thus we expect a significant Age × Speech Type interaction. However, given our predictions, we will test for significant preferences at each age, even in the absence of a significant interaction.

Method

Participants. The participants for this experiment were 62 infants, 24 at 4 months (M = 130.7 days), 19 at 6 months (M = 182.6 days), and 19 at 8 months (M = 244.2 days). An additional 27 infants participated, but were dropped from the final analysis due to fussiness or inattentiveness (n = 18), experimenter error or equipment failure (n = 6), or interference by the parent (n = 3).

Procedure. The procedure was the same as in Experiment 1.

Stimuli. Stimuli were the OIDS and OADS excerpts used in Experiment 1.

Results

Looking times were entered into a 3 (age) × 2 (speech type) ANOVA, with speech type as a repeated measure. This analysis revealed a main effect of age, $F(2, 59) = 4.13$, $p = .021$ ($\eta^2 = .13$), indicating that overall looking times declined as infants got older. Looking times for 4-month-olds (M = 10.94 sec, SD = 7.66) were significantly longer than for 8-month-olds (M = 5.75 sec, SD = 2.77), $t(41) = 2.88$, $p = .006$ ($\eta^2 = .17$). Looking times for 6-month-olds were intermediate (M = 7.39 sec, SD = 6.62), but were not significantly different from either of the other ages. There was also a significant main effect of speech type, $F(1, 59) = 7.66$, $p = .007$ ($\eta^2 = .12$), indicating that across ages infants looked and listened longer to OIDS (M = 8.76 sec, SD = 6.67) than to OADS (M = 7.76 sec, SD =

6.45). The Age × Speech Type interaction was not significant, $F(2, 59) = 1.75$, $p = .183$. Planned comparisons of OIDS and OADS looking times at each age indicated a significant preference for IDS at both 4 months, $t(23) = 2.33$, $p = .029$ ($d = .22$, a small effect), and 8 months, $t(18) = 2.16$, $p = .044$ ($d = .39$, approaching a medium effect). However, at 6 months, there was no significant difference between OIDS and OADS, $t(18) = 0.80$, $p = .43$ ($d = .00$, a near zero effect). See Figure 2.

Discussion

Experiment 2 had three goals. The first goal was to assess whether prosodic features were a factor in the failure of the 6-month-olds to show a preference for the OIDS in Experiment 1. Previous studies suggest that 4-month-old infants' preferences are due to the affective or prosodic features of IDS. To test the sufficiency of the prosodic features of OIDS we tested 4-month-olds on the OIDS and OADS stimuli from Experiment 1. Our results show that 4-month-olds had a significant preference for IDS directed to older infants. This result is not consistent with the

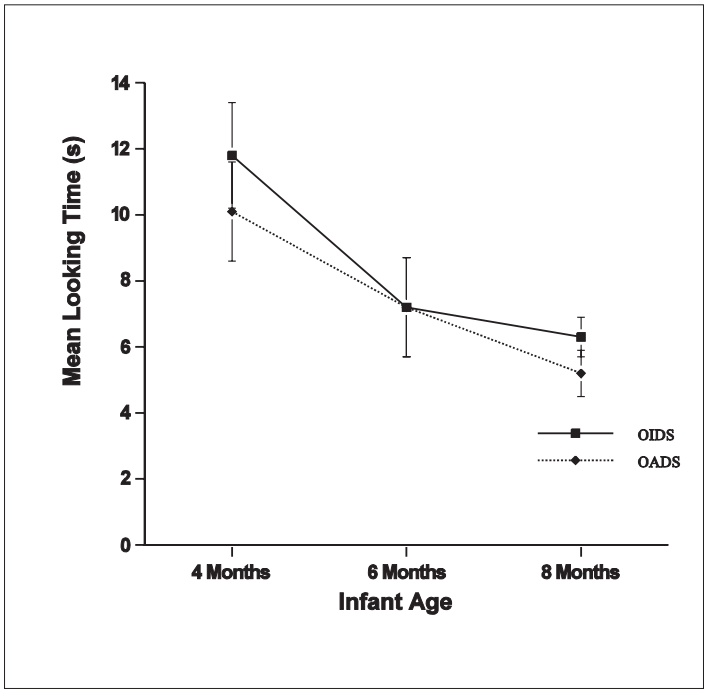

FIGURE 2 Mean looking times for 4-, 6-, and 8-month-old infants listening to older infant-directed speech (OIDS) and older adult-directed speech (OADS) by the same speakers.

hypothesis that the minor differences in prosodic features of OIDS were insufficient for 6-month-olds to have a preference. Because 4-month-olds found the OIDS sufficiently engaging, there is little reason to believe that prosodic factors underlie the failure of the 6-month-olds to have a preference for OIDS in Experiment 1.

The second goal of Experiment 2 was to further investigate the development of IDS preferences in older infants. Reports by Hayashi et al. (2001) failed to find preferences by infants between 7 and 9 months for IDS from an older cohort. Our results in Experiment 1 showed that 10-month-olds had a preference for IDS to 12- to 14-month-olds, but 6-month-olds did not. The question in Experiment 2 was whether 8-month-olds would perform like the 10-month-olds or the 6-month-olds. Our results show that 8-month-olds have a robust preference for IDS directed to infants from an older cohort (d = .39, approaching a medium effect). Thus, 8- and 14-month-olds have shown a preference for OIDS.

The final goal of Experiment 2 was to replicate the failure in Experiment 1 of 6-month-olds to show a preference for the OIDS. Thus, a new sample of 6-month-old infants was tested with the OIDS and OADS from Experiment 1. The results were consistent with Experiment 1; this new group of 6-month-olds also failed to show a preference for OIDS over OADS. As in Experiment 1, only about half of the infants (10 of 19) listened longer to the OIDS. This is in contrast to the performance of the 4-month-olds, who a showed significant preference for the IDS to older infants. Taken together, the performance of the 6-month-olds in Experiments 1 and 2 and the performance of the 4-month-olds in Experiment 2 suggest that affective or prosodic factors alone might not be driving IDS speech preferences in infants at 6 months of age.

The results of Experiments 1 and 2 suggest the possibility of a developmental trend in speech preferences in which the affective or prosodic characteristics of IDS are of primary importance in early infancy, but that more structural linguistic factors begin to play a role beginning by about 6 months of age. Such a trend would be consistent with recent studies showing that by 8 to 10 months of age, infants are beginning to segment and remember word-like patterns in continuous speech (e.g., Jusczyk, 1999; Jusczyk & Aslin, 1995; Marcus, Vijayan, Bandi Rao, & Vishton, 1999; Saffran et al., 1996; Tincoff & Jusczyk, 1999). It is possible that infants begin to attend preferentially to speech that affords them the greatest opportunity to exercise these emerging skills to find consistent segmental structure or organization.

The question is which properties of IDS support the speech perception skills that are emerging around 6 months, and are differentially present (or sufficiently present) in YIDS but not in OIDS. One property that appears to fit this description is the degree of redundancy in the form of verbal repetition. Mothers exactly repeat every fourth or fifth utterance (on average) when interacting with 4- to 6-month-old infants in play settings (e.g., Stern et al., 1983). Repeated utterances could pro-

vide infants with the opportunity to recover additional details from the transient speech signal that they might not be able to access from a single presentation, and might be engaging in the earliest stages of infants' access to the linguistic structure of speech. A preference to listen to speech with repeated utterances at 6 months might mark the beginning of a developing facility to gain access to structure in speech over the first and second year, as demonstrated by segmentation and statistical learning abilities at 7 to 8 months (e.g., Jusczyk & Aslin, 1995; Saffran et al., 1996), and the emergence of "online" word recognition between 18 and 24 months (Fernald, McRoberts, & Swingley, 2001; Fernald, Pinto, Swingley, Weinberg, & McRoberts, 1998). Thus, Experiment 3 explores the possibility that 6-month-old infants' speech preferences are partially determined by the repetition of utterances in the IDS they typically hear at this age.

EXPERIMENT 3

Repetition in IDS, and its role in language and cognitive development, is a potentially important but understudied phenomenon. Early descriptive studies of maternal speech to young language learners noted the high degree of repetition in IDS (e.g., Ferguson, 1964, 1977; Snow, 1972). Several studies included quantitative measures of maternal repetition in the form of exactly or partially repeated utterances (e.g., Broen, 1972; Kaye, 1980; McLaughlin, White, McDevitt, & Raskin, 1983; Rondal, 1980; Stern et al., 1983; Watson, 1979). Results across these studies suggested that the amount of repetition reaches a maximum at 4 to 6 months, when exactly repeated utterances represent up to 20% of maternal speech, and then declines during infants' second year of life to near adult levels by 24 months. Furthermore, two unpublished studies suggest that infants' sensitivity to verbal repetition in IDS emerges at about 6 months of age (Miners, 1994; Pinto, 1996). Thus, both descriptive studies of mothers' IDS and experimental studies of speech preferences suggest that verbal repetition might be salient at 6 months of age.

The selection of speech samples for the OIDS and YIDS stimuli were made without regard to the amount of repetition. However, analysis of the stimuli indicated that on average 17.4% of the YIDS, but only 12.4% of the OIDS utterances were exactly repeated on each trial (see Table 2). This approximates the amount of repetition reported for younger and older infants in the literature. If repetition in IDS is a significant factor in speech preferences at 6 months, then increasing the repetition in the OIDS stimuli should result in 6-month-old infants having a preference where previously they did not. Experiment 3 investigates this hypothesis by selectively enhancing the frequency of repeated utterances in the OIDS stimuli to match IDS to younger infants.

Method

Participants. The participants in this experiment were 24 6-month-old infants (M = 183.9 days). Half of the infants were female. An additional 14 infants participated, but were dropped from the final analysis due to fussiness or inattentiveness (n = 9), experimenter error (n = 3), or interference by the parent (n = 2).

Procedure. The procedure was the same as in Experiment 1.

Stimuli. For this experiment, a repetition-enhanced version of the OIDS stimuli was produced, in which the amount of repetition was increased through digital editing, which allows exact duplicates of individual utterances to be inserted into new locations in the audio files that correspond to each trial (see Table 3). In no cases were the duplicated utterances adjacent. Rather, at least one or two utterances were always between the original and copy. This process guaranteed that an exactly repeated utterance occurred every 4 to 5 sec, and resulted in an average of 20% of the utterances being exactly repeated, which is approximately what the literature suggests infants normally hear at 4 to 6 months (Kaye, 1980; Stern et al., 1983). However, because the digital copy is identical in all ways to the original, both the words and the prosodic pattern of the original utterance were preserved in the duplicated utterance. In addition, because the process of increasing repetition also resulted in increased file length, one or two utterances near the end of the file were deleted to maintain the approximate original trial durations (see Table 4). No changes were made to the OADS stimuli.

Results

Looking times were entered into a 2 (speech type) repeated measures ANOVA. This analysis revealed a significant main effect of speech type, $F(1, 23) = 6.91$, $p = .015$ ($\eta^2 = .23$), indicating that the infants looked and listened significantly longer

TABLE 3
Example of Repetition Enhancement

Original	*Repetition Enhanced*
I've got some toys to play with today. Yeah! OK? I've got some toys. Do you want to sit on my lap? Shall we do some books? How 'bout we do Spot? Spot goes to the farm! Look at this book! I've got some toys. I've got some toys to play with.	Do you want to sit on my lap? I've got some toys to play with today. Yeah! OK? I've got some toys. Do you want to sit on my lap? Shall we do some books? How 'bout we do Spot? Shall we do some books? Spot goes to the farm! Look at this book! I've got some toys. ~~I've got some toys to play with.~~

TABLE 4
Percentage Exact, Partial, and Total Repetition Before and After Enhancement in Repetition-Enhanced Stimuli

	Original (Exp. 1 & 2)			*Repetition Enhanced (Exp. 3)*		
Addressee	*Exact*	*Partial*	*Total*	*Exact*	*Partial*	*Total*
OID speech	12.4	21.4	33.8	21.6*	21.4	43.0*
OAD speech	0.0	16.3	16.3	0.0	16.3	16.3

Note. OID = older infant directed; OAD = older adult directed.
*Differs from original OIDS, $p < .01$.

to the repetition-enhanced OIDS ($M = 5.65$ sec, $SD = 2.28$) than to the OADS ($M = 4.42$ sec, $SD = 1.25$).

To further explore the response of 6-month-old infants to the OIDS/OADS stimuli, we compared looking and listening times across Experiments 1, 2, and 3. Recall that in Experiments 1 and 2 there were effectively no differences in looking times for the OIDS vs. OADS stimuli, but in Experiment 3 there was a significant difference. Thus, a significant Experiment × Speech Type interaction would confirm a difference in response to the stimuli in Experiments 1 and 2 compared to Experiment 3. A 3 (experiment) × 2 (speech type) ANOVA was performed, with speech type treated as a repeated measure. The results indicate no significant main effects of either experiment or speech type. However, a significant Experiment× Speech Type interaction, $F(2, 64) = 6.959$, $p = .04$ ($\eta^2 = .054$), confirms that the pattern of results in Experiment 3 was different from Experiments 1 and 2.

Discussion

Six-month-old infants in this experiment preferred the repetition-enhanced OIDS over OADS by the same speakers. In contrast, separate groups of 6-month-old infants in Experiments 1 and 2 failed to show a preference for the original OIDS, which differed from the stimuli in Experiment 3 mainly by containing less repetition. This suggests that the amount of repetition is a factor in 6-month-old infants' IDS preferences. However, the digital editing method we used to increase the repetition introduced a confound into the repetition-enhanced OIDS stimuli because inserting exact copies of utterances resulted in repetition of both the prosodic and segmental components of the utterances. Thus, verbal and prosodic repetition is confounded and it is unclear whether one component separately or the combination of both components accounts for the preference. Separating the potential roles of prosodic and verbal repetition requires a stimulus set in which the same utterances are spoken with different prosodic patterns, controlling for factors such as F_0 range and rate of speech. Spontaneous maternal speech produced during interac-

tive play with infants is unlikely to provide such a sample of utterances. Therefore, in Experiment 4 a new set of stimuli were produced under controlled conditions to unconfound prosodic and verbal repetition.

EXPERIMENT 4

In Experiments 1 and 2, we found consistent preferences for younger IDS over ADS. Additionally, we found preferences for older IDS over ADS at all ages except 6 months. In Experiment 3, we found that when the older IDS was repetition enhanced, 6-month-olds preferred it over ADS. However, because the prosodic patterns and the verbal content were confounded by our method of increasing the amount of repetition in the OIDS stimuli in Experiment 3, the 6-month-olds' preference for repetition-enhanced IDS could indicate a preference for repeated verbal content, repeated prosodic patterns, or their combination. To unconfound prosody and verbal content, new stimuli were created for Experiment 4 under laboratory-controlled conditions.

In addition to creating new stimuli in which the repetitions of each utterance had a different prosodic pattern, we also needed to change our testing strategy. In Experiments 1 through 3, we tested for a preference between IDS and ADS and established that at every age we tested infants prefer IDS over ADS. The question now is whether it is repetition in IDS that drives speech preferences at 6 months of age. To unambiguously show that 6-month-old infants attend preferentially to the verbal content of repeated utterances in IDS, we needed to change our test strategy from comparing IDS and ADS to comparing two versions of IDS: one with repeated utterances and one with no repeated utterances. By directly comparing the same IDS utterances, arranged with repetition and without repetition, we show that any preference infants display can only be due to the arrangement of the utterances, and not to any differences between IDS and ADS prosody, or differences in the linguistic structure of IDS and ADS utterances.

We adopted a technique reported in two unpublished studies (Miners, 1994; Pinto, 1996) that suggested infants as young as 6 months of age prefer repeated patterns in speech. We constructed new stimuli in which the verbal content of each utterance was spoken with different IDS prosodic patterns. The utterances were then arranged into sets corresponding to the 12 trials of a preference test. Thus, six trials were constructed in which each utterance occurred twice in immediate succession with varying prosodic patterns. In the other six trials, the exact same utterances were organized so that no utterances were repeated within any trial. This resulted in six trials with repeated utterances and six trials with no repeated utterances, and each utterance operated as its own control.

If 6-month-old infants are becoming interested in the linguistic structure of speech in the form of verbal repetition, they should show a preference for the trials

in which utterances are repeated compared to the trials in which the same utterances are arranged without repetition. In Experiment 2, 4- and 6-month-olds responded differently, with the younger age group having a preference for the original OIDS despite its reduced redundancy, whereas the older age group did not. To provide further evidence that 4-month-olds and 6-month-olds attend to different aspects of IDS, we will directly compare their preference in Experiment 4. Because all the trials in Experiment 4 contain similar amounts of IDS prosody, differing only in the amount of verbal repetition, 4-month-olds should find them equally interesting if they are attending primarily to the prosodic or affective aspects of IDS. Therefore, we predict that 6-month-olds will show a preference for verbal repetition, whereas 4-month-olds will show no preference between the trials with repetition and the trials without repetition.

Method

Participants. The participants for this experiment were 48 infants, 24 at 6 months (M = 186.4 days) and 24 at 4 months (M=125.6 days). Half of the infants at each age were female. An additional 10 infants participated, but were dropped from the final analysis due to fussiness or inattentiveness (n = 8) or experimenter error or equipment failure (n = 2).

Procedure. The procedure was the same as in Experiment 1.

Stimuli. The stimuli consisted of utterances selected from our archive of mothers talking to their infants. A total of 84 utterances were selected from 12 mothers of infants ranging from 4 to 16 months. The main criterion for selection was that utterances had to be consistent with previous descriptions of the complexity of IDS to young infants (i.e., short, simple, etc.). In accordance with this, all selected utterances were simple (i.e., single clause) and had a mean utterance length of 3.79 words (range = 2–5 words). Several tokens of each utterance were recorded by a female speaker using several different intonation contours previously identified as common in IDS (e.g., Fernald, 1989; Fernald & Simon, 1984; Stern et al., 1983). The nine contours included rise, fall, bell-shaped, and U-shaped, as well as several simple combinations of these four basic contours. Across the 84 utterances, no content words (e.g., nouns, verbs, adjectives, or adverbs) were repeated. Acoustic analysis confirmed that the utterances were produced using the prosodic and other characteristics of IDS (e.g., Fernald, 1989; Fernald & Simon, 1984). Mean F_0 of the utterances was 368.8 Hz (range = 272.5–461.0 Hz). Mean F_0 range (maximum F_0 – minimum F_0) of the utterances was 286.8 Hz (range = 166–430 Hz). Means for minimum and maximum F_0 were 225.7 Hz (range = 210.7–340.3 Hz) and 510 Hz (range = 287.7–645 Hz), respectively. Mean utterance duration was 1.45 sec (range = 0.6–2.5 sec).

The utterances were organized into two trial types, with six trials each containing verbal repetition or no repetition. The repeated utterances in the verbal repetition trials are immediately adjacent to each other. This differs from our manipulation in Experiment 3, where we never placed duplicated utterances adjacent to the original. We avoided immediate repetition in Experiment 3 because, although mothers appear to use prosodic repetition as well as verbal repetition, they never produce utterances with exactly repeated verbal and prosodic patterns. Thus we felt that introducing the duplicated utterances after one or two intervening utterances would reduce the likelihood of infants noticing this unnatural form of repetition. In this experiment, this is not a concern because the repetitions of each utterance have different prosodic patterns. In addition, the natural sequences that constituted the original OIDS stimuli contained immediately repeated utterances, as well as utterances repeated after intervening utterances. In this case, we wanted to have a more uniform arrangement of locations for the repeated utterances. Furthermore, because immediately repeated utterances might be easier to detect than delayed repetition, it provides the strongest test of our developmental prediction that 4-month-olds will not show a preference for verbal repetition.

Each of the no repetition trials consisted of 14 unique utterances, with each utterance occurring only once. Each of the repetition trials consisted of seven utterances, each of which was presented twice in immediate succession, but with different intonation contours. Because there are more utterances per trial (14) than prosodic patterns (9), it was not possible to completely eliminate prosodic similarities using the common set of IDS F_0 patterns. To control for the possibility that prosodic repetition (repeated contours) might contribute to infants' attention, no single prosodic contour was repeated within three subsequent utterances, and no contour appeared more than three times in a given trial. Furthermore, although a given contour (e.g., bell-shaped) could appear more than once in a trial, it is not likely to be an exact prosodic repetition, as there were differences in duration, timing, and F_0 across the different instances of a similar contour type, as well as differences in the verbal content. Additionally, if a prosodic contour was repeated at any place within a trial, the verbal content of the utterance varied across the prosodically similar utterances. Univariate analyses confirmed that there were no differences in duration, number of syllables, number of unique prosodic contours, mean F_0, F_0 range, minimum F_0, or maximum F_0 between the two trial types.

As in the previous experiments, trial types alternated and trial order was counterbalanced so that half of the infants heard a no repetition trial first and half heard a repetition trial first.

Results

Looking times were entered into a 2 (age) × 2 (speech type) repeated measures ANOVA, with speech type treated as a repeated measure. As predicted, there

was a significant Age × Speech Type interaction, $F(1, 44) = 5.13$, $p = .028$ ($\eta^2 = 0.10$). Follow-up tests were performed to investigate this interaction. Separate repeated measures ANOVAs on the looking times for trial type (repetition and no repetition) at each age showed that 6-month olds listened significantly longer on repetition trials (repetition $M = 9.92$, $SD = 4.8$; no repetition $M = 7.58$, $SD = 3.3$), $F(1, 23) = 6.49$, $p = .018$ ($d = 0.57$, a medium effect), whereas 4-month-olds' listening was not different for the two trial types (repetition $M = 8.71$, $SD = 6.8$; no repetition $M = 9.28$, $SD = 6.4$), $F(1, 23) = 0.38$ $p = .543$ ($d = –.09$, a near zero effect).

Discussion

This experiment investigated 4- and 6-month-old infants' listening preferences for the same IDS utterances organized in two ways, one containing immediate repetition of the verbal patterns (but not the prosodic patterns) and the other containing no repetition. Across trials, the exact same utterance tokens were presented in both types of trials. Thus, the only way in which infants could prefer one type over another was on the basis of the organization of the utterances within trials; some trials contained repeated utterances and some did not. Statistical analysis indicated a significant Age × Speech Type interaction. Six-month-old infants showed a significant preference for the trials with repeated verbal patterns, but 4-month-old infants did not have a significant preference for either trial type. These results are consistent with previously unpublished results by Pinto (1996) and Miners (1994). These results clarify the outcome of Experiment 3, where the basis for the 6-month-olds' preference for the repetition-enhanced OIDS was unclear due to a confounding of repeated verbal and prosodic patterns. In Experiment 4 this confounding was removed, and the results now clearly indicate that the 6-month-old infants were responding to the presence of repeated verbal patterns, even in the absence of repeated prosodic patterns. Four-month-olds failed to show any preference for repeated verbal patterns despite listening longer overall than the 6-month-olds (4-month-olds $M = 18.49$ sec; 6-month-olds $M = 17.5$ sec). Thus, repeated verbal patterns have become a factor in infants' speech preferences by 6 months of age, but not yet at 4 months.

GENERAL DISCUSSION

Several important findings emerge from this study. First, infants older than 6 months of age continue to have a robust preference for IDS over ADS. Our groups of 8-, 10-, and 14-month-old infants all had significant preferences for IDS to older infants, with effect sizes ranging from medium to large. Furthermore, our 10- and 14-month-olds also preferred IDS directed to younger infants (8-month-olds were

not tested in this condition). These results are partially consistent with Hayashi et al. (2001), who found preferences by 10- to 14-month-olds, but not 7- to 9-month-olds. However, they contradict Newman and Hussain (2006), who failed to find IDS preferences by 9- and 13-month-olds. Our results clearly show that infants across the age range from 4 to 14 months have listening preferences for IDS. We found no age at which infants failed to prefer some form of IDS. Second, as suggested by previous studies, infants at some ages fail to show a preference for some forms of IDS. In this study, two separate groups of 6-month-olds failed to prefer IDS to older infants. However, infants at this age will prefer IDS to older infants if there is sufficient redundancy in the form of repeated utterances, or if the IDS is directed to infants their own age. This finding suggests that the properties of IDS that drive infants' preferences change over the course of early development, and points to a transition in infant attention from prosodic and affective aspects of IDS to some aspects of the linguistic structure of IDS. This transition has important implications for the nature and development of infants' IDS preferences and for early language development. These results, in conjunction with the results of other studies, demonstrate continuity in infants' preference for IDS from neonates (e.g., Cooper & Aslin, 1990) into the second year of life, and should lay to rest any doubts about older infants' preference for IDS as they enter the transition to linguistic communication.

Shift in Attention Between 4 and 6 Months

Another major outcome of this study is evidence of a transition in what infants attend to in speech. Fernald and Kuhl (1987) found that F_0 modulation was the basis of the IDS preference at 4.5 months. More recent studies (e.g., Kitamura & Burnham, 1998; Singh et al., 2002) point to positive affect rather than F_0 modulation as the basis for IDS preferences at 6 months of age. In fact, Singh et al. (2002) reported that 6-month-olds prefer ADS that expressed positive affect, even with lower F_0 and narrower F_0 range, over IDS with higher F_0 and wider F_0 range that did not express positive affect. Thus, they concluded that IDS prosody alone was not sufficient to obtain an IDS preference at 6 months. The prosodic characteristics of our OIDS stimuli (IDS to older infants) were similar to the YIDS stimuli (IDS to younger infants), and sufficient to elicit a preference from 4-month-olds. Thus, the failure of 6-month-olds to prefer OIDS in Experiments 1 and 2 is consistent with the idea that prosodic features of IDS, by themselves, are not the basis of the IDS preference at this age (Kitamura & Burnham, 1998; Singh et al., 2002). However, the results of this study also show that positive affect is not the only feature of IDS that attracts 6-month-old infants' attention. Our results show that by 6 months, but not yet at 4 months, infants are beginning to attend to nonaffective and nonprosodic aspects of IDS structure. Specifically, the results of Experiments 3 and 4 show that 6-month-old infants are attending to linguistic structure in IDS in the

form of repeated verbal patterns. This suggests that the beginnings of infants' access to language structure in speech emerges by at least 6 months of age as attention to repeated utterances, and segmentation of familiar words and coherent sound patterns by 8 months (e.g., Jusczyk & Aslin, 1995; Marcus et al., 1999; Saffran et al., 1996), and word learning soon thereafter.

Failures to Find IDS Preferences

We hypothesized that failures to find IDS preferences in previous studies could be attributed to mismatches between infants' developing linguistic abilities and the structure of the IDS stimuli, rather than to an inherent lack of interest in IDS on the part of infants. With these findings in mind, we can now offer an explanation for the failures to find IDS preferences by Newman and Hussain (2006), and inconsistencies between the results of Hayashi et al. (2001) and our findings. First, regarding Newman and Hussain's (2006) failure to find a preference by either 9- or 13-month-olds, our findings that 6-month-olds are attending preferentially to repeated patterns in speech underscores other evidence that infants are becoming increasingly sophisticated in their ability to access linguistic structure from speech during the second half of the first year. In particular, during the second half of their first year, infants are beginning to segment words and statistically coherent sound patterns from the speech stream (e.g., Jusczyk & Aslin, 1995; Marcus et al., 1999; Saffran et al., 1996) and are becoming sensitive to a variety of language-specific features. It seems likely that infants will attend preferentially to speech that supports these newly acquired abilities. We would argue that IDS stimuli with 15-syllable utterances and faster than typical IDS speech rates, such as those used by Newman and Hussain (2006), do not support these emerging speech perception capabilities, despite the fact that the F_0 characteristics were sufficient to elicit a preference from 4.5-month-olds. In short, we believe that the reason Newman and Hussain's 9- and 13-month-olds failed to show a preference is because the IDS stimuli were too complex for beginning speech processors. This analysis is further supported by Hayashi et al.'s (2001) finding that 10- to 14-month-olds demonstrated a preference for IDS directed to an 11-month-old, and our findings of a preference at 8, 10, and 14 months for IDS directed to 12- to 14-month-old infants.

One inconsistency between Hayashi et al. (2001) and our results remains to be explained. Hayashi et al. reported that 4- to 6-month-old infants had a preference for speech to an 11-month-old infant, but 7- to 9-month-olds did not. This is in contrast to our findings in Experiments 1 and 2, where 6-month-olds failed to show a preference for IDS to older infants, but both 4- and 8-month-olds had a preference for the same stimuli. Thus, both studies suggest that infants fail to show a preference for IDS to older infants at some age between 4 and 9 months, but the two studies differ on when that failure occurs. We suggest two possible explanations for these differences. One possibility has to do with how the age groups were con-

structed in the two studies. Hayashi et al. tested infants between 4 and 14 months and then established wide age groupings post hoc (e.g., 4–6 months), whereas we established very narrow age groupings (± 2 weeks) as a part of the design of our study. An inspection of the scatter plot in Figure 3 in Hayashi et al. (2001) shows that although Group I (4–6 months) had a significant IDS preference, the youngest 10 infants tended to have substantial IDS preferences, whereas the oldest 10 to 12 infants tended to have small IDS preferences. It is possible that the wide age grouping in Hayashi et al.'s study might be masking a result that is actually consistent with ours.

The other possibility is that language-specific or cultural differences between Japanese IDS and American English IDS, or differences in the development of speech perception by infants in these two language environments, could underlie the different results. Fernald and Morikawa (1993) studied Japanese and American mothers' speech to infants at 6, 12, and 19 months. They noted both similarities and differences across cultures and languages. Among the potentially important differences were that American mothers across the age range from 6 to 19 months used significantly more repetition (exactly and partially repeated utterances), labeled objects more often, and used more consistent noun labels than Japanese mothers. Fernald and Morikawa also found that American mothers reported twice as many object words in their infants' spoken vocabularies between 12 and 19 months than Japanese mothers, a significant difference. It appears that Japanese and American English IDS are structured somewhat differently and that early differences in language development could be associated with those differences in IDS. These differences might also play a role in the inconsistencies between Hayashi et al. (2001) and our results.

The results of Experiment 2 showing that both 4- and 8-month-old infants prefer OIDS over OADS suggests that the influence of repeated utterances as a necessary condition for a preference is specific to 6-month-olds. This raises the question of why the influence of repetition is so age specific. We believe that the answer to this question is that infants' linguistic capabilities are developing very rapidly during this period. Four-month-olds appear to still find the prosodic and affective properties of speech highly salient, and in general, have not yet been shown to be sensitive to linguistic structure. Emerging evidence suggests that 8-month-olds, on the other hand, are likely much more linguistically competent. Segmentation based on stress cues and cooccurrence probabilities emerges by 8 months of age (e.g., Jusczyk & Aslin, 1996; Saffran et al., 1996; Thiessen & Saffran, 2003; Thiessen, Hill, & Saffran, 2005). This would suggest that the support of repeated utterances might be much less necessary than for infants just a few months younger who have not yet begun to segment the speech stream. This suggests to us that by 8 months infants are no longer dependent on repeated utterances to sustain their attention in IDS, whether directed to younger or older infants. As long as the utterances are not so complex as to be outside their capabilities, 8-month-olds are able to apply their

emerging skills in a manner that sustains their interest and attention. It could be that, just as for older children and adults, the opportunity to apply a newly learned skill has its own intrinsic reward.

The results of this study show that infants' sensitivity to repeated patterns of speech sounds appears at about the same time other studies show infants are becoming sensitive to prosodic markers for phrase and clause structure in continuous speech (Nazzi, Kemler Nelson, Jusczyk, & Jusczyk, 2000; Seidl, 2007; Soderstrom, Seidl, Kemler Nelson, & Jusczyk, 2005), and at least one to two months prior to the emergence of infants' ability to segment words or statistically regular patterns of syllables from continuous speech (e.g., Jusczyk, 1999; Jusczyk & Aslin, 1995; Saffran et al., 1996). Taken together with these previous results, our findings point to the period between 4 and 6 months of age as the time when infants begin attending to certain aspects of the linguistic structure in speech.

The fact that verbal repetition in speech is salient and interesting to infants by 6 months of age should perhaps come as no surprise. Repeated events, and the expectations that can be developed from repetition, have previously been suggested to play an important role in infant cognitive and social development. For example, Fernald and O'Neill (1993) described similarities in peek-a-boo games across cultures and noted the potential importance of these types of games and routines for the development of infants' social expectancies. Significantly, it is usually between 5 and 7 months of age that infants begin to make anticipatory looking before the mother's face reappears during the game. The high degree of exactly and partially repeated utterances in IDS during this same period suggests that repetition in speech might play a similar role by allowing infants to anticipate that identical or highly similar sound patterns will be repeated within a short time. This could provide the infant with an opportunity to deploy attentional and perceptual resources to access finer grained structure in the speech signal than would be available from a single presentation. It could be that the lack of adequate repetition in the OIDS stimuli violates these expectations, thereby reducing 6-month-old infants' interest and attention, resulting in the lack of preference for OIDS over OADS in Experiments 1 and 2.

This set of experiments points to an important shift in our understanding of the development of infants' attention to speech. However, important questions remain unanswered. It seems unlikely that the shift from affective to linguistic aspects of IDS is either abrupt or an all-or-none phenomenon. Further studies in which infants' preference for age-appropriate and age-inappropriate IDS are directly compared might provide insight into the relative weighting of infants' interest or attention for aspects of IDS structure (e.g., exaggerated prosody vs. verbal repetition). In addition, as infants' linguistic abilities develop, there might be aspects of language structure other than verbal repetition that become highly salient and influence their speech preferences. This study does not address these issues.

Summary

In summary, this study shows a continued preference for IDS over ADS across the age range from 4 to 14 months. Further, we clarify previous inconsistent findings in the literature by showing that infants older than 6 months of age continue to have a listening preference for IDS over ADS, whether it is directed toward infants of approximately the same age as those being tested or to infants at another age. Only 6-month-olds appear to have very specific requirements about the structure of IDS. At this age they seem to have a strong preference for IDS that contains more repeated utterances than are typically present in speech to older infants. In addition, this study documents an important shift in infants' attention from prosodic affective aspects of IDS to some aspects of the linguistic structure of IDS in the form of repeated utterances between 4 and 6 months. This shift in attention to structural properties of speech might very well underlie the segmentation abilities that appear shortly thereafter.

ACKNOWLEDGEMENTS

This research was supported by grants from the National Institutes of Health (DC005947, DC00403). We wish to thank Siobhan O'Brien, Lauren Dullum, Jamie Nelson, Danielle Wolf, Allison Newhart, Rebekah Masters, and Samantha Johnson for their contributions. We are especially grateful to the many infants and their parents who participated in this research.

REFERENCES

Bahrick, L. E., & Lickliter, R. (2000). Intersensory redundancy guides attentional selectivity and perceptual learning in infancy. *Developmental Psychology, 36,* 190–201.

Boersma, P. (2001). Praat, a system for doing phonetics by computer. *Glot International, 5,* 341–345.

Broen, P. A. (1972). *The verbal environment of the language-learning child* (ASHA Monographs No. 17). Washington, DC: American Speech and Hearing Association.

Cohen, J. (1988). *Statistical Power Analysis for Behavioral Science.* Hillsdale, NJ: LEA.

Columbo, J., & Bundy, R. S. (1981). A method for the measurement of infant auditory selectivity. *Infant Behavior and Development, 4,* 219–223.

Cooper, R. (1993). The effect of prosody on young infants' speech perception. In C. Rovee-Collier & L. Lipset (Eds.), *Advances in infancy research* (Vol. 8, pp. 137–167). Norwood, NJ: Ablex.

Cooper, R., & Aslin, R. (1990). Preference for infant-directed speech in the first month after birth. *Child Development, 61,* 1584–1595.

Cooper, R., & Aslin, R. (1994). Developmental differences in infant attention to the spectral properties of infant-directed speech. *Child Development, 65,* 1663–1677.

Ferguson, C. A. (1964). Baby talk in six languages. *American Anthropologist, 66,* 103–114.

Ferguson, C. A. (1977). Baby talk as a simplified register. In C. E. Snow & C. A. Ferguson (Eds.), *Talking to children: Language input and acquisition* (pp. 209–235). Cambridge, UK: Cambridge University Press.

Fernald, A. (1984). The perceptual and affective salience of mothers' speech to infants. In L. Feagans, C. Garvey, & R. Golinkoff (Eds.), *The origins and growth of communication* (pp. 5–19). Norwood, NJ: Ablex.

Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. *Infant Behavior and Development, 8,* 181–195.

Fernald, A. (1989). Intonation and communicative intent in mothers' speech to infants: Is the melody the message? *Child Development, 60,* 1497–1510.

Fernald, A. (1992). Meaningful melodies in mothers' speech to infants. In H. Papousek & U. Juergens (Eds.), *Nonverbal vocal communication: Comparative and developmental approaches* (pp. 262–282). New York: Cambridge University Press.

Fernald. A., & Kuhl, P. (1987). Acoustic determinants of infant preference for motherese speech. *Infant Behavior and Development, 10,* 279–293.

Fernald, A., McRoberts, G. W., & Swingley, D. (2001). Infants' developing competence in recognizing and understanding words in fluent speech. In J. Weissenborn (Ed.), *How to get into language: Approaches to bootstrapping in early language development* (pp. 49–56).

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., & O'Neill, D. K. (1993). Peek-a-boo across cultures: How mothers and infants play with voices, faces, and expectations. In K. MacDonald (Eds.), *Parent–child play: Descriptions and implications* (pp. 259–285). Albany: State University of New York Press.

Fernald, A., Pinto, J. P., Swingley, D., Weinberg, A., &. McRoberts, G. W. (1998). Rapid gains in speed of verbal processing by infants in the 2nd year. *Psychological Science, 9,* 228–231.

Fernald, A., & Simon, T. (1984). Expanded intonation contours in mothers' speech to newborns. *Developmental Psychology, 20,* 104–113.

Fernald, A., Taescher, T., Dunn, J., Papousek, M., de Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of Child Language, 16,* 477–501.

Friedlander, B. Z. (1968). The effect of speaker identity, voice inflection, vocabulary and message redundancy on infants' selection of vocal reinforcement. *Journal of Experimental Child Psychology, 6,* 443–459.

Garnica, O. (1977). Some prosodic and paralinguistic features of speech to young children. In C. E. Snow & C. A. Ferguson (Eds.), *Talking to children: Language input and acquisition* (pp. 63–88). Cambridge, UK: Cambridge University Press.

Glenn, S. M., & Cunningham, C. (1983). What do babies listen to most? A developmental study of auditory preferences in nonhandicapped infants and infants with Down's syndrome. *Developmental Psychology, 19,* 332–337.

Glenn, S. M., Cunningham, C., & Joyce, P. (1981). A study of auditory preferences in nonhandicapped infants and infants with Down's syndrome. *Child Development, 52,* 1303–1307.

Hayashi, A., Tamekawa, Y., & Kiritani, S. (2001). Developmental change in auditory preferences for speech stimuli in Japanese infants. *Journal of Speech, Language and Hearing Research, 44,* 1189–1200.

Jusczyk, P. W. (1999). Finding and remembering words: Some beginnings by English- learning infants. *Current Directions in Psychological Science, 6,* 170–174.

Jusczyk, P., & Aslin, R. (1995). Infants' detection of the sound patterns of words in fluent speech. *Cognitive Psychology, 29,* 1–23.

Kaye, K. (1980). Why we don't talk "baby talk" to babies. *Journal of Child Language, 7,* 489–507.

Kitamura, C., & Burnham, D. (1998). The infant's response to vocal affect in maternal speech. In C. Rovee-Collier, L. Lipsett, & H. Hayne (Eds.), *Advances in infancy research* (Vol. 12, pp. 221–236). Stamford, CT: Ablex.

Marcus, G. F., Vijayan, S., Bandi Rao, S., & Vishton, P. M. (1999). Rule-learning in seven-month-old infants. *Science, 283,* 77–80.

McLaughlin, B., White, D., McDevitt, T., & Raskin, R. (1983). Mothers' and fathers' speech to their young children: Similar or different? *Journal of Child Language, 10,* 245–252.

Miller, C. L. (1983). Developmental changes in male–female voice classification by infants. *Infant Behavior and Development, 6,* 313–330.

Miners, L. (1994). *Infant preference for repetition in speech.* Unpublished undergraduate honors thesis, Stanford University, Stanford, CA.

Nazzi, T., Kemler Nelson, D., Jusczyk, P. W., & Jusczyk, A. M. (2000). Six-month-olds' detection of clauses embedded in continuous speech: Effects of prosodic well-formedness. *Infancy, 1,* 123–147.

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

Newport, E., Gleitman, H., & Gleitman, L. (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: Language input and acquisition* (pp. 109–149). Cambridge, UK: Cambridge University Press.

Papousek, M., Papousek, H., & Haekel, M. (1987). Didactic adjustments in fathers' and mothers' speech to their 3-month-old infants. *Journal of Psycholinguistic Research, 16,* 491–516.

Pegg, J., Werker, J., & McLeod, P. (1992). Preference for infant-directed over adult-directed speech: Evidence from 7-week-old infants. *Infant Behavior and Development, 1,* 325–345.

Pinto, J. P. (1994). Pref (version 4.2): Multimedia experimental control software for Macintosh. Palo Alto, CA: Author.

Pinto, J. P. (1996). *Infants' sensitivity to repetition in speech.* Unpublished doctoral dissertation, Stanford University, Stanford, CA.

Pinto, J. P., Fernald, A., McRoberts, G. W., & Cole, S. (1998). Reliability and validity in infant auditory preference procedures. In C. Rovee-Collier, L. Lipsett, & H. Hayne (Eds.), *Advances in infancy research* (Vol. 12, pp. 278–297). Stamford, CT: Ablex.

Rondal, J. A. (1980). Fathers' and mothers' speech in early language development. *Journal of Child Language, 7,* 353–369.

Saffran, J. R., Aslin, R. N., & Newport, E. L. (1996). Statistical learning by 8-month-old infants. *Science, 274,* 1926–1928.

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

Singh, L., Morgan, J. L., & Best, C. T. (2002). Infants' listening preferences: Baby talk or happy talk? *Infancy, 3,* 365–394.

Snow, C. (1972). Mothers' speech to children learning language. *Child Development, 43,* 549–565.

Soderstrom, M., Seidl, A., Kemler Nelson, D., & Jusczyk, P. (2005). The prosodic bootstrapping of phrases: Evidence from prelinguistic infants. *Journal of Memory and Language, 49,* 249–267.

Stern, D., Spieker, S., Barnett, R. K., & MacKain, C. (1983). The prosody of maternal speech: Infant age and context-related changes. *Journal of Child Language, 10,* 1–15.

Thiessen, E. D., & Saffran, J. R. (2003). When cues collide: Use of stress and statistical cues to word boundaries by 7- to 9-month-old infants. *Developmental Psychology, 39,* 706–716.

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

Tincoff, R., & Jusczyk, P. W. (1999). Some beginnings of word comprehension in 6-month-olds. *Psychological Science, 10,* 172–175.

Watson, L. R. (1979). *Maternal self-repetition as a function of child feedback.* Unpublished doctoral dissertation, Boston University, Boston.

Werker, J., & McLeod, P. (1989). Infant preference for both male and female infant-directed talk: A developmental study of attentional and affective responsiveness. *Canadian Journal of Psychology, 43,* 230–246.

Werker, J., Pegg, J., & McLeod, P. (1994). A cross-language investigation of infant preference for infant-directed communication. *Infant Behavior and Development, 17,* 323–333.