The Development of Infants’ Preference for Motherese

ROBIN PANNETON COOPER
JANE ABRAHAM
SHERYL BERMANN
MARGARET STASKA

Virginia Polytechnic Institute and State University

Generally, infants prefer infant-directed (ID) to adult-directed (AD) speech. Mostly, researchers have used unfamiliar female voices in these studies. We investigated preferences for maternal ID speech in 1- and 4-month-olds. Using a procedure in which infants controlled access to voices by fixating a visual display, infants listened to recordings of natural female ID and AD speech. In Experiment 1, 1-month-olds heard recordings of maternal ID and AD speech, but these infants showed no preference for maternal ID speech. In Experiment 2, 1-month-olds heard the same ID and AD speech tapes but were not familiar with the speakers. Contrary to Experiment 1, these infants preferred ID speech. In Experiment 3, 4-month-olds heard recordings of maternal ID and AD speech and showed a significant preference for ID speech. Collectively, these results suggest that infant attention to ID speech depends on both speaker-general and speaker-specific characteristics, with interesting developmental changes occurring during early infancy.

Infant-directed speech motherese preference infant mother-infant interaction infant attention

"Motherese" is a term that has historically referred to the prosodic exaggerations that are typically found in mothers’ speech to their infants and young children. Specifically, observational work across the world has shown that when mothers talk to their infants, the melodic, rhythmic qualities of maternal voices increase (Fernald et al., 1989; Fernald & Simon, 1984; Grieser & Kuhl, 1988; Papousek & Hwang, 1991; Shute & Wheldall, 1989). Typically, mothers accomplish this by elevating the fundamental frequency (or “pitch”) of their voices, expanding their pitch range and variability, extending their pitch excursions over time, and often repeating themselves. These prosodic exaggerations give maternal speech to infants its song-like quality and infants appear to be differentially attracted to such speech. Infants from a few days old, across the first year after birth have shown preferences for infant-directed (ID) compared to adult-directed (AD) speech (Cooper & Aslin, 1990; Fernald, 1985; Pegg, Werker, & McLeod, 1992; Werker & McLeod, 1989). Moreover, this stylized way of talking to infants is not restricted to mothers; fathers also exaggerate the prosodic features of their voices (Fernald et al., 1989; Papousek, Papousek, & Haeckel, 1987), as do non-parent females and males (Jacobsen, Boersma, Fields, & Olson, 1983). As in the female ID speech literature, infants also prefer to listen to male ID over male AD speech (Pegg, Werker, & McLeod, 1992; Werker & McLeod, 1989).

Empirical interest in ID speech stems from three possible developmental functions. ID speech appears to play a role in the following:

1. Regulation of arousal and attention in infants.
2. Infant’s learning to interpret emotional signals from others.
3. Highlighting of linguistic structure in caretakers’ speech, making certain language-relevant events more apparent to the infant.

However, ID speech does not necessarily serve all of these functions at the same point in time during infant development. According to a recent model proposed by Fernald (1992), the function of ID speech changes qualitatively across the first postnatal year. Fernald argues that early in development, infants are biologically predisposed to respond differentially to ID speech (in this sense, certain prosodic features of ID speech serve as “unconditioned stimuli”). As the infant becomes more perceptually adept, ID speech
increases in its power to modulate and regulate infant attention. As infants grow older and begin to integrate the vocal activity of their caretakers with other sensory inputs (e.g., facial expressions), they learn about the socioemotional meaning of such multimodal displays. Ultimately, ID speech (still within this socioemotional context) conveys important linguistic information to the infant, such as cuing the infant about object-label correspondences and helping the infant to segment the speech stream. Thus, ID speech is seen as a multifaceted event during infancy which progressively affects infants' attention/arousal, socioemotional knowledge, and language learning.

Although infant-directed speech is a reliable feature of many infant-adult interactions (even the youngest infants), it is no doubt a prominent feature of the mother-infant relationship, especially in those cultures in which the mother assumes the role of primary caretaker. However, little is known about infant responsiveness to the prosodic features of maternal speech. We do know from the available literature that young infants are sensitive to a variety of other maternal characteristics. For example, newborns who are breast-fed recognize the breast (MacFarlane, 1975) and axillary (Cernoch & Porter, 1985) odors of their own mothers. By the end of the first postnatal month, infants also recognize some aspect(s) of their mothers' faces (Carpenter, 1975, cited in Sullivan & Horowitz, 1983).

In the auditory domain, newborns show preferences for the maternal voice over an unfamiliar female's voice (DeCasper & Fifer, 1980; Fifer & Moon, 1995). In contrast, newborns do not prefer the voices of their fathers over those of unfamiliar males, even though newborns can discriminate male voices (DeCasper & Prescott, 1984). This early attraction to the mother's voice may derive from prenatal auditory experience with maternal speech (Cooper & Aslin, 1989; Richards et al., 1992). We do know that newborns respond differently to maternal speech which simulates some aspects of prenatal sound over unfiltered maternal speech (Moon & Fifer, 1990a; Spence & DeCasper, 1987), that newborns prefer a particular story or melody that was vocally produced by the mother during late gestation over a novel story or melody (DeCasper & Spence, 1986; Panneton, 1985), and that newborns prefer recordings of their native language over non-native ones (Mehler et al., 1988; Moon, Cooper, & Fifer, 1993).

Regarding infant responsiveness to the prosodic cues of the maternal voice, Mehler et al. (1978) found that 1-month-old infants sucked at higher rates when sucking produced a recording of the maternal voice than when sucking produced a non-maternal voice, but only if the voices were normally intoned (i.e., both the mother's and unfamiliar female's voice were recorded as these women imagined speaking to their infants). If the maternal and non-maternal voices were presented in monotone (i.e., the women read aloud the text of a book in reverse order), no difference in sucking rate was found. This finding suggests that young infants are quite sensitive to the normally-occurring intonation patterns of their mothers' voices.

More recently, Spence and Freeman (1995) investigated whether intonational features (i.e., primarily the fundamental frequency pattern) were important determinants of newborns' preferences for the maternal voice. Spence and Freeman found that newborns preferred a low-pass filtered version of the maternal voice over the low-pass filtered voice of an unfamiliar woman (this replicates an earlier study by Moon & Fifer, 1990a). However, when listening to recordings of whispered speech (in which no fundamental frequency is present, but harmonic structure remains approximately equal albeit of diminished amplitude), newborns showed no preference for their mothers' voices. From these data, it appears that pitch characteristics are important determinants of newborns' recognition of the maternal voice.

Because young infants differentially attend to both ID speech and the maternal voice, and appear to be particularly sensitive to the pitch characteristics of their mothers' voices, it seems reasonable to predict that the combination of these variables (i.e., maternal speech + ID speech) would be particularly powerful in attracting infant attention. According to Fernald's (1992) model, infant's are biologically predisposed to attend differentially to maternal ID vocalizations, presumably because of past selection pressures which have favored the effectiveness of maternal vocalizations on infant arousal, attention, and emotional regulation. Interestingly, only one published study has investigated the effects of maternal ID speech
The purpose of our first experiment was to investigate infant attention. Using an operant motor task, Glenn and Cunningham (1983) found that both developmentally delayed (i.e., Downs syndrome) and normal 9-month-olds increased response frequency and duration when responding to produced recordings of maternal ID speech compared to maternal AD speech. Unfortunately, when recording maternal voices, these authors encouraged the mothers to talk about their infants’ favorite activities. In this way, the familiarity of the mother’s ID speech was confounded with the familiarity of her linguistic content. Therefore, it is possible that, independent of ID speech, the infants responded on the basis of familiarity with these verbal routines. Because no other known studies exist on infant preference for maternal prosody, the first experiment reported here tested 1-month-olds with recordings of maternal ID and maternal AD speech. We predicted that young infants would be strongly attracted to their own mothers’ ID speech.

EXPERIMENT 1: PREFERENCE FOR MATERNAL ID SPEECH IN 1-MONTH-OLDS

The purpose of our first experiment was to investigate 1-month-olds’ preferences for maternal ID vs. maternal AD speech. Given young infants’ interest in their mothers’ voices and in infant-directed speech, we predicted that 1-month-olds would show a robust preference for maternal ID speech.

METHOD

Participants

Twenty 1-month-old infants (12 males and 8 females) composed the final sample (M age = 38.70 days, SD = 5.50 days). An additional twenty-two infants failed to complete testing due to excessive crying (12), sleeping (5), difficulty observing infant’s eye movements (2), or experimenter/equipment error (3). All subjects were recruited from our community through birth announcements published in local newspapers. Parents were contacted initially by mail with a letter explaining the nature of the study, and subsequently by phone. All infants were healthy full-term infants with no maternally reported prenatal or postnatal complications. At the time of testing, mothers reported that their infants were in good health.

Maternal Voice Recordings

The voice of each mother was recorded during a 30-45 min home visit approximately one week prior to the scheduled laboratory session. Each mother’s infant was with her during these interviews. In order to obtain clear voice samples with minimal extraneous noise and distraction to the mother, a lightweight, professional lapel microphone (Sony, Model ECM-011) was clipped to the mother’s shirt as close to her mouth as possible, and fed into a portable, high-quality audio cassette recorder (Sony, Model WM-D6C). The microphone was attached at the beginning of the session and the tape remained running throughout the visit.

To facilitate the mother speaking in a natural manner during the home visit, the interviewer casually conversed with her, unless the mother began to interact with her infant at which time the interviewer would quietly listen. In this way naturalistic AD samples were obtained from the mother’s speech directed towards the interviewer and naturalistic ID samples were obtained from the mother’s speech to her infant. If the mother did not vocalize to her infant within the first 20-25 min of the recording session, the interviewer specifically asked the mother to engage the infant’s attention to a toy, or to vocalize to the infant in order to elicit the infant’s attention. During the entire visit the interviewer did not directly interact with the infant, so as not to model the characteristics of ID speech for the mother. Only two mothers did not vocally interact with their infants within the first 20 min of the session and were prompted in the ways just described.

From each mother’s home session a complete written transcript was made and ID and AD utterances were selected according to the following criteria: a) good overall recording quality; b) the absence of background noise (including infant or experimenter vocalizations); c) easily understood linguistic content and d) bounded by at least 300 ms of silence. In this way utterances were selected both acoustically and linguistically, following similar procedures used by both Femald and Simon (1984) and Femald et al. (1989).

In order to equate for varying lengths of individual utterances, a total of 20 s of maternal ID (Maternal-ID) and maternal AD (Maternal-AD) speech were randomly selected from those deemed to be of good quality. The selected samples were then used to construct a 20 s continuous TDK cassette tape by recording the Maternal-ID and Maternal-AD samples independently onto separate channels of a multichannel cassette recorder (TASCAM, Model Port 05), with approximately 500 ms between each utterance. This procedure resulted in the construction of a single 20 s loop tape for each mother–infant pair, with Maternal-ID on one channel and Maternal-AD on the other.

Apparatus

For testing of 1-month-olds, an infant seat was positioned within a grey-colored, 3-sided enclosure with the infant seat facing the front panel. A 12.70 cm black-and-white checkerboard (with 2.50 cm square checks) was located on the front panel, offset from midline 7.60 cm to the right. The infant seat was positioned approximately 40.60 cm from this front panel so that the checkerboard subtended a visual angle of approximately 17°. A smaller grey panel was used to cover the checkerboard between trials. A small, high-quality loudspeaker (Jamo, Compact 60) was located at the front, right corner of the enclosure, under the visual display. A 1.3-cm observation hole was located at the center of the front panel.

All observers had access to the keyboard of a Macintosh SE computer that was connected to a custom-built interface which controlled independent access to the channels of the
cassette recorder. The audio output from the interface was amplified (Harman/Kardon integrated amplifier Model PM635) and presented via loudspeakers at 65-70 dB SPL. (A scale, measured at the head location of the infant). In order to prevent clicks at the onset and offset of the speech during presentation, the tape recording was ramped on and off with a rise-fall time of 30 ms (that is, the beginning and ending of the speech tape on any given trial was gradually increased/decreased between 0 and 65-70 dB over a 30 ms window of time).

Procedure
Testing of all infants took place in the infant speech perception laboratory at Virginia Polytechnic Institute and State University. A modification of an auditory preference procedure was used, originally designed by Colombo and Bundy (1981) and used previously in our laboratory (see Cooper & Aslin, 1994). Once the infant was awake, alert and non-fussy, he/she was placed in the infant seat within the enclosure. If the infant was asleep upon arrival, the parents and/or experimenter attempted to awaken the infant. Gentle massage, speech, turning off of overhead lights, or undressing the infant have all been found to gently awaken a sleeping infant and were attempted in such instances. If the baby was fussy, a diaper change, feeding, or rocking was used in an attempt to soothe the infant. If the infant could not be calmed, the session was terminated. If the infant could be brought to an awake, alert, non-fussy state, the procedure continued.

After placing the infant in the infant seat, an observer looked through the observation hole at the infant's face (1-month-olds). Prior to the start of the session, all observers donned earphones over which continuous hard-rock music was played in order to mask the speech sounds being presented (all observers reported that no extraneous sounds could be heard). When the infant looked towards midline, the grey panel covering the checkerboard was removed (1-month-olds). When the observer judged that the infant was looking at the display, she or he depressed a key to signal the onset of a look. The computer then accessed Channel 1 (or 2) of the tape recorder and either Maternal-ID [or Maternal-AD] was played over the loudspeaker. The speech remained on for the duration of the look. When the infant looked away from the checkerboard, the observer pressed the key again, signalling the end of the look. The speech stimulus and the visual display were turned off. This sequence comprised one trial, with trial length being determined by the infant's looking time and recorded by the computer.

The second trial accessed channel 2 (or 1), with the subsequent presentation of the speech type that was not played during Trial 1. The subjects were randomly assigned to receive either Maternal-ID or Maternal-AD speech first, with Maternal-ID and Maternal-AD speech alternating across trials for the remainder of the session. Sessions continued until a total of 10 trials (five each of Maternal-ID and Maternal-AD) had been completed, with the contingency that each trial must be at least 2 s in duration. In addition, if the infant closed his/her eyes or cried for more than approximately 20 consecutive s the session was discontinued and the data from that session were not included in any analyses.

In the present experiments, the amount of time an infant spent looking at the checkerboard while listening to different speech recordings was the primary dependent measure. “Preference” was operationally defined as significantly longer mean looking times to the visual display when looking was associated with a particular recording.

RESULTS
Looking Times
To determine whether infants looked longer at the checkerboard during either presentation of Maternal-ID or Maternal-AD speech, mean looking times to both speech types were calculated by dividing the sum of time spent looking during the presentation of each speech type by 5 (the number of trials of that speech type). A mixed 2 x 2 analysis of variance (ANOVA) was computed on the infants’ mean looking times, with order [Maternal-ID-first, Maternal-AD-first] as the between-subjects factor and speech type [Maternal-ID, Maternal-AD] as the within-subjects factor. Contrary to what we predicted, there was no significant main effect of speech type, $F(1, 18) = 1.61, ns$, with the average looking times for Maternal-ID speech ($M = 30.60 \text{s}, SE = 2.99$) being no longer than those for Maternal-AD speech ($M = 36.30, SE = 4.01$). Also, there was no significant order by speech type interaction, $F(1, 18) < 1.00$. However, the main effect of order approached statistical significance, $F(1, 18) = 4.27, p < .05$.

Because it was possible that the marginal main effect of order occurred due to an initial arousing effect of the Maternal-AD speech, we examined first trials independently. Previous studies in our lab using the same methodology found that infants often looked longer on the first trial depending on which speech recording was presented (e.g., Cooper & Aslin, 1990; 1994). In order to determine if a similar pattern of initial looking times was shown in the present study, an analysis of the first looks was conducted. There was a statistically significant difference between mean looking times on the first trial, $t(18) = 2.35, p < .03$, with longer looking times occurring when Maternal-AD speech was presented first ($M = 69.60 \text{s}, SE = 14.90$) compared to when Maternal-ID speech was presented first ($M = 31.50 \text{s}, SE = 6.60$). In order to examine whether the arousing effect of Maternal-AD speech increased attention across all trials in the session or was more transient in nature, a second ANOVA was conducted with the length of the first trial being omitted from the calculations of the mean looking times. Once
again, there was no significant main effect of speech type, $F(1, 18) < 1.00$, or order by speech type interaction, $F(1, 18) < 1.00$. Moreover, there was no significant main effect of order, $F(1, 18) = 1.99$, ns. Therefore, it appears that the order effect obtained in the first analysis was carried predominantly by longer looking times on the first trial when Maternal-AD speech was presented.

Acoustic Analyses
Because the speech samples from each mother were collected in naturalistic situations, acoustic analyses were conducted to insure that the selected samples did indeed vary on those parameters previously discussed as being important in the discrimination of ID from AD speech (e.g., pitch, pitch variability, duration, etc.). It was also considered important to determine the comparability of these prosodic features with previously reported analyses of the prosodic features of maternal ID and maternal AD speech (Fernald & Simon, 1984; Fernald et al., 1988; Grieser & Kuhl, 1988; Jacobsen et al., 1983; Stern et al., 1983).

The maternal speech samples were processed on a Micro Speech Lab II (MSL) system for the IBM computer, which allows measurement of fundamental frequency, amplitude, and duration of speech. By using the MSL program several acoustic parameters were identified for each selected Maternal-ID and Maternal-AD utterance (mean $F_0$, $F_0$ minimum and maximum, $F_0$ range, $F_0$ variance and utterance duration; see Table 1). Maternal utterances from each test tape were analyzed at 20,000 samples per s with a frame size of 20 ms. Mean values for each parameter were calculated for individual mothers’ ID and AD utterances. The mean value of each parameter was then calculated for Maternal-ID utterances and Maternal-AD utterances across mothers. Paired $t$ tests comparing Maternal-ID to Maternal-AD speech were calculated using the means across subjects. In order to adjust for inflated experimenter-wise error rates due to multiple comparisons, an alpha level of 0.01 was adopted for these analyses.

Statistically significant differences were found on all parameters with mean $F_0$, $F_0$-minimum, $F_0$-maximum, $F_0$-range and $F_0$-variability being greater in the ID samples, and the duration of the AD utterances being longer. These results are similar to those found in previous research on maternal speech to infants up to 24 months of age (see Table 2 for a cross-study comparison of the pitch features of ID and AD speech).

DISCUSSION
The results of this first experiment showed that 1-month-old infants did not look at a visual display (a checkerboard) significantly longer during the presentation of maternal ID speech as compared to the presentation of maternal AD speech. Thus, 1-month-olds do not appear to be differentially attentive to ID speech as compared to AD speech when both are spoken by the infant’s own mother.

In addition to overall looking time, another measure that may reflect differential responsiveness is the length of attention (e.g., looking) upon initial exposure to one stimulus type (e.g., Cooper & Aslin, 1990; Pegg et al., 1992). In these studies, infants looked longer during the first trial of their sessions when looking produced ID speech. Although the present study also found a marginally significant order effect,

<table>
<thead>
<tr>
<th>Prosodic Features</th>
<th>Maternal-ID</th>
<th>Maternal-AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M F_0$ (Hz)</td>
<td>219.30 (22.80)</td>
<td>184.30 (22.70)**</td>
</tr>
<tr>
<td>$M F_0$ Minimum (Hz)</td>
<td>96.00 (18.60)</td>
<td>82.90 (15.20)**</td>
</tr>
<tr>
<td>$M F_0$ Maximum (Hz)</td>
<td>386.20 (45.30)</td>
<td>328.20 (58.00)**</td>
</tr>
<tr>
<td>$M F_0$ Range (Hz)</td>
<td>291.60 (39.10)</td>
<td>251.30 (63.70)**</td>
</tr>
<tr>
<td>$M$ Variance (Hz)</td>
<td>74.50 (12.40)</td>
<td>49.10 (9.00)**</td>
</tr>
<tr>
<td>$M$ Duration (sec)</td>
<td>2.30 (1.00)</td>
<td>3.50 (1.50)**</td>
</tr>
</tbody>
</table>

Note: * $p < .01$, ** $p < .001$. 

TABLE 1
Summary of Prosodic Features of Maternal Infant-directed (ID) and Maternal Adult-directed (AD) Speech to 1-Month-Olds
TABLE 2
Cross-study Comparison of Pitch Features of Infant-Directed (ID) and Adult-Directed (AD) Speech

<table>
<thead>
<tr>
<th>Ages/Languages</th>
<th>Pitch Features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F₀ Mean</td>
</tr>
<tr>
<td></td>
<td>ID</td>
</tr>
<tr>
<td><strong>Newborn</strong></td>
<td></td>
</tr>
<tr>
<td>Fernald &amp; Simon (1984; German)</td>
<td>257</td>
</tr>
<tr>
<td>Stern et al. (1983; English)</td>
<td></td>
</tr>
<tr>
<td><strong>One month</strong></td>
<td></td>
</tr>
<tr>
<td>Cooper &amp; Aslin (1990; English)</td>
<td>312</td>
</tr>
<tr>
<td>Cooper et al. (present; English)</td>
<td>219</td>
</tr>
<tr>
<td><strong>Two months</strong></td>
<td></td>
</tr>
<tr>
<td>Grieser &amp; Kuhl (1988; Mandarin)</td>
<td>247</td>
</tr>
<tr>
<td><strong>Four to eight months</strong></td>
<td></td>
</tr>
<tr>
<td>Stern et al. (1983; English)</td>
<td>222</td>
</tr>
<tr>
<td>Cooper et al. (present; English)</td>
<td></td>
</tr>
<tr>
<td>Jacobsen et al. (1989; English)</td>
<td>255</td>
</tr>
<tr>
<td><strong>Twelve months</strong></td>
<td></td>
</tr>
<tr>
<td>Fernald et al. (1989) (English)</td>
<td>308</td>
</tr>
<tr>
<td>(German)</td>
<td>241</td>
</tr>
<tr>
<td>(French)</td>
<td>288</td>
</tr>
<tr>
<td>(Japanese)</td>
<td>277</td>
</tr>
<tr>
<td>(British)</td>
<td>262</td>
</tr>
<tr>
<td>(Italian)</td>
<td>266</td>
</tr>
<tr>
<td>Shute et al. (1989; British)</td>
<td>239</td>
</tr>
<tr>
<td>Stern et al. (1983; English)</td>
<td>366</td>
</tr>
</tbody>
</table>

in contrast to previous studies additional analyses showed that first looks were significantly longer when maternal AD speech was presented. When first looks were subsequently removed from the calculation of mean looking times, this order effect was eliminated. Thus, the only data to support differential responsiveness of infants in the present study were in the direction of maternal adult-directed speech.

One potential reason for the lack of preference for maternal ID speech over maternal AD speech is that the samples may not have differed enough on those prosodic parameters that differentiate ID from AD speech. However, acoustic analyses of the ID and AD utterances from the test tapes showed that on all measures examined, the ID utterances significantly differed from the AD utterances in the expected directions.

Because the ID and AD utterances in the present study were prosodically and linguistically distinct, it is surprising that the infants did not show a preference for the maternal ID speech. It was expected that the combination of ID speech and maternal voice would be especially attractive to young infants. Perhaps early in development, the maternal voice per se is such a perceptually powerful event that it overrides the preference for ID speech. If this is the case, then the removal of mother-as-speaker should enhance infants' interest in the ID speech. The next experiment tested this possibility.

**EXPERIMENT 2: PREFERENCE FOR NON-MATERNAL ID SPEECH IN ONE-MONTH-OLDS**

In this experiment, the maternal ID and AD recordings used in Experiment 1 were used to test 'naive' 1-month-olds' preferences. That is, infants unfamiliar with the women involved in these recordings were tested in the preference
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procedure, with each infant randomly assigned to one of the mother-voice tapes. It was predicted that these infants would show a preference for the ID speech because this study would be a partial replication of Cooper and Aslin (1990), in which 1-month-old infants were shown to prefer ID over AD speech.

METHOD

Participants

Twenty 1-month-old infants (16 males and 4 females) composed the final sample (M age = 42.70 days, SD = 6.70 days). An additional nineteen infants failed to complete testing due to excessive crying (11), sleeping (5), hiccups (1), and experimenter/equipment error (2). Infants were recruited in the same manner as those in Experiment 1, and all were healthy at the time of testing.

Apparatus and Procedure

The same as in Experiment 1.

RESULTS

Mean looking times were calculated by dividing the sum of time spent looking during the presentation of each speech type (ID and AD) by 5. A mixed 2 x 2 ANOVA was computed on these averaged looking times, with order (ID first, AD first) as the between subjects factor and speech type (ID, AD) as the within subject factor. The results of this analysis showed a significant main effect for speech type, F(1, 18) = 4.50, p < .05, with infants looking longer across ID trials (M = 34.25 s, SE = 5.60) compared to AD trials (M = 24.82 s, SE = 3.65). No other significant effects were found. As in Experiment 1, we also examined whether infant attention on the first trial was greater if listening to ID or AD speech. Although infants did look at the checkerboard longer on initial ID trials (M = 64.47 s, SE = 27.11) compared to initial AD trials (M = 36.35 s, SE = 13.29), this was not a statistically significant difference, t(18) < 1.00.

DISCUSSION

Importantly, the results from Experiment 2 help to clarify the lack of preference found in Experiment 1. That is, the 1-month-olds’ lack of preference for Maternal-ID speech in the first experiment cannot be attributed to the properties of the speech per se, otherwise the infants in this second experiment should not have preferred one recording over the other. In contrast, when listening to the same tapes that were presented in Experiment 1, the 1-month-olds in this second experiment preferred ID over AD speech.

It appears that listening to both ID and AD speech by one’s own mother overrides young infants’ general preference for ID speech. Infants’ preference for maternal ID speech must emerge sometime after this early postnatal period. Because Glenn and Cunningham (1983) found preferences for maternal ID speech in nine-month-olds, we know that this speech preference develops within the first postnatal year. We wanted to further explore the emergence of maternal ID speech preferences and decided to focus on 4-month-olds because it is at this age that mothers’ increase the use of exaggerated prosody in their speech to infants (Stern, Spieker, Barnett, & MacKain, 1982). We reasoned that this would be a good starting point because infants at this age have had a considerable amount of experience with both the maternal voice and infant-directed speech, and are increasing their participation in dynamic, multimodal interactions with their mothers (Brazelton, Koslowski, & Main, 1974; Schaffer, 1977; Sullivan & Horowitz, 1983).

EXPERIMENT 3: PREFERENCE FOR MATERNAL ID SPEECH IN FOUR-MONTH-OLDS

In this final experiment, 4-month-old infants and their mothers were recruited as were the participants in Experiment 1. Following the procedures presented in Experiment 1, recordings of mothers’ natural AD and ID speech were obtained from home visits and used to create test tapes for the mothers’ 4-month-old infants.

METHOD

Participants

Twenty-three 4-month-old infants (12 males and 11 females) composed the final sample (M age = 18 weeks, SD = 1 week). An additional six infants failed to complete testing due to excessive crying (1) or experimenter/equipment error (5).

Apparatus and Procedure

Generally the same procedure as that used in Experiments 1 and 2 was employed here, except that the 4-month-olds were tested in a slightly different apparatus. Their infant seat was positioned inside of a 4-walled black enclosure (80 cm x 80 cm x 60 cm, with an open ceiling), in which a 13-inch color television monitor (Mitsubishi KS1347R) was positioned in the front wall (approximately 40 cm from infant), offset slightly to the infant’s right side. Four-month-olds viewed a
RESULTS

To determine whether infants looked longer at the visual display (colored concentric circles) during either presentation of Maternal-ID or Maternal-AD speech, mean looking times to both speech types were calculated by dividing the sum of time spent looking during the presentation of each speech type by 5 (the number of trials of that speech type). A mixed 2 x 2 ANOVA was computed on the infants’ mean looking times, with order (Maternal-ID-first, Maternal-AD-first) as the between-subjects factor and speech type (Maternal-ID, Maternal-AD) as the within-subjects factor. The results of this analysis indicated a statistically significant main effect for speech type, $F(1,21) = 4.73$, $p < .05$, with infants showing longer average looking times on Maternal-ID trials ($M = 23.72$ s, $SE = 2.66$) compared to M(AD) trials ($M = 19.90$ s, $SE = 2.02$). No other significant effects were found.

Acoustic Analyses

As in Experiment 1, the maternal speech samples to 4-month-olds were analyzed on a Micro Speech Lab II (MSL) system for the IBM computer for differences in mean $F_0$, $F_0$ range, $F_0$ variability, and utterance duration. Paired $t$-tests comparing Maternal-ID to Maternal-AD speech were then calculated using the means across subjects. Again, an alpha level of .01 was used to adjust for inflated experimenter-wise error rates. The mean values and standard deviations for each parameter are presented in Table 3. Statistically significant differences were found on all parameters with mean $F_0$, $F_0$-minimum, $F_0$-maximum, $F_0$-range and $F_0$-variability being greater in the ID samples, and the average duration of the AD utterances being longer (see Table 3).

DISCUSSION

In contrast to the 1-month-olds tested in Experiment 1, the 4-month-olds in Experiment 3 showed a significant preference for Maternal-ID speech over Maternal-AD speech. Thus, sometime in the first months during postnatal life, infants appear to learn to attend more to their mothers when the mothers’ attention is focused primarily on the infant, at least in terms of the properties of the maternal voice. The acoustic analyses of the mothers’ voices in Experiment 3 bear out the results from similar analyses on mothers’ speech to younger infants (Experiment 1; see also Table 2). That is, maternal ID speech differed significantly from maternal AD speech on all of the comparison measures.

GENERAL DISCUSSION

In this series of experiments, infants were presented with recordings of female ID and female AD speech. When the female speaker was the participant’s own mother, 4-month-olds preferred her ID speech. In contrast, 1-month-olds did not show a preference for Maternal-ID over Maternal-AD speech. This finding is surprising given other studies showing that young infants prefer ID over AD speech when spoken by unfa-
familiar females (Cooper & Aslin, 1990; Pegg et al., 1992; Werker & McLeod, 1989). One explanation for this lack of preference may stem from the fact that we collected the voice samples "in the field", and may not have captured the maternal voices under ideal conditions. However, the results of Experiment 2 showed that 1-month-olds did prefer the ID over AD speech recordings provided that the infants did not recognize the female speaker. These results replicate earlier work showing preferences for ID speech in 1-month-olds (Cooper & Aslin, 1990; Pegg et al., 1992) and expand the reliability of this finding to include natural samples of maternal speech to young infants.

Another explanation for the lack of preference for maternal ID speech in 1-month-olds is that because the infants were present during the recording of their mothers' voices, they may not have preferred her ID speech during the subsequent testing situation due to its familiarity. This seems unlikely for two reasons. First, the average length of time between the interview session in the home and the test session in the laboratory was around 5 days. It can be safely assumed that within this interval, the infants heard quite a bit of maternal ID speech. In order for the ID speech during the interview to interfere with the infants' preferences several days later, the infants would need to have encoded and stored that speech separately from all subsequent ID speech. Second, if the familiarity of maternal ID speech masked infants' ID speech preferences, we would expect them to show preferences for the maternal AD speech due to its relative novelty. However, no such preference was found.

Instead, the preference for maternal ID speech appears to be an emergent feature of the infant's early perceptual experience and not a predisposition (biological or otherwise; Fernald, 1984; 1992; Jusczyk & Bertoncini, 1988; Trehub & Trainor, 1990) towards ID speech. The data presented here point to the importance of specifying the context in which infants' speech preferences are viewed, and raise the possibility that infants learn to respond selectively to their own mothers' intonated speech. One explanation for the changing patterns of preference for maternal ID speech may derive from differences in experience with maternal speech across the first postnatal months.

As discussed earlier, the literature on prenatal auditory experience suggests that fetuses are able to hear the maternal voice in the last weeks of pregnancy and that specific prenatal auditory experiences can bias newborns' attention to certain voices and sound patterns (DeCasper & Spence, 1986; Moon & Fifer, 1990a; Panneton, 1985; Spence & DeCasper, 1987; Spence & Freeman, 1995). Although there are no empirical data on maternal speaking styles to fetuses, it seems likely that a large amount of fetal experience with the maternal voice is within an AD speech context. That is, fetuses primarily listen to their mothers' speech to other adults and, perhaps, older children. At birth, the newborn should be most familiar with maternal AD speech. On the basis of previous findings, we do know that newborns prefer their mothers' voices (over that of an unfamiliar female) in an ID-speech-like context (e.g., reading a children's nursery rhyme; DeCasper & Fifer, 1980) but also when the mother is talking to another adult (Moon & Fifer, 1990b). However, a comparison of maternal ID to maternal AD speech has not been done. Future experiments could be designed to examine newborns' preferences for maternal ID vs. maternal AD speech. According to our discussion here, newborns may prefer maternal AD speech, even though newborns have shown preferences for ID speech when spoken by unfamiliar females (Cooper & Aslin, 1990).

The preference for maternal ID speech may develop as the context of mother-infant interaction changes across the first months after birth. During the first postnatal month, infants hear both maternal ID and AD speech which may explain why no preference is shown for either speech type. With the increased use of pitch contouring in ID speech by parents (particularly mothers) to their 4-month-old infants (Stern et al., 1983) ID speech emerges as a perceptually salient aspect of the infant-mother interaction. Interestingly, the maternal ID speech to 4-month-olds was not noticeably different from maternal speech to 1-month-olds in our study (compare Tables 1 and 3). In fact, the average range and average variability in F0 were greater in maternal speech to 1-month-olds compared to 4-month-olds. In spite of the similarity between the prosodic features of mothers' speech to their infants at these two ages, however, there may be
a large increase in the relative amount of maternal ID speech as the infant grows older. We are currently assessing this possibility in our lab by comparing speech samples of mothers talking to their 1-month-olds or 4-month-olds.

Moreover, increases in positive emotional signals from infants may act to further enhance positive emotional signals from caretakers (not only in caretakers’ speech patterns, but in their facial and postural expressions as well). For example, Werker and McLeod (1989) investigated 4- to 5- and 7- to 9-month-old infants’ preferences for ID speech as well as increased facial affect of infants who were listening to ID and AD speech. Werker and McLeod found that infants at these ages who were listening to ID speech displayed greater levels of positive affect than infants who were listening to AD speech. In this way, early infant-caregiver interactions may be mediated by the adult usage of ID speech and the infant’s preference for ID speech, both of which produce each other (a process of “co-regulation,” as used by Fogel, 1993).

Although the data from the present experiments do not completely rule out an adaptationist argument for maternal vocalizations as powerful biological signals (Fernald, 1992), perhaps a more parsimonious account could be derived from a “bioecological model” (see Bronfenbrenner & Ceci, 1994). According to these authors (as well as others), genetic material cannot produce finished behaviors (or traits) outside of the context in which gene-environment coactions take place. In other words, all developmental outcomes (whether or not they are regarded as biologically predisposed) depend on environmental influences. Bronfenbrenner and Ceci (1994) argue that much of human development is derived from “proximal processes”, which are defined as enduring patterns of interactions between “...evolving biopsychological human organisms and the persons, objects, and symbols in its immediate environment” (p. 572). The bioecological model contends that genetic potential, even for behaviors such as infants’ responsiveness to speech, can only be realized through proximal processes (in this case, the infant-caregiver relationship). Thus, we cannot fully understand the development of infants’ attractiveness to maternal vocalizations without considering both past and present proximal processes that have acted on this perceptual propensity. Continuing research on the role of ID speech in general, and specifically, the role of maternal ID speech is necessary in order for a more complete understanding of the development of mother-infant interactions.

AUTHORS’ NOTES

The first experiment of this study was conducted by Sheryl Berman, in partial fulfillment of the requirements for the Master of Science degree at Virginia Tech. The results of these experiments were presented at the 1992 and 1994 International Conferences for Infant Studies and at the Thirteenth Biennial Conference on Human Development. We are grateful to the infants and parents who participated in these experiments, to Amy Westfall, Julie Hicks, Jeff Piston, and Christine Dennis for their help with the data collection, and to the reviewers for their helpful suggestions.

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