MOTHERS' SINGING TO INFANTS AND PRESCHOOL CHILDREN

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Mothers were recorded singing two versions of the same song, one to their infants and the other to their preschool children. In Experiment 1, naive adult listeners accurately identified the infant-directed versions from each pair of mothers' songs. Pitch was higher for the infant-directed versions but tempo and intensity did not differ across contexts. In Experiment 2, naive listeners judged which version of each pair sounded more "loving" and which had clearer enunciation of lyrics. The versions sung to preschoolers were rated as more clearly enunciated than those sung to infants. Although there were no differences in "loving" tone of voice, "loving" ratings of infant-directed versions predicted identification accuracy.

Mothers speak differently to their infants than they do to adults, the former speech register variously known as motherese, baby talk, or infant-directed speech (Ferguson, 1964; Fernald & Simon, 1984; Garnica, 1977; Snow, 1977). The age of the child affects the nature of maternal speech (Snow, 1972; Stern, Spieker, Barnett, & MacKain, 1983), reflecting, perhaps, different communicative intentions—"social regulatory" versus "informational" (Fernald, 1991; Garnica, 1977; Warren-Leubecker & Bohannon, 1984)—and listener capabilities (Fernald, 1991; Stern et al., 1983; Trainor, 1996). Parental singing also differs noticeably in an infant's presence or absence (Trehub, Unyk et al., 1997; Trehub, Unyk, & Trainor, 1993b). There is no indication, however, whether the age of the child listener affects the nature of such singing. Accordingly, the current investigation aimed to compare maternal singing to preverbal (infant) and verbal (preschool) listeners.

The differences between infant-directed and adult-directed speech are numerous. Mothers raise their pitch, expand their pitch range, produce smooth, simple, and highly exaggerated pitch contours, decrease their tempo, slur their words, use a "sing-song" rhythm, repeat

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sounds, and elongate their vowels when speaking to their infants (Ferguson, 1964; Fernald & Simon, 1984; Garnica, 1977; Snow, 1977). Moreover, comparable changes in mothers’ and fathers’ speech to infants have been found in several languages, including Mandarin, French, Italian, German, Japanese, Swedish, and Russian (Fernald & Simon, 1984; Fernald et al., 1989; Grieser & Kuhl, 1988; Jacobson, Boersma, Fields, & Olson, 1983; Kuhl et al., 1997; but see also Ingram, 1995; Ratner & Pye, 1984). The characteristic features of infant-directed speech—higher pitch, increased pitch range, slower tempo—have been associated with happiness or affection (Fonagy & Magdics, 1963; Scherer, 1981). In fact, the speaker’s emotional state affects his or her vocal musculature (Scherer, 1986) and the resulting voice quality (Bachorowski & Owren, 1995; Murray & Arnott, 1993; Tartter, 1980; Tartter & Braun, 1994).

These vocal alterations have notable consequences for young listeners. In the early days and months of life, infants show attentional “preferences” for infant-directed speech over adult-directed speech (Cooper & Aslin, 1990, 1994; Fernald, 1985; Pegg, Werker, & McLeod, 1992). Spectral structure is presumed to be responsible for such preferences in newborns and 1-month-olds (Cooper & Aslin, 1994); pitch modulation is thought to underlie preferential responding in older infants (Cooper, 1997; Fernald & Kuhl, 1987; Papoušek, Bornstein, Nuzzo, Papoušek, & Symmes, 1990). Although attentional preferences are evident for male as well as female infant-directed speech (Pegg et al., 1992; Werker & McLeod, 1989), only female infant-directed speech has comparable affective consequences in early infancy (Fernald, 1993; Werker & McLeod, 1989). Moreover, differential attentional or affective responsiveness does not depend on previous exposure to the language in question (Fernald, 1993; Werker, Pegg, & McLeod, 1994). In any case, the melody (i.e., pitch contour) is considered to be the defining feature of infant-directed speech (Fernald, 1989; Papoušek et al., 1990), particularly after 1 month of age (Cooper & Aslin, 1994).

In an attempt to identify age-related changes in speech to infants, Stern et al. (1983) recorded mothers’ speech to their newborns and, subsequently, when the same infants reached 4, 12, and 24 months of age. Maximum pitch, pitch variability, and repetitiveness increased from birth to 4 months of age, decreasing thereafter until 24 months. Mothers talked longest and utterance length was greatest for 24-month-olds, but pauses between utterances were greatest for newborns. Stern et al. (1983) interpreted these differences in terms of changing infant needs and caregiving goals. For example, maternal concerns about overstimulating newborns may generate long pauses between utterances. By contrast, face-to-face contact reaches a maximum at 4 months of age, when many features of infant-directed speech achieve their most extreme values. According to Stern et al. (1983), mothers use various speech maneuvers to gain and hold infants’ attention. From 12 to 24 months, when infants become increasingly object- and language-oriented, mothers talk more and use longer utterances. In so doing, they support infants’ exploratory and communicative goals.

Age-related changes in maternal articulation are also evident. When Kuhl et al. (1997) examined mothers’ spoken vowels to 2- to 5-month-old infants in the United States, Sweden, and Russia (relative to typical adult speech), they found exaggerated acoustic values, which presumably conferred a flowing or soothing quality to such speech. Moreover, mothers pronounce vowels and consonants more distinctly for children who are beginning to talk than for younger or older children (Malsheen, 1980; Ratner, 1984). Specifically, consonants are pronounced with considerable precision for 12-month-olds (Malsheen, 1980); vowels are pronounced more clearly for children with a mean length of utterance (MLU) of 2.5-4.0 than for prelinguistic infants or for children with MLUs of 1.0 (Ratner, 1984). Mothers also stress important or new information in their speech to 14-month-olds by means
of higher pitch, greater intensity, or placement of key words in utterance-final position (Fernald & Mazzie, 1991). In short, mothers tend to highlight relevant linguistic units to their language-learning children.

Maternal speech may be responsive not only to children’s linguistic capabilities but also to the social context. For example, mothers who assist their children in the performance of specific tasks show the characteristic increase in pitch height and pitch range when talking to 2-year-olds but not to 5-year-olds (Garnica, 1977). By contrast, Warren-Leubecker and Bohannon (1984) failed to find comparable differences in pitch (but not in pitch range) in mothers’ speech to 2- and 5-year-olds during spontaneous play. According to Fernald (1991), the speech to 2-year-olds served “social regulatory” functions, such as attempting to influence children’s mood or social responsiveness; by contrast, the speech to 5-year-olds had social regulatory goals (Warren-Leubecker & Bohannon, 1984) at times and “informational” goals, such as instructing or guiding children in the performance of a task (Garnica, 1977), at other times. Although informational speech would be reserved for children with appropriate linguistic skills, social regulatory speech is applicable over a wider range of linguistic ability. Nevertheless, Fernald and Dorado (cited in Fernald, 1991) showed that mothers use more social regulatory speech with infants than with children 3-4 years of age, which may be reflected in higher pitch level with infant listeners. As noted, maternal pitch range reaches a peak at 4 months, decreasing subsequently until 24 months of age (Stern et al., 1983). Perhaps maternal pitch range continues to decrease until children reach some threshold of communicative competence such as 3-5 years of age. At that time, it may not be critical to use distinctive vocal devices to attract and direct children’s attention, as it is with less able children. Instead, conventional informational speech may recruit attention as successfully as high-pitched, social regulatory speech does for younger children.

If mothers are sensitive to their children’s needs and abilities, as the aforementioned studies imply, then children’s differential responsiveness to aspects of the speech signal may come to shape maternal speech style. For example, 4- to 11-month-olds notice the pitch contours of speech and musical patterns (Fernald, 1991, 1992; Papoušek et al., 1990; Trehub, Bull, & Thorpe, 1984; Trehub, Thorpe, & Morrongiello, 1987), 6- to 11-month-olds notice the rhythmic organization of tone sequences (Thorpe & Trehub, 1989; Thorpe, Trehub, Morrongiello, & Bull, 1988; Trehub & Thorpe, 1989), and 4.5- to 10-month-olds are sensitive to phrase boundaries in speech and music (Juszczyk & Krumhansl, 1993; Kemler Nelson, Hirsh-Pasek, Juszczyk, & Cassidy, 1989; Krumhansl & Juszczyk, 1990).

Mothers change their singing style as well as their speech style for infant listeners. Performances of songs in an infant’s presence involve a more emotionally engaging voice quality (Trehub, Uynk et al., 1997) and a more “loving” tone of voice (Trainor, 1996) compared to performances of the same material in an infant’s absence. Mothers also produce “exaggerated” performances—more playful versions of playsongs and more soothing versions of lullabies—when they sing directly to their infants than in the infant’s absence (Trainor, 1996; Trainor, Clark, Huntley, & Adams, 1997; Trehub, Hill, & Kamenetsky, 1997). Infant-directed playsongs are typically characterized by increased duration and intensity of stressed syllables, increased intensity range, higher pitch level, more variable pitch, more energy at lower frequencies, slower tempo, and lengthened inter-phrase pauses relative to non-infant-directed playsongs (Trainor et al., 1997; Trehub & Trainor, 1998). Even the lyrics are rendered more expressively in infant-present than in infant-absent contexts (Trehub et al., 1997). These features of songs to infants closely parallel those observed in speech to infants.

Trehub, Uynk, and Trainor (1993b) recorded North American and Indian mothers singing in English and Hindi, respectively, in
the presence and in the absence of their infants (same song in both contexts). On average, mothers sang more slowly and showed more gliding between pitch levels (more typical of speech than of music) when the infant was present than when the infant was absent. Adult listeners readily identified the infant-directed versions, even in unfamiliar languages, lending support to the notion of cross-cultural similarities in infant-directed singing (Trehub, Unyk, & Trainor, 1993a), as in speech (e.g., Fernald, 1993; Fernald et al., 1989; Grieser & Kuhl, 1988). Even when English-speaking mothers and fathers attempted to simulate their infant-directed singing in the infant's absence, the infant-absent versions were still distinguishable from infant-present versions, even for listeners who were unfamiliar with the language and culture of the singers (Trehub, Unyk et al., 1997).

If parents sing in a unique style for their infants, does this imply that such young listeners notice and prefer this style? Indeed, infants show attentional preferences for infant-directed over non-infant-directed performances (Trainor, 1996). Moreover, they show affective preferences for lullabies over play-songs as well as adults' songs, and for mothers' singing over fathers' singing (Trehub & Henderson, 1994). The pitch level of the sung performances seems to play a role in these preferences. For example, infants prefer the higher pitched of two versions of the same song by the same singer (Trainor & Zacharias, in press). However, they show no preference between fathers' infant-present and infant-absent songs except when the performances are electronically altered to make the pitch level approximate that of mothers (O'Neill, 1997).

Although the findings on infant-directed singing are consistent with those on infant-directed speech, it is unclear whether mothers produce comparable age-related changes in singing style. We know that mothers change their speech style to children of different ages (Garnica, 1977; Snow, 1972; Stern et al., 1983), but altered content may be at least partially responsible for the altered speech style.

To date, however, no study has equated the content of maternal utterances across different naturalistic contexts. Mothers would be unlikely to say the same things to their infants and preschoolers, but they might very well sing some of the same songs. In principle, at least, it would be feasible to compare mothers' sung performances to listeners of different ages.

There are a number of reasons why stylistic differences as a function of listener age might be less marked for singing than for speech. In the case of speech, informational aspects are primary and social regulatory aspects secondary except for very young listeners and specific social contexts (Fernald, 1991). Thus, one would expect a progressive shift in emphasis from social regulatory to informational components of speech as children gain in linguistic and cognitive maturity (Fernald, 1991; Garnica, 1977; Warren-Leubecker & Bohannon, 1984). Songs, by contrast, serve social or "mood-altering" functions throughout life even though some of them, such as "The ABC Song," have pedagogical components. If songs were primarily informational, their singing would cease once the content had been mastered. What happens, instead, is that mothers initially sing songs to their infants and toddlers; they subsequently sing some of these songs with their toddlers and preschoolers (Trehub & Schellenberg, 1995). This situation should lead to reduced variation as a function of listener age, just as free play contexts reduce the differences between mothers' speech to children of different ages (Warren-Leubecker & Bohannon, 1984). A mother's singing style would likely reflect her feelings as well as her social goals. Although her caregiving goals might differ somewhat for her infant and preschooler, her feelings would likely have a similar, presumably positive, valence. Finally, songs are more constrained than speech in the sense that the melody, rhythm, and words of the former are prescribed.

Nevertheless, it is conceivable that mothers' singing style would differ for children with different linguistic abilities (i.e., their potential for understanding the words or infor-
mational components of songs) and different social-emotional needs. For example, performances of songs for infants and preschoolers might reflect different relative emphases on state optimization versus play or pedagogy. Mothers likely sing in a soothing or playful manner to alter or maintain the mood of infants and preschoolers, but they might add informational elements for preschoolers, highlighting key words such as labels for numbers, alphabetic symbols, or objects. Within the constraints of song form, these different goals could be accomplished, in principle, by means of different performance devices. To maintain attention and positive affect, mothers might raise their pitch level, decrease their tempo, increase their intensity range, or elongate their vowels, in line with maternal adjustments in speech and song to infants and young children (Ferguson, 1964; Fernald & Simon, 1984; Gar- nica, 1977; Snow, 1977; Stern et al., 1983; Trainor, 1996; Trainor et al., 1997). The extent to which such goals are similar for infants and preschoolers, differences in the use of these devices might be minimal or absent altogether. Because of the apparent importance of pitch level for infant song preferences (O’Neill, 1997; Trainor & Zacharias, in press), a finely tuned performance for infants might incorporate higher pitch. For preschoolers, particularly if they were “song learners,” mothers might emphasize the linguistic components of songs by means of clearer articulation, as in their speech to language-learning children (Fernald & Mazzie, 1991; Malsheen, 1980; Ratner, 1984).

We recorded and compared mothers’ performances of the same songs to their infants and preschool children. First, we examined the ability of naive adult listeners to identify the infant-directed versions (Experiment 1). Second, we measured a number of acoustic features of the performances such as pitch, tempo, intensity (loudness), phrase duration, and vowel elongation (Experiment 1). Third, naive listeners provided ratings of various features such as tone of voice and articulation (Experiment 2).

**EXPERIMENT 1**

**Method**

**Participants**

The mothers (N = 18), who were recruited from the community, had an infant 6 to 11 months of age (M = 8;6 months) and a preschooler 2;10 years to 3;11 years of age (M = 3;3 years), approximately 2 1/2 years older than the infant. The educational level of mothers included a 4-year college degree (n = 14), some college education (n = 3), and a high school diploma (n = 1). The adult listeners consisted of 31 women and 35 men, 19 to 66 years of age (M = 27.5 years), who volunteered or received partial course credit for their participation. The latter participants had an average of 3.3 years of musical training (77.7% with little or no musical training).

**Stimuli and Apparatus**

Digital recordings of the mothers were made in an IAC sound-attenuating booth by means of a SHURE 5155D microphone, a Denon PMA-680R stereo amplifier, and SoundScope software (GW Instruments, Inc.) on a Radius 81/110 computer. Identical portions of two recordings from each mother were selected according to the following criteria: (a) as close as possible to the beginning of the song; and (b) little noise or extraneous cues to the age of the child listener (e.g., child vocalizations). Although some noise remained in a few of the excerpts, it provided no unique cues to the age of the listener, as judged by two independent, skilled listeners. The stimuli for adult listeners consisted of 18 pairs of singing samples (one pair from each mother) in random order (total of 36 songs), with order of infant-directed and preschooler-directed songs (first or second in the pair) counterbalanced. The stimuli were presented to adult participants over Sony CD550 headphones through a
Power Macintosh 8100/100 computer connected to a NAD 3225PE stereo amplifier.

**Procedure**

Mothers were instructed to sing a song that they normally sang to both of their children at home. The order of singing to the infant or preschooler was counterbalanced across mothers. To reduce the mother’s self-consciousness, the mother was alone with her infant or preschooler child for each recording session. Each mother was encouraged to select the most comfortable of the following arrangements: (a) sitting on a chair with her child on her lap; or (b) sitting on a blanket on the floor. Adult listeners were tested individually. They listened to successive paired excerpts of mothers’ songs (infant-directed and preschooler-directed), judging, for each mother, which of the two versions had been sung to an infant. They were also asked to list the basis for their judgments.

**Results and Discussion**

The songs sung by each of the mothers are listed in Table 1. As can be seen in Table 1, the variety of sung material was limited. For example, 5 of the 18 mothers sang “Twinkle, Twinkle, Little Star,” 2 sang “The ABC Song,” and 1 sang “Baa, Baa Black Sheep,” all of which share the same tune. In a previous study of parental singing (Trehub, Unyk et al., 1997), 26.7% of mothers sang this tune when asked to sing a song of their choice in the presence and absence of their infants. In fact, five different songs in the present study had been sung in the previous study. The parallels in song selection confirm the local repertoire of songs for infants and the use of comparable songs with preschoolers.

Of the 66 participants who attempted to identify the infant-directed version, 5 were excluded because of experimenter error (n = 3) or for noting that they had listened for extraneous noises to guide their judgments (n = 2). Adults identified the infant-directed version on 61.84% of trials (SD = 11.45), which significantly exceeded chance values (M = 50%), t (60) = 42.177, p < .0001. Correct identification of infant-directed songs for individual mothers ranged from 27% to 84% (see Figure 1).

The following acoustic measures (with the exception of tempo) were obtained using SoundScope software. The average tempo (beats per minute) of each song was matched by ear to a metronome by two skilled listeners. To ensure that the obtained tempo values accurately reflected the songs, we measured the duration of the same phrase in each of the mothers’ songs. We also measured the duration of pauses between phrases and the duration of vowel portions in each syllable. The overall intensity (loudness) of the songs was obtained.
by summing the voltages for the vowel portion of each syllable. Comparisons of tempo, phrase duration, pauses between phrases, vowel elongation, and intensity (loudness) across singing contexts failed to reveal differences between infant and preschooler versions (see Table 2). Note, however, that intensity measurements could have been influenced by the distance of the mother from the microphone or by the tendency of recording equipment to equalize intensities. Nevertheless, variations in intensity were evident within each performance but not across performing contexts.

Pitch was initially measured by means of SoundScope software, but some samples were sung too softly or in a whisper-like tone, precluding reliable instrumental measurements. Because the pitch was audible, even for softly rendered or whispered portions, an alternative procedure was used. The initial pitch in each recording was independently matched to notes on an electric keyboard by two musically trained listeners who had no information about the context of the recordings (inter-rater reliability = 97.2%). The difference in semitones between the initial pitch of mothers’ perfor-

<table>
<thead>
<tr>
<th>Acoustic Measure</th>
<th>Infant</th>
<th>Preschooler</th>
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<tbody>
<tr>
<td><strong>Pitch (Hz)</strong></td>
<td>219.90</td>
<td>210.15</td>
</tr>
<tr>
<td><strong>Tempo (beats per minute)</strong></td>
<td>118.00</td>
<td>117.44</td>
</tr>
<tr>
<td><strong>Phrase duration (s)</strong></td>
<td>7.08</td>
<td>7.21</td>
</tr>
<tr>
<td><strong>Pause duration (s)</strong></td>
<td>1.08</td>
<td>0.99</td>
</tr>
<tr>
<td><strong>Total length of vowels (s)</strong></td>
<td>4.44</td>
<td>4.53</td>
</tr>
<tr>
<td><strong>Intensity (volts per syllable)</strong></td>
<td>0.20</td>
<td>0.20</td>
</tr>
</tbody>
</table>

*p = .0002.
performances to infants and preschoolers is shown in Figure 2. It is interesting to note that when these pitches are converted into frequency equivalents, the initial pitch level of mothers’ songs to infants ($M = 219.90$ Hz) corresponds closely to the measured level ($220.03$ Hz) in a previous study (Trehub, Uvný et al., 1997). To ensure that the initial pitch was a reliable estimate of the overall pitch level for each performance, we measured another instance of the same note (by the same means) in a later portion of the excerpt. If a second instance of the same note was unavailable, we measured two instances of another note. There were no reliable differences across the two notes. Because mothers generally stayed in key throughout the excerpts, any single note provided a reasonable estimate of their pitch level.

The obtained pitch differences, in semitones, between mothers’ performances to infants and preschoolers ($M = .81, SD = .73$) significantly exceeded the expected differences ($M = 0$), $t(17) = 4.68, p = .0002$, indicating that the initial pitch of infant-directed songs was significantly higher than that of preschooler-directed songs. A second analysis was performed on the 10 mothers for whom instrumental measurements were available. Because the pitch measurements were in logarithmically scaled units (Hz), we facilitated the analysis of subtle pitch differences across contexts by converting the measurements to pitch intervals (following Campbell & Greated, 1987). This conversion involves taking the ratio of the fundamental frequency of the infant-directed and preschooler-directed versions and applying the formula: $12 \times \log_2 (\text{infant } F_0 / \text{preschool } F_0)$. The resulting value ($M = 1.07, SD = .89$) significantly exceeded the expected value ($M = 0$), $t(9) = 3.79, p = .0043$. As can be seen in Figure 2, every mother’s pitch in the infant-directed context was equal to or higher than her pitch in the preschooler-directed context. The differences in pitch ranged from 0 to 5 semitones, with a modal pitch difference of 1 semitone.

A simple regression of pitch level differences on the average percent correct identifica-
tion for each mother was not significantly predictive of identification, accounting for a mere 2.18% of the identification variance. The failure of pitch level differences to predict identification implies that listeners were using other characteristics of mothers’ performances to distinguish the infant-directed from preschooler-directed versions.

Why, then, might the songs for infants have a higher pitch level than those for preschoolers? Perhaps mothers have to work harder to gain and hold the attention of infants compared to preschoolers. In other words, mothers’ performances to infants may be geared primarily to state optimization, and they may be sensitive to infants’ preference for high pitch (Fernald, 1991; Trainor & Zacharias, in press). If mothers’ higher pitch also reflects greater emotional engagement (Trainor, 1996; Trehub et al., 1997) or more positive affect (Fonagy & Magdics, 1963; Scherer, 1981; Tartter, 1980; Tartter & Braun, 1994) with infants relative to preschoolers, then ratings of the emotional quality of the performances should differ. For preschoolers, the familiarity of mothers’ songs may have been sufficient to engage their attention. Indeed, a number of preschoolers chose to sing along with their mothers for a verse or two.

**EXPERIMENT 2**

To evaluate the possibility that mothers were more emotionally engaged with their infants than with their preschool children, we had adult listeners judge which of the two versions was sung with a more “loving” tone of voice, a quality that had previously distinguished infant-present from infant-absent versions of mothers’ songs (Trainor, 1996), and was presumably equivalent to ratings of emotional engagement that had also distinguished infant-present from infant-absent versions (Trehub, Unyk et al., 1997). To ascertain whether mothers altered their articulation for more linguistically skilled children, as would be expected in speaking contexts (Fernald & Mazzie, 1991; Malsheen, 1980; Ratner, 1984), these adult listeners also judged which of the two versions incorporated clearer pronunciation of the words.

**Method**

**Participants**

The adult listeners (N = 22), consisting of 15 women and 7 men, 23 to 44 years of age (M = 35.0 years), were college and community volunteers, who had, on average, 1.9 years of musical training (90.9% with little or no musical training).

**Stimuli and Apparatus**

The stimuli consisted of the same 18 counterbalanced pairs of singing samples (one pair from each mother) from Experiment 1 presented in random order (total of 36 songs). Adult participants listened to these materials over Sony CD550 headphones through a Radius 81/110 computer connected to a Denon PMA-680R stereo amplifier.

**Procedure**

Adult listeners, who were tested individually, judged which of the two versions was sung with clearer articulation of the words and in a more loving tone of voice after listening to each pair of mothers’ songs.

**Results and Discussion**

Listeners rated preschooler-directed versions of the mothers’ songs as more clearly articulated than the infant-directed versions in 59.85% of all comparisons (SD = 13.05), which significantly exceeded the expected value (M = 50%), t (21) = 3.54, p = .0019. However, neither version received systematic ratings of a more “loving” tone of voice. Nevertheless, “loving” ratings (i.e., the percentage of naive listeners who judged each infant-directed version as more loving than the corresponding preschooler-directed version) were highly cor-
Table 3

Summary of stepwise regression analysis for variables predicting correct identification
(N = 18)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
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<tbody>
<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Loving” ratings</td>
<td>.647</td>
<td>.134</td>
<td>.770*</td>
</tr>
<tr>
<td>Step 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Loving” ratings</td>
<td>.626</td>
<td>.129</td>
<td>.746*</td>
</tr>
<tr>
<td>Articulation ratings</td>
<td>.273</td>
<td>.147</td>
<td>.294</td>
</tr>
</tbody>
</table>

*p = .0002.

related with the accuracy of identification of infant-directed versions, r = .755, p < .0001. In fact, a stepwise regression revealed that “loving” ratings were the best predictor of the accuracy of identification of infant-directed versions, R² = .593, p = .0002. The addition of articulation ratings to the model was marginally significant (ΔR² = .082, p = .07), together accounting for 67.52% of the variance (see Table 3). Pitch differences between infant-directed and preschooler-directed versions did not add predictive power to the model.

It is reasonable that mothers enunciated their words more carefully for preschoolers who could understand the words than for infants who were merely being soothed or entertained. Although mothers in general did not exhibit greater emotional engagement when singing to infants than to preschoolers, those who did complied with naive listeners’ expectations, facilitating their identification of infant-directed versions. In short, mothers produced distinctive versions for their infants and preschoolers, using different devices for each—more precise articulation for preschoolers and higher pitch for infants. Clear presentation of words may hold the attention of preschoolers just as high pitch does for infants.

**General Discussion**

The present findings confirmed the use of somewhat different styles of maternal singing for infants and preschoolers. Mothers sang at a higher pitch level for infants than for pre-
schoolers, but their tempo, phrase duration, pause duration, vowel elongation, and intensity levels were comparable across contexts (Experiment 1). Moreover, adults rated mothers’ pronunciation of words as clearer for preschool than for infant listeners (Experiment 2). Despite the subtlety of these differences, independent listeners identified the infant-directed versions at better than chance levels. In previous comparisons of mothers’ singing in infant-present and infant-absent contexts, mothers sang more slowly, with more emotional engagement, and at a higher pitch level in the infant’s presence than in the infant’s absence (Trainor, 1996; Trehub et al., 1997; Trehub, Unyk, & Trainor, 1993b). The failure to find tempo, phrase duration, pause duration, vowel elongation, intensity, and tone of voice differences in the present study indicates that such adjustments in sung performances are not directed uniquely to infants but to children in general. For example, the mother’s tone of voice may reflect similar, positive feelings for each of her children. Other maternal vocal devices may be used for similar attentional goals with infants and preschoolers.

How can we interpret higher maternal pitch for infant than for preschool listeners? High pitch as a signal of affection (e.g., Föngny & Magdics, 1963; Scherer, 1981; Trainor, 1996; Trehub et al., 1997) is unworkable as an explanation of infant-preschooler differences, given the absence of “loving” tone of voice differences. Although more smiling to infants would result in higher pitch (Tartter, 1980; Tartter & Braun, 1994), there is no basis for arguing that mothers smile more to infants than to preschoolers. Instead, the attention-getting function of high pitch (Fernald, 1991; Stern et al., 1983) may be relevant for prelinguistic listeners. By contrast, careful articulation for preschoolers may serve attention-holding as well as pedagogical goals. In any case, the differences in articulation parallel those observed in speech contexts (Ferguson, 1964; Fernald & Simon, 1984; Garnica, 1977; Snow, 1977), indicating, perhaps, that mothers are modeling the songs for their preschoolers.
Although ratings of articulation did not allow access to the relative accentuation of consonants and vowels, it is likely that judgments of clear articulation arose from the distinct pronunciation of consonants. Mothers typically accentuate their vowels to infants (Kuhl et al., 1997), which may be a by-product of their slow speaking rate and their emotive goals. Mothers’ vowel elongation (Fernald & Simon, 1984; Gamaica, 1977) contributes a flowing quality to the resulting speech or song. By contrast, clear production of consonants in speech (e.g., Maliseen, 1980; Ratner, 1984) and song is likely to have informational, even instructional, goals. Although songs performed for infants are mainly about feeling (e.g., contentment, security, happiness), those performed for preschoolers are also about objects and events in the world. In other words, songs for preschoolers have denotative meanings as well as emotional connotations.

Some researchers have hypothesized that the meaning of infant-directed speech is principally in its melody (Fernald, 1989; Papaoušek et al., 1990; Stern, Spieker, & Mackain, 1982), but this type of meaning (i.e., melody) was constrained by the predetermined tunes of songs and by the use of the same songs for both children. Mothers seemed to fine-tune their performances by means of higher pitch for infants and clearer articulation for preschoolers. To the extent that the “meaning” of mothers’ performances was in the melody (Fernald, 1989), this meaning was similar for infants and preschoolers, as reflected in common pitch contours, rhythm, tempo, and tone of voice. Presumably, these features conveyed positive affect and a playful or soothing quality. Moreover, all mothers sang songs in the major mode, which children are thought to associate with positive affect (Dolgin & Adelson, 1990; Hill, Kamenetsky, & Trehub, 1996; Kastner & Crowder, 1990).

The present findings are consistent with the view that singing to infants and preschoolers is primarily a social regulatory activity, but that mothers also enhance informational components in their songs to preschoolers. In light of the subtle differences between the two sung versions, it is likely that the primary function in both cases is to maximize the mood of the interactants. For example, mothers use lullabies or playsongs to modulate the arousal level of their children (e.g., Trainor et al., 1997). Indeed, a number of mothers in the present study reported that they sing to their children to get them to sleep or to entertain them while doing chores, practices that are widespread across cultures (Trehub & Trainor, 1998). In the case of infants, at least, we know that they are suitably responsive listeners (Trainor, 1996; Trehub & Trainor, 1998).

Although the infant-directed versions were primarily (or exclusively) social regulatory, the preshooler-directed versions also contained informational components. Apart from soothing or entertaining their preschool-aged children, mothers engaged them by dramatic emphasis of key words. Presumably preschoolers knew all or part of these songs, so that mothers’ clear articulation generated the appropriate associations. Perhaps mothers’ performances of novel songs would reveal even clearer articulation of the words.

Maternal speech to infants and preschoolers seems to be characterized by considerably greater stylistic variation than is the case for maternal singing. From data provided by Fernald et al. (1989) and Garnica (1977), we estimated the pitch difference between maternal speech to infants and preschoolers as roughly 3-5 semitones. The modal difference between mothers’ songs to infants and preschoolers was 1 semitone. However, mothers’ speech to children of different ages differs not only in pitch level but also in content and syntactic structure. By contrast, mothers in the present study were required to sing the same song to both of their children. In all likelihood, the repertoire of maternal songs for infants and preschoolers differs. If the entire repertoire were sampled or if mothers were free to choose different songs for each listener, greater differences might become apparent. For conversational situations involving stereotyped speech patterns (“Good morning!”) or those in which social
regulation is primary ("That’s a good girl!"), stylistic variation may be reduced across age levels. For example, Warren-Leubecker and Bohannon (1984) found subtle pitch differences but no other differences in maternal speech to 2- and 5-year-olds during free play.

Comfort may also dictate the range of pitch variation in speech and song. Adults seem to experience no difficulty sustaining high pitch levels when they speak to infants, young children, or foreigners. Moreover, they are not obligated to maintain any pitch level. By contrast, inexperienced singers may be unable to go beyond relatively narrow limits without experiencing vocal strain. Moreover, the tune dictates how subsequent pitches must be related to earlier pitches.

Although the present study permitted systematic comparisons of acoustic and stylistic features of the same songs performed for different listeners, it lacked ecological validity in a number of respects. The requirement of singing in a sound-attenuating chamber may have contributed to expressive inhibition on the part of singers and/or listeners. Furthermore, asking children not to sing along with their mothers, at least initially, further reduced the natural quality of the interaction. If mothers usually sing different songs to their infants and preschoolers except when the children are together, then similar performances across contexts would be expected. Having mothers sing the most appropriate (i.e., typical) songs for each of their children may well maximize performance differences, but it would trivialize the identification task, allowing it to be based on song selection rather than performance cues.

In summary, mothers sang at a higher pitch level for their infants than for their preschoolers; their lyrics were judged to be more clearly pronounced when they sang for preschoolers than for infants. These and other as yet unspecified differences may reflect fine-tuning to the children’s linguistic abilities and attentional responsiveness. Regardless of the subtlety of the performance differences, naive listeners successfully distinguished the versions for infants from those for preschoolers.

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