

## Mothers' and Fathers' Singing to Infants

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Mothers and fathers sang a song of their choice, once to their infant and once as if to their infant (simulated). The pitch of songs was higher and the tempo slower for infant-directed than for simulated versions. Listeners varying in child-care experience, musical background, and cultural origin reliably identified which of the two versions was infant-directed (Experiment 1). Identification accuracy was enhanced by musical training, knowledge of the singers' language and culture, and by greater pitch and tempo differences between versions. Other adult listeners who rated the singer's emotional engagement assigned significantly higher ratings to infant-directed than to simulated versions (Experiment 2). Differences in pitch and tempo between both versions predicted emotional engagement ratings. Finally, rating differences between infant-directed and simulated versions were highly correlated with identification accuracy.

Affectional ties that bind infants to their most intimate companions (Bowlby, 1969, 1973) have their roots in communication between caregiver and infant. Such communication can take various forms including touching, rocking, smiling, laughing, talking, and singing. Perhaps "babyish" appearance (Sternglanz, Gray, & Murakami, 1977) and vocal quality (Bloom, 1990; Bloom & Lo, 1990) are among the factors that contribute to the infant's appeal and, in turn, to the caregiver's emotional engagement. If this engagement is reflected in the caregiver's vocalizations, then it may have affective consequences for the infant listener (Fernald, 1993; Werker & McLeod, 1989) and corresponding implications for the development of attachment.

When mothers interact with their prelinguistic infants, they elevate their pitch, simplify their pitch contours, expand their pitch range, and speak slowly and repetitively (Fernald, 1991; Papoušek, Papoušek, & Haekel, 1987; Stern, Spieker, & MacKain, 1982). These speech adjustments are likely universal, having been documented in numerous languages and cultures (Fernald, Taeschner, Dunn, Papoušek, de Boysson-Bardies, & Fukui, 1989; Grieser & Kuhl, 1988; Papoušek & Hwang, 1991; Papoušek, Papoušek, & Symmes, 1991; but see Brice Heath, 1983; Ratner & Pye, 1984). Although men, women, and children alter their infant-directed speech in fundamentally similar ways (Fernald et al., 1989; Jacobson, Boersma, Fields, & Olson, 1983; Papoušek et al., 1987; Tomasello & Mannle, 1985), fathers typically engage in less vocalization, pitch range expansion, and

melodic repetition compared with mothers (Fernald et al., 1989; Papoušek et al., 1987).

The prosody of infant-directed speech may provide insight into the speaker's state, caregiving attitudes, and awareness of infant signals. Indeed, the link between specific pitch contours and caregiving circumstances is best exemplified by the provision of low, falling contours to soothe distressed infants; high, rising contours to capture and maintain their interest; and intense, abrupt vocalizations to discourage undesirable actions (Fernald, 1989; Ferrier, 1985; Papoušek et al., 1991; Stern et al., 1982). Such speech seems to accomplish the desired goals, as indicated by enhanced attention and affect to expressions of approval (Cooper & Aslin, 1990; Fernald, 1985, 1993; Papoušek, Bornstein, Nuzzo, Papoušek, & Symmes, 1990; Pegg, Werker, & McLeod, 1992) and reduced attention to expressions of disapproval (Fernald, 1993; Papoušek et al., 1990).

Given the links between music and emotion (Brown, 1981; Davies, 1994; Langer, 1957), the biological roots of emotional vocalizations (Frick, 1985; Scherer, 1981, 1986), and the prominence of musiclike features in infant-directed speech (Fernald, 1992; Papoušek & Papoušek, 1981; Papoušek et al., 1987), parental singing to infants might be expected to serve communicative and regulatory functions comparable to those of infant-directed speech. In fact, singing to infants is prevalent across cultures (Brakeley, 1950) and historical periods (Tucker, 1984), but it has received relatively little attention from the scholarly community. We know, however, that adult listeners can distinguish foreign lullabies from nonlullabies, even when the songs are matched on prominent cues such as tempo (Trehub, Unyk, & Trainor, 1993a). Moreover, songs with simple contours (few changes in pitch direction) and a preponderance of falling contours—features characteristic of soothing infant-directed speech—tend to be judged as lullabies (Unyk, Trehub, Trainor, & Schellenberg, 1992).

Not only is there a distinctive repertoire of songs for infants (Trehub & Schellenberg, 1995), but there is also a distinctive performing style. The presence of an infant generates an explicit or implicit caretaking agenda and may also alter the caregiver's

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emotional state. Because facial gestures (e.g., smiling) and body posture can change the shape of the vocal tract and the acoustic features of the resulting speech (Laver, 1980; Tartter, 1980; Tartter & Braun, 1994) or song (Fonagy, 1981; Sundberg, 1973, 1991), the caregiver's feelings and actions have potentially audible consequences. Perhaps it is not surprising, then, that naive adult listeners are highly accurate at differentiating English and foreign songs that are sung with an infant audience from the same songs that are sung with no infant audience (Trehub, Unyk, & Trainor, 1993b). Nevertheless, listeners are better with same-culture materials, which implies that culture-specific as well as culture-general components are present in songs to infants, as in speech (Fernald et al., 1989; Grieser & Kuhl, 1988; Papoušek et al., 1991).

Despite the parallels between speech and song to infants (Trehub, Trainor, & Unyk, 1993), the devices for achieving appropriate vocal performances necessarily differ across domains. For example, pitch contour is considerably less constrained in speech than it is in song, in which the dictates of a tune must prevail. Similarly, the temporal patterning of adult speech to noncomprehending listeners is, in principle, free of the metrical and rhythmic constraints of particular songs. Moreover, musical exposure and training would have an obvious bearing on song reception and production but would be irrelevant to speech. Nevertheless, the ability to identify lullabies (Trehub et al., 1993a) and to discern infant-directed song performances (Trehub et al., 1993b) across disparate cultures implies that there are at least some universal structural and stylistic adjustments in infant-directed singing that are perceptible to untrained listeners. Although researchers are making some headway in delineating the structural features of musical compositions for infants (see Trehub & Schellenberg, 1995; Unyk et al., 1992), the characteristic performance adjustments remain to be specified.

The goals of the present investigation were fourfold. First, we sought to determine whether the presence of an infant is necessary for the full set of infant-directed song adjustments, as it is for infant-directed speech (Fernald & Simon, 1984; Jacobson et al., 1983; Murray & Trevarthen, 1986). Although adult listeners in previous research (Trehub et al., 1993b) could distinguish between songs that were sung in an infant's presence or absence, the singers had not attempted to achieve identical performance quality in both contexts. Rather, they simply sang in ways that were appropriate to each context. In the present study, however, parents were asked to simulate, as closely as possible, their usual manner of singing to infants, even when the infant was not there to hear the song. If listeners could distinguish actual from simulated renditions of infant-directed singing, then it would imply that the presence of an infant audience induced perceptible changes in performance. On the basis of acoustic correlates of emotion in speech (Bachorowski & Owren, 1995; Ohala, 1984; Scherer, 1986) and their association with emotional labels (Tartter, 1980; Tartter & Braun, 1994), we expected parental singing to infants to be distinguishable from its simulated counterpart.

Second, we sought to describe the performance adjustments, if any, associated with parental singing to infants, estimating the contribution of particular adjustments to listeners' identification accuracy. Although the infant's presence would likely lead to

more emotive performances, the need for infant monitoring might divide the singer's attention, resulting in some performance degradation.

Third, we sought to establish whether fathers as well as mothers sing distinctively to their infants. On the basis of fathers' secondary role in caregiving, coupled with their fewer infant-directed speech adjustments (Fernald et al., 1989; Papoušek et al., 1987) and lesser sensitivity to children's attentional focus (Brachfeld-Child, Simpson, & Izenson, 1988; Malone & Guy, 1982; Mannle & Tomasello, 1987; Power, 1985) than mothers, we expected mothers' infant-directed singing to be more transparent than that of fathers. Clearer evidence of acoustic cues to positive emotion in women's speech compared with men's (Bachorowski & Owren, 1995) is also in line with these predictions.

Fourth, we sought to specify the contribution of culture, caregiving experience, and musical background to listeners' identification of infant-directed singing. Specifically, would it be possible for listeners whose language and culture differ from those of singers to detect differences between actual and simulated infant-directed performances? Would extensive child-care experience such as that involved in parenting facilitate the identification of infant-directed singing? Would musically trained listeners be more sensitive than untrained listeners to performance nuances associated with infant-directed singing?

### Pilot Study

To shed light on the ecology of singing to infants, we conducted a preliminary investigation in which 67 families documented all instances of singing to infants on a designated day in which the families were pursuing their usual routine. They recorded, on a standardized form, who sang what song to their infant, when (time of day), and in what situations (feeding, playing, soothing, putting infant to bed) on the day in question. They also provided more general information on the frequency and regularity of their singing to infants.

What we learned was that 74% of all songs to infants were sung by mothers, 14% by fathers, 8% by siblings, and 4% by others. The majority of mothers (72%) claimed to sing often or always; a minority of fathers (26%) did likewise. By contrast, far more fathers than mothers (74% and 28%) reported singing only occasionally or rarely. Typically, singing to infants accompanied other activities such as play, sleep preparation, feeding, travelling by car, diaper changing, and bathing (see Table 1). Thus, it is not surprising that the most common songs were play songs, followed by lullabies, popular songs, and invented songs (see Table 1). In short, mothers were the predominant singers, play songs the predominant song type, and play the typical activity accompanying singing. On the basis of this pilot study, we had reason to believe that mothers and fathers might sing to their infants very differently.

### Experiment 1

Mothers' and fathers' singing was recorded in their infant's presence and in their infant's absence. Listeners differing in child-care experience, musical training, and language-culture

Table 1  
Incidence of Song Context and Song Type

Classification	Percentage
Song context	
Play	36
Feeding	19
Sleep preparation	19
Travelling by car	10
Diaper changing	6
Bathing	6
Other	4
Song type	
Play	62
Lullaby	11
Popular	10
Invented	8
Other (religious, folk, unknown)	9

attempted to distinguish the infant-directed from the simulated versions.

### Method

**Participants.** The singers consisted of 16 mothers and 15 fathers, all from different families, who had infants 4–18 months of age. In all of these families, mothers assumed the primary caregiving role and fathers an assistive or secondary role. None of the singers had more than a few years of musical training in childhood. One father and one mother were excluded from the composite audiotape because, unlike the other parents, they did not sing regularly to their infants. An additional father was excluded because of extremely poor vocal control, which precluded reliable instrumental measurements of his singing. Accordingly, the final sample of singers (for purposes of data analysis) consisted of 15 mothers and 13 fathers.

The 170 listeners in the musically “untrained” group consisted of (a) 18 mothers, 28–44 years of age ( $M = 36.2$  years), the majority (94%) of whom had little or no musical training and all of whom were primary caregivers of children under 2 years of age; (b) 38 college freshmen (introductory psychology students: 18 women, 20 men), 18–22 years of age ( $M = 19.5$  years), the majority (84%) of whom had little or no formal training in music; and (c) 114 adults from the local community (57 women, 57 men), 18–64 years of age ( $M = 32.0$  years), the majority (85%) of whom had little or no formal training in music. “Untrained” participants across the three subgroups had 0 to 8 years of music lessons ( $M = 1.18$  years) in childhood. The “trained” group consisted of 42 adults (26 women, 16 men), 18–43 years of age ( $M = 21.2$  years), all of whom were college music education majors. These participants had several years of instrument training, ear training, and choral music experience. The “foreign” group consisted of 20 recent immigrants (12 women, 8 men), 22–74 years of age ( $M = 44.7$  years), all of whom were enrolled in elementary ESL (English as a second language) classes. Cultures of origin included Chinese, Somali, Polish, Punjabi, Indonesian, Spanish, Japanese, Russian, German, Korean, Iranian, Ukrainian, and Armenian. The majority (90%) reported no formal training in music.

**Apparatus and procedure.** Samples of singing were recorded (Marantz #PMD 430 cassette tape recorder, lapel microphone) in the homes of mothers and fathers who had infants 4–18 months of age. Parents were told that we were studying informal singing and were gathering casually sung materials from numerous sources. We asked half of the mothers and fathers to sing a song of their choice to their infant. We

asked the other half to sing a song as they typically sang it to their infant but to do so without the infant present (i.e., simulated). Some time after completing the initial songs, parents were instructed to sing the same song again in the contrasting condition. To minimize the singer's self-consciousness, the experimenter left the room before each recording session, leaving the parent to start and stop the recording equipment. From these recorded samples, we created four composite tapes, consisting of two orders of the song pairs of the 15 mothers and two orders of the song pairs of the 14 fathers (including 1 father whose data were subsequently discarded). Each tape had a series of paired excerpts of infant-directed and simulated infant-directed singing, each pair featuring the same singer in both contexts. We used the identical initial portions of the songs for both excerpts in each pair, unless they did not meet the principal selection criteria of good recording quality, no infant vocalizations (an obvious cue to infant-directed singing), and no distracting environmental noises. In such instances, another representative portion of the song was selected. The position of the infant-directed excerpt (first or second) was randomized.

The untrained participants listened to the sung materials individually (audio cassette player 3191C, Bell & Howell, Skokie, Illinois) in a quiet room on campus (for students) or in the community (for community-based volunteers). Participants were informed, by means of standardized written instructions, that (a) they would hear several pairs of excerpts of singing by mothers and fathers, (b) one excerpt in each pair had been sung to an infant, the other “as if” to an infant but without the infant present, and (c) they were required to identify the infant-directed excerpt in each pair (labelled as *a* or *b* on the recording) on a standardized answer sheet. After completing each part of the task (the mothers' or fathers' tape), they were asked to report, in writing, the criteria used in making their judgments. Participants were randomly assigned to one of the four composite tapes described above. Musically trained participants were tested as a group in a regularly scheduled class, receiving the same standardized written instructions and answer sheet as the untrained listeners. Group administration necessitated a single order (mothers-fathers and song pairs); recordings of mothers were presented first, followed by those of fathers. An experimenter closely monitored participants in the group session to ensure that students worked independently on the task. The foreign participants were tested individually with the help of a translator when necessary.

### Results and Discussion

The titles of songs that parents sang are shown in Table 2. It is interesting that “Twinkle, Twinkle Little Star,” “The ABC Song,” and “Baa, Baa Black Sheep” apply different lyrics to a common tune, which means that the melody selected by a full 25% of the singers (7 of 28) was indeed the same. Performance style was classified as *playful* (15 song pairs) or *soothing* (11 song pairs) on the basis of independent ratings by several individuals who had no knowledge of the study. For two parents, their infant-directed and simulated performances received different classifications. Perhaps some songs (e.g., “Twinkle, Twinkle Little Star,” “Baa, Baa Black Sheep”) are more amenable than others to alternative renderings (playful or soothing) by different singers, which might account for their greater incidence.

Analyses of the samples of singing were performed by means of SoundScope software (GW Instruments, Somerville, MA) used in conjunction with a Macintosh Quadra 950 computer and an Audiomeia II sound card (Digidesign, Menlo Park, CA). The pitch of each excerpt, defined as the tonic or principal pitch (first degree of the scale of the melody), was identified by a musicologist and measured (i.e., fundamental frequency mea-

Table 2  
Incidence of Parental Songs and Singing Styles

Title	Style		
	Playful	Soothing	Mixed <sup>a</sup>
Twinkle, Twinkle Little Star	1	2	0
Itsy, Bitsy Spider	3	0	0
Row, Row, Row Your Boat	0	2	0
A,B,C Song	0	2	0
Baa, Baa Black Sheep	1	1	0
Three Little Monkeys	2	0	0
If You're Happy	1	0	0
Happy Birthday	1	0	0
The Wheels on the Bus	0	1	0
Flowers are Red, Young Man	0	0	1
Humphra to the Bottom	1	0	0
Hush Little Baby	0	1	0
Doo-Wah Ditty	1	0	0
I Love Amanda Dear <sup>b</sup>	0	0	1
If You're Messy (from <i>Sesame Street</i> )	1	0	0
Mandy	0	1	0
Slippery Fish	1	0	0
Skinna-Marink	1	0	0
Michael Row Your Boat Ashore	0	1	0
It's Bath Time in Canada <sup>b</sup>	1	0	0

<sup>a</sup> Playful in one context, soothing in another.

<sup>b</sup> Invented songs.

surement) by means of the SoundScope software. For the two parents who chanted (i.e., recited the words of a song rhythmically) rather than sang, their poetic line endings served as reference pitches. An analysis of variance (ANOVA) with repeated measures (singer sex as a between-subjects factor and context as a within-subject factor) revealed a significant effect of singer sex,  $F(1, 26) = 37.55, p < .0001$ , and of context (infant-directed vs. simulated),  $F(1, 26) = 5.57, p < .05$ . The pitch levels of male and female singers are presented in Table 3. As would be expected on the basis of differences in vocal tract size, mothers' pitch was significantly higher than that of fathers. More relevant for the present purposes, however, was that the pitch of infant-directed excerpts was significantly higher than

Table 3  
Fundamental Frequency of Tonic Pitch in  
Infant-Directed and Simulated Contexts

Singer	Tonic pitch level			
	<i>M</i>	<i>SD</i>	Minimum	Maximum
Infant-directed				
Mother	220.03	35.66	147.51	279.16
Father	140.81	37.66	94.87	243.35
Mothers and fathers	183.25	53.93	94.87	279.16
Simulated				
Mother	214.98	31.70	146.38	276.94
Father	135.11	34.16	90.77	220.27
Mothers and fathers	177.90	51.82	90.77	276.94

Table 4  
Tempo in Beats per Minute in Infant-Directed  
and Simulated Contexts

Singer	Tempo			
	<i>M</i>	<i>SD</i>	Minimum	Maximum
Infant-directed				
Mother	109	25	48	151
Father	71	17	47	100
Mothers and fathers	91	29	47	151
Simulated				
Mother	114	25	51	143
Father	77	23	52	130
Mothers and fathers	97	30	51	143

that of simulated excerpts. The 20 parents who sang their infant-directed versions at a higher pitch level than their simulated versions (as reflected in tonic pitch) raised their pitch by two semitones or less, reflecting the greater constraints on pitch adjustments in infant-directed singing compared to speaking, in which a pitch change of 3–4 semitones is typical (Fernald et al., 1989).

To achieve a measure of musical tempo (i.e., speed), a musicologist parsed each excerpt into metrical units (i.e., bars or measures), selecting three units from each excerpt for further analysis. (The same bars were used for a given infant-directed–simulated pair.) Beats per bar were divided by the duration of the bar in seconds, and the resulting beats per second were averaged across representative bars. Finally, this average was converted to beats per minute (i.e.,  $\times 60$ ), the standard unit of musical tempo. Tempo data are shown in Table 4. A repeated-measures ANOVA revealed a significant effect of singer sex,  $F(1, 26) = 19.32, p < .0005$ , with mothers singing faster than did fathers. The context also exerted a significant effect on tempo,  $F(1, 27) = 12.89, p < .005$ , with infant-directed versions sung more slowly than simulated versions. A simple regression analysis revealed that increases in pitch in the infant-directed context were associated with slowing of tempo in the same context ( $r = .45, p < .05$ ).

Correct identification of infant-directed songs by the untrained group of listeners ranged from 46–86% correct ( $M = 71.8\%$ ) for mothers' singing and 53.1–83% correct ( $M = 69.6\%$ ) for that of fathers. A repeated-measures ANOVA comparing percentage correct identification for mothers' and fathers' singing across the three subgroups of untrained English-speaking listeners (mothers, psychology students, and general community members) revealed no group differences and no significant effect of singer or listener sex. Accordingly, the three subgroups were combined into a single group of untrained listeners. A one-sample  $t$  test revealed that performance was well above chance levels (50% correct),  $t(27) = 9.05, p < .0001$ . These results imply that mothers and fathers make perceptible adjustments when singing to their infants compared with their simulations of such singing. Moreover, these adjustments are perceived by mothers of young children, male and female college students

with relatively limited child-care experience, and members of the local community.

A repeated-measures ANOVA comparing the accuracy of identifying mothers' and fathers' infant-directed singing revealed significant effects of group (musically untrained, musically trained, and recent immigrants),  $F(2, 229) = 21.58, p < .0001$ , and of sex of singer,  $F(1, 229) = 5.10, p < .05$ . Overall, musically trained listeners were most accurate ( $M = 79.1\%$ ), followed by musically untrained listeners from the local community ( $M = 70.6\%$ ), and, finally, by recent immigrants ( $M = 60.0\%$ ), whose performance was still above chance levels,  $t(27) = 3.91, p < .001$ . All three groups differed significantly from one another (Fisher's least significant difference,  $p < .0001$ ). Although listeners identified mothers' infant-directed songs ( $M = 72.7\%$ ) more accurately than those of fathers ( $M = 69.8\%$ ), these performance differences were relatively small, and no effects were attributable to the order of presentation of mothers and fathers. Moreover, there was no effect of sex of listener and there were no significant interactions.

The failure of mothers of young children to outperform college students implies that extensive child-care experience was unrelated to the identification of infant-directed singing. Extensive musical training, however, facilitated identification accuracy. Although foreign listeners' successful identification of parents' infant-directed singing suggests universals in song performance to infants, their attenuated performance relative to same-culture listeners also suggests culture-specific adjustments. Contrary to expectations, the marked differences in frequency and regularity of mothers' and fathers' singing, as revealed in the pilot study, failed to translate to major differences in the identification of their singing.

What cues facilitated the identification of infant-directed singing? Simple regression analyses revealed that the higher the pitch of infant-directed excerpts relative to simulated excerpts, the greater was identification accuracy ( $r = .379, p < .05$ ). Moreover, the greater the decrease in tempo from simulated to infant-directed contexts (calculated as simulated tempo  $\div$  infant-directed tempo in beats per minute), the more accurate the identification of infant-directed singing,  $r = .54, p < .005$ . A multiple regression analysis revealed that changes in pitch and tempo, considered together, predicted correct identification only slightly better than did changes in tempo alone,  $R = .561, p < .01$  (see Table 5). Thus, tempo changes and, to a lesser extent, pitch changes in parental singing are cues to the presence of an infant, but other features of sung performances are likely implicated. For example, participants' open-ended (written) responses regarding the basis for their judgments indicated a preponderance of comments about vocal quality: "smiling sound," "soft voice," "sense of involvement," and "warm voice."

## Experiment 2

The purpose of the present experiment was to ascertain whether vocal qualities indicative of emotional engagement differentiate infant-directed from simulated excerpts, and whether such vocal qualities contribute to listeners' accuracy of identifying infant-directed singing. Accordingly, listeners who were unaware of the singing context rated the degree of emotional engagement for infant-directed and simulated excerpts. On the

Table 5  
Summary of Multiple Regression Analysis for Variables Predicting Correct Identification ( $N = 28$ ) and Emotional Engagement ( $N = 28$ )

Variable	B	SE B	$\beta$
Correct identification			
Changes in tempo	.616	.246	.471*
Changes in pitch	.001	.002	.154
Emotional engagement			
Changes in tempo	3.176	1.267	.411*
Changes in pitch	.022	.009	.397*

\*  $p < .05$ .

basis of listeners' comments about singers' vocal quality in Experiment 1, we expected ratings of emotional engagement to be significantly higher for infant-directed than for simulated excerpts. We also expected differences in emotional engagement between infant-directed and simulated excerpts to be related to the accuracy of identifying infant-directed excerpts in Experiment 1. Finally, Bachorowski and Owren's (1995) finding of clear acoustic cues to positive emotions in female but not male speakers would be consistent with higher ratings of emotional engagement on the part of female singers.

## Method

**Participants.** The participants were 100 adults (50 women, 50 men), 18–75 years of age ( $M = 37.2$  years), who were recruited from the general community. Although we did not solicit information about education and musical training from this sample, our experience has revealed a lower average level of education and musical training for community samples recruited unselectively compared with typical samples of college students.

**Materials.** We used the tapes of infant-directed and simulated excerpts from Experiment 1, one tape for mothers and one for fathers.

**Procedure.** Participants were tested individually with recorded materials presented by means of a cassette tape player (Craig JS8222, Cerritos, CA) and stereo headphones (Sony MDR-P10 or Koss WM/60, Milwaukee, WI). They were informed by means of standardized written instructions (a) that they would hear several pairs of recorded excerpts of parents singing to their infant children (two versions of each song by each singer), and (b) that they should make spontaneous judgments about the voice quality of each excerpt, rating the singer's emotional engagement with the infant listener on a 9-point scale with the following designations of emotional engagement: 1 (*very low*); 3 (*some*); 5 (*intermediate*); 7 (*high*); and 9 (*total*). Intervening numbers had no accompanying description. To reduce the possibility that very high ratings of the initial excerpt of a pair might constrain the ratings of the second excerpt, participants were told to reserve the highest possible scores (8 and 9) for vocal qualities associated with unexpected or outstanding degrees of emotional engagement. Half of the participants listened to the mothers' tape first; the other half listened to the fathers' tape first.

## Results and Discussion

Data from one of the fathers were excluded, as in Experiment 1. A repeated-measures ANOVA, with context (infant-directed–

simulated) and singer sex as within-subject factors, revealed a significant main effect of context,  $F(1, 99) = 177.85$ ,  $p < .0001$ . Infant-directed versions ( $M = 5.25$ ) were rated as more emotionally engaging than simulated versions ( $M = 4.61$ ), but there was no effect of singer sex and no interaction between singer sex and context. Moreover, there was no effect of the order of presentation of mothers' and fathers' excerpts. Thus, listeners heard more emotional engagement in the infant-directed than in the simulated version of the same song by the same singer, but they found mothers' singing no more emotionally engaging than that of fathers.

We used simple regression analyses to determine whether untrained listeners' accuracy of identifying infant-directed singing in Experiment 1 was related to differences in emotional engagement ratings between simulated and infant-directed versions. Rating differences were highly predictive of percentage correct identification,  $r = .755$ ,  $p < .0001$ , indicating that the larger the difference in emotional engagement ratings between infant-directed and simulated versions, the higher the accuracy of identifying infant-directed excerpts. Moreover, the higher the pitch of infant-directed compared with simulated versions, the greater the difference in emotional engagement,  $r = .593$ ,  $p < .001$ . Tempo differences between infant-directed and simulated excerpts also predicted differences in emotional engagement between the two versions,  $r = .596$ ,  $p < .001$ . Specifically, the more parents slowed their tempo of singing from infant-directed to simulated contexts, the greater the differences in perceived emotional engagement. Absolute values of tempo, however, were unrelated to emotional engagement. Similarly, only relative differences in tonic pitch between infant-directed and simulated versions were predictive of differences in emotional engagement. Finally, a multiple regression analysis revealed that changes in pitch and tempo, considered together, were more predictive of differences in emotional engagement between infant-directed and simulated versions than was either factor alone,  $R = .694$ ,  $p < .005$  (see Table 5).

### General Discussion

The results of Experiments 1 and 2 shed light on the four principal goals of the present investigation. First, adult listeners, whether men or women, musically trained or untrained, experienced or inexperienced in child care, and familiar or unfamiliar with the language and culture of the singers, distinguished samples of parents' singing to infants from comparable samples in which parents simulated such singing. These findings imply that mothers and fathers intuitively adjust their infant-directed singing, as is the case for their infant-directed speech (Fernald & Simon, 1984; Jacobson et al., 1983). In other words, an infant's presence seems to be necessary for parents' production of the full complement of infant-directed song features. What may be most difficult for parents to simulate are those features that are a consequence of their emotions. Even trained actors achieve less than perfect simulations of emotional speech (Williams & Stevens, 1972).

Second, when parents sing directly to their infants, they do so at a higher pitch level, slower tempo, and in a more emotionally engaging manner than is the case for their simulations. Pitch is acknowledged to be an important vocal indicator of emotion,

with higher pitch associated with happiness, affection, tenderness, and increased arousal (Ekman, Friesen, & Scherer, 1976; Ponagy & Magdics, 1963; Ohala, 1984). Listeners' accuracy of distinguishing infant-directed from simulated versions was highly correlated with ratings of emotional engagement by independent listeners, which implies that the singer's emotional engagement is an important cue to the presence of an infant listener. Such emotional engagement, which may arise, in part, from affection for the infant and, in part, from attempts to engage the infant's attention, seems to be transmitted by means of vocal quality or timbre (i.e., spectral structure). Indeed, vocal quality, which continues to elude precise description (Murray & Arnott, 1993), is believed to be more important than pitch in differentiating one emotion from another (Scherer, 1986).

The emotional expressiveness of the parent's sung messages may promote and sustain reciprocal emotional ties between parent and infant. By contrast, performance features such as tempo and pitch level, along with metrical articulation and phrasing, may define the soothing or arousing character of the song. Thus, despite the constraints on pitch and temporal patterning imposed by musical compared with spoken materials, parents, who were all untrained singers, used a considerable range of features to achieve emotionally expressive performances. The demands of infant monitoring did not obscure the expressive aspects of the performance but may have even enhanced the resulting performance.

Why do parents sing more slowly in the presence of infant listeners? Slowing of tempo may accommodate the infant's limited processing capacity. It may also result, in part, from division of the singer's attention between the song, on the one hand, and the infant's behavior, on the other. The correlation of changes in tempo and pitch with changes in perceived emotional engagement would be consistent with these interpretations. It is also possible that slowing of tempo is linked more directly to emotional expression. According to Knower (1941), much of the emotional content of speech is transmitted by means of its timing patterns. There are claims, moreover, that gentleness and affection are expressed by slow tempo (Davitz, 1964; Magdics, 1963).

Third, fathers, like mothers, produced perceptible adjustments in their infant-directed singing. Despite fathers' lesser involvement in caregiving and less frequent singing to infants, their infant-directed singing was readily distinguishable from their simulated singing, as was the case for mothers. Moreover, fathers produced vocal changes (e.g., pitch, tempo) that were roughly comparable to those of mothers, with the result that listeners found their songs to infants to be as emotionally engaging as mothers' songs. Can we be confident, then, that there are minimal differences between mothers' and fathers' singing to infants? Not at all! Our cursory survey of singing to infants indicated that mothers provided most of the singing that infants heard (74%), fathers contributing relatively little (14%) in this regard. Moreover, our long-term experience of requesting samples of singing from parents indicates that mothers rarely refuse such a request but that fathers (for a variety of reasons) frequently do so. It follows, then, that a sample of mothers and fathers who sing regularly to their infants, as in the present study, will necessarily be less representative of fathers than it is of mothers. What must remain unspecified, then, are the "true"

stylistic differences between mothers' and fathers' singing to infants. Nevertheless, it is possible that visual and behavioral characteristics of infants act as innate releasing stimuli (Alley, 1981; Lorenz, 1943), leading to emotional engagement that is apparent in the singing voice, if parents choose to sing, and in the speaking voice, if they choose to talk.

Despite similarities in the singing style of mothers and fathers, some differences were evident. Mothers tended to sing songs that were more stereotyped, child-oriented, and simpler in form and content (e.g., "Twinkle, Twinkle Little Star," "Itsy, Bitsy Spider") than those of fathers, some of whom altered popular or folk songs (e.g., "Mandy") or created complex songs especially for their infant. Conventional children's songs are highly repetitive, verbally and melodically (Trehub & Schellenberg, 1995), much like typical speech to infants and young children (Fernald, 1991). The lesser frequency with which fathers sang children's songs may have stemmed from unfamiliarity with the children's repertoire as opposed to a preference for complex materials. Nevertheless, the greater complexity of fathers' non-singing interactions with their infants, independent of degree of caretaking involvement (Lamb, 1982), is consistent with the greater complexity of their songs. In any case, parental differences in song choices were largely irrelevant to the stylistic distinctiveness of infant-directed and simulated versions or to the degree of emotional engagement.

Fourth, high levels of musical training increased the accuracy of distinguishing mothers' and fathers' infant-directed singing from their simulations. The extended and broad-based training of college majors in music education may have given them privileged access to nuances in emotional expressiveness and other aspects of singing performance. The absence of such training merely lessened but did not prevent the detection of relevant changes in infant-directed singing. In previous research, less extensive levels of musical training had no impact on the identification of lullabies (Trehub et al., 1993a) or on the differentiation of infant-directed singing from casual performances without an audience (Trehub et al., 1993b).

An examination of other listener variables indicated that listeners who were relatively unfamiliar with the language and culture of the singers performed more poorly than those from the same culture. What is unclear, however, is whether cultural differences in caregiving, social display rules (Buck, 1984), or expressiveness in singing were responsible for the performance differences. Comparable difficulties with English-speaking listeners and Hindi-speaking singers have been noted previously (Trehub et al., 1993b). In any case, above chance performance by immigrants who were unfamiliar with the English language and with local customs points to commonalities across cultures, which may stem from performance features indicative of emotional engagement.

Listeners' sex or child-care experience had no bearing on the accuracy of discerning infant-directed singing or the evaluation of its expressiveness. These findings underline the emotive quality of mothers' and fathers' singing to infants and its transparency to listeners who are inexperienced in music or in child care. Finally, it is imperative to assess the impact of such performances on the infant listeners for whom they are intended. Infants' "preference" for infant-directed over noninfant-directed (but not simulated) versions of the same songs (Trainor,

1996) indicates that they are sensitive to at least some nuances of performance. Whether they are sensitive to the more subtle distinctions between simulations and actual performances to an infant audience remains to be determined.

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