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## Infants' Responsiveness to Fathers' Singing

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Fathers were recorded singing a song once to their infants and once in the absence of their infants. Adults readily identified fathers' infant-directed renditions and rated them as more rhythmic, loving, and appropriate for infants than the infant-absent renditions. Unlike mothers, however, fathers did not consistently raise the pitch of their infant-directed versions. Moreover, infants showed no preference for infant-directed over infant-absent versions unless the infant-directed versions were higher in pitch. Nevertheless, infants showed greater visual attention when listening to fathers' singing than to mothers' singing. The results confirm that a distinctive infant-directed style is used by singing fathers as well as mothers, that pitch height is a salient dimension of songs for infant listeners, and that fathers' singing in general is highly engaging to infant listeners.

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SINGING, like speaking, is a universal form of human communication and an important medium for emotional expression and cultural transmission (see Trehub & Trainor, 1998, for a review). Mothers alter their style of singing in the presence of an infant (Trehub, Unyk, et al., 1997), and such infant-directed (ID) singing recruits infants' attention more effectively than does their usual, infant-absent (IA) singing (Trainor, 1996). Adults readily identify the ID versions (Trehub, Unyk, & Trainor, 1993b); adults' ratings of "emotional engagement" and "loving" tone of voice are highly predictive of their identification accuracy (Trainor, 1996; Trehub, Unyk, et al., 1997). Although fathers also modify their singing in the presence of an

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infant (Trehub, Unyk, et al., 1997; Trehub, Hill, & Kamenetsky, 1997), the consequences for infant listeners are unknown. Accordingly, the principal goal of the present investigation was to examine infants' responsiveness to fathers' singing.

Cross-cultural investigations have revealed a number of similarities in caregivers' ID speech (Ferguson, 1964; Fernald & Simon, 1984; Fernald, Taeschner, Dunn, Papoušek, Boysson-Bardies, & Fukui, 1989; Grieser & Kuhl, 1988; Papoušek, Papoušek, & Symmes, 1991) and singing (Trehub, Unyk, & Trainor, 1993a, 1993b; Unyk, Trehub, Trainor, & Schellenberg, 1992). In general, ID speech and song are characterized by higher pitch, greater pauses between phrases, slower tempo, and simpler structures relative to their IA counterparts (Trainor, Clark, Huntley, & Adams, 1997; Trehub & Trainor, 1998). As with singing, emotional communication is a primary function of the prosodic modifications of ID speech (Trainor, Austin, & Desjardins, 2000). One factor that may motivate the use of the ID style is favorable feedback from infant listeners, who show clear preferences for ID over non-ID speech (e.g., Cooper & Aslin, 1990; Fernald, 1985; Fernald & Kuhl, 1987) and for ID over IA singing (Trainor, 1996).

The two principal song genres for infants, lullabies and play songs, are associated with several systematic differences in performance. Mothers' renditions of ID play songs, but not ID lullabies, have increased shimmer (variations in intensity across short time periods), increased pitch variability, and greater rhythmicity (as indicated by the relative duration of stressed to unstressed syllables) compared with IA renditions (Trainor et al., 1997). By contrast, ID lullabies exhibit decreased rhythmicity relative to IA renditions. Infants respond somewhat differently to the two song types, as reflected in greater focus on themselves while listening to lullabies and greater focus on caregivers while listening to play songs (Rock, Trainor, & Addison, 1999). At the same time, ID renditions of lullabies and play songs share many acoustic features, including increased pitch, increased jitter (frequency variation across short time periods), and relatively intense lower frequencies (resulting in a distinctive timbre or voice quality; Trainor et al., 1997). Although infants prefer to listen to ID over IA singing, the impact of most of these features remains unknown. The one exception is pitch. Trainor and Zacharias (1998) showed that infants preferred higher- over lower-pitched renditions of the same songs by the same singers. This is particularly interesting because across cultures, and indeed species, high pitch is associated with friendliness and submission whereas low pitch is associated with aggression (Morton, 1977).

Although most of the research has been conducted on mothers' singing, the ID singing style is not unique to mothers. For example, when children sing in proximity to their infant siblings, they also raise their pitch and use a more "smiling" tone of voice (Trehub, Unyk, & Henderson, 1994). Moth-

ers, whether they work or not, spend considerably more time with infants than fathers do (Bailey, 1994; Darling-Fisher & Tiedje, 1990; Lamb, 1987). Mothers also sing much more to their infants than fathers do (Trehub, Unyk, et al., 1997). It is surprising, then, that fathers' sung performances for infants exhibit similar adjustments in pitch, tempo, and emotional engagement (Trehub, Unyk, et al., 1997). Fathers, however, in line with their gender stereotyping of infants from the newborn period (Rubin, Provenanzo, & Luria, 1974; Stern & Karraker, 1989) tend to generate playful song renditions for their infant sons and soothing renditions for their infant daughters (Trehub, Hill, et al., 1997).

In the case of speech, fathers exhibit fewer ID adjustments compared with mothers (Fernald et al., 1989; Papoušek & Papoušek, 1987; Walker & Armstrong, 1995), which could arise, in part, from contrastive speech styles for infant boys and girls. Alternatively, lesser involvement in child care may generate reduced sensitivity to the specific needs of individual children (Lamb, 1986) and, consequently, less finely tuned speech and song. Nevertheless, infants prefer men's ID over IA speech (Pegg, Werker, & McLeod, 1992, Werker & McLeod, 1989), although their preferences are less pronounced than those observed for women's ID over IA speech (Werker & McLeod, 1989). Fathers and mothers also play distinctively with their young children, fathers' play being more physical and arousing, and mothers' play being more vocal and toy-centered (Roopnarine, Talukder, Jain, Joshi, & Srivastav, 1990; Stevenson, Leavitt, Thompson, & Roach, 1988). Indeed, fathers' distinctive play style generates considerable enthusiasm from their young children, especially boys (Ross & Taylor, 1989).

On the basis of infant preferences for women's ID over IA singing (Trainor, 1996) and for men's ID over non-ID speech (Pegg et al., 1992; Werker & McLeod, 1989), we expected infants to exhibit attentional preferences for men's ID over IA singing. Before proceeding to assess such preferences, however, it was necessary to assemble samples of men's ID and IA songs that exhibited the characteristic features of fathers' ID and IA singing (Trehub, Hill, et al., 1997; Trehub, Unyk, et al., 1997).

## Experiment 1

In the present experiment, we recorded fathers' ID and IA singing and evaluated adults' identification and judgments of such singing. For comparability with previous research on mothers' singing (Trainor, 1996), we focused on naïve adult listeners' judgments of five aspects of fathers' singing: (1) identification of ID versions, (2) identification of fathers' sung performances as lullabies or play songs, (3) selection of ID or IA versions as more rhythmic, (4) selection of ID or IA versions as more "loving" in qual-

ity, and (5) ratings of the appropriateness for infants of the present samples of fathers' singing as well as previously recorded samples of mothers' singing (Trainor, 1996). We expected adults to be highly accurate at identifying fathers' ID versions (Trainor, 1996; Trehub, Unyk, et al., 1997) and to rate fathers' singing in ways that were roughly comparable to previous ratings of mothers' songs (Trainor, 1996).

## METHOD

### Participants

#### *Singers*

The singers were 15 English-speaking fathers who lived in cities in Southern Ontario. Although the fathers worked and were not the primary caregivers, they reported that they sang regularly (most days) to their 5- to 7-month-old infants. With respect to the representativeness of the sample, it should be noted that it was harder to recruit fathers to sing for the present study than it was to recruit mothers to sing for previous studies conducted in our labs, and that some fathers who declined to participate indicated that they did not sing regularly to their infants.

#### *Adult Listeners*

The listeners were 60 university students (30 men, 30 women) who participated in one of five conditions.

### Stimuli and Apparatus

An ID and an IA version of a song were recorded from each of the 15 fathers. That is, each father sang two versions of the same song, although different fathers chose different songs. For the ID condition, fathers were instructed to sing to their infant as they usually do. For the IA condition (which preceded or followed the ID condition, in counterbalanced fashion), fathers were told to sing as they would in the shower or car while alone. Three song pairs were excluded from the final sample of songs because of excessive infant vocalizations in the ID versions, leaving a final sample of 12 song pairs (Table 1). Some fathers ( $n = 8$ ) were recorded digitally with a video production microphone (Shure VP64), Tucker-Davis Technologies hardware (amplifier [MA2], and stereo analog interface [DD1] via fiber-optic cables to a AP2 processor card in the computer) onto a PC (Comptech 486) running CSRE (Computerized Speech Research Environment) recording software in a room adjacent to the recording room. The remaining fathers ( $n = 7$ ) were first recorded in a sound attenuating chamber (Industrial Acoustics,  $3 \times 2.8 \times 2$  m) with a Marantz tape recorder (model PMD430), and the recordings were subsequently digitized. Fathers, who were not monitored during recording, were instructed to press a buzzer to signal to the experimenter (in an adjacent room with the recording equipment) when they were about to begin and when they had finished singing. The infant was held or placed in a car seat on a table (according to the father's choice) directly in front of the father.

All recordings were transferred to a Macintosh IIfx computer. To control for infant vocalizations and/or extraneous noises (e.g., "rustling") in the ID versions, prerecorded "baby-noise" and "rustling" tracks were mixed into 10 of the IA versions to correspond to the locations of comparable sounds in the ID versions (using Sound Designer II software). Composite audio cassette tapes of single-judgment or paired-comparison trials were created from the recordings using Sound Designer II software and a Denon precision audio component/

TABLE 1  
**Classification of the 12 Songs Sung by Fathers**

Category	Song Title
Play Songs	"Row, Row, Row Your Boat"
	"Row, Row, Row Your Boat"
	"Itsy Bitsy Spider"
	"Old MacDonald Had a Farm"
	"William Tell"
Lullabies	"Itsy Bitsy Spider"
	"You Are So Beautiful"
	"Hush Little Baby"
Neutral	"Twinkle, Twinkle Little Star"
	"Twinkle, Twinkle Little Star"
	"Itsy Bitsy Spider"
	"Green Hills"

stereo cassette tape deck (DRS-610). Trials were separated by 5 s to allow listeners to record their responses.

The 12 trials on the paired-comparison tapes consisted of identical excerpts from the ID and IA renditions of each of the 12 fathers. The order of the ID/IA excerpts (first or second) was randomized across trials, with the ID version presented first half of the time. The order of the fathers was randomized for one tape (Order 1), and this order was reversed for the other tape (Order 2). The 12 trials on the single-judgment tapes consisted of the 12 ID songs that had been sung by fathers. Again the order of trials was randomized for one tape (Order 1) and reversed for the other tape (Order 2). A third set of tapes included single trials of the 12 ID and 12 IA fathers' songs as well as 17 ID and 17 IA songs sung by mothers of 5- to 7-month-olds from a previous study (Trainor, 1996). Order 1 was created randomly, and Order 2 was the reverse of Order 1. The tapes were presented to adult listeners in a quiet room via a Sony audio tape player (CFD-440) with a two-way speaker system.

**Procedure**

Five groups of different adults participated in the five conditions to eliminate potential transfer effects across conditions. Half the participants in each condition heard Order 1 of the appropriate tape and half heard Order 2. Participants were told to ignore infant vocalizations and background noises, making their judgments solely on the basis of fathers' singing style. The identification group (4 men, 6 women) listened to the 12 fathers' renditions of a song sung with and without an infant present (the paired-comparison tapes), identifying the ID version in each pair. The rhythmicity group (4 women, 6 men) also heard the paired comparison tapes and judged which version was more rhythmic; the loving group (5 women, 5 men) heard the same tapes and judged which version was more loving. Participants in the identification, rhythmicity, and loving groups were asked to list reasons for each of their judgments. The classification group (5 men, 5 women) heard the 12 ID songs of fathers (single-judgment tapes) and judged whether each had been rendered as a lullaby or play song. Finally, the infant-appropriateness group (10 women, 10 men) heard single trials of mothers' and fathers' ID and IA versions, rating each rendition for its appropriateness for an infant audience on a 7-point scale (1 = not at all appropriate, 4 = neutral, 7 = very appropriate.) During debriefing, raters were asked whether they noticed any system-

atic differences between versions other than the feature of interest. No rater reported differences in background noises or infant vocalizations between the versions.

## RESULTS AND DISCUSSION

The percent correct across raters for each father was calculated and formed the input for the following analyses. Two-tailed  $t$  tests revealed no effect of order in any of the conditions, so the data were collapsed across orders. Correct identification of the ID versions was high ( $M = 92.25\%$  correct,  $SE = 2.79$ ) and significantly above chance (i.e., 50%),  $t(11) = 15.25$ ,  $p < .0001$  (Figure 1). For six of the fathers, ID versions were correctly identified across all raters; the lowest score was 70% correct. The most commonly cited cues were “softer voice,” “smiling tone,” and “slower pace.” ID versions were rated as more rhythmic than IA versions on 63.33% ( $SE = 5.12$ ) of the trials, which was above chance,  $t(11) = 2.60$ ,  $p < .03$  (Figure 1). ID versions were rated as more loving than IA versions on 81.67% ( $SE = 4.90$ ) of the trials, which was significantly above chance levels,  $t(11) = 24.44$ ,  $p < .0001$  (Figure 1). Scores ranged from 50% to 100%. Interestingly, the lowest “loving” rating was assigned to the father whose ID song was least accurately identified. The most commonly cited cues for loving tone of voice were “softer tone” and “smiling” while singing.

Five of the songs were rated as play songs and three were rated as lullabies by 80% or more of the participants (see Table 1). The remaining four songs were rated by 50% of the adults as play songs and by 50% as lulla-

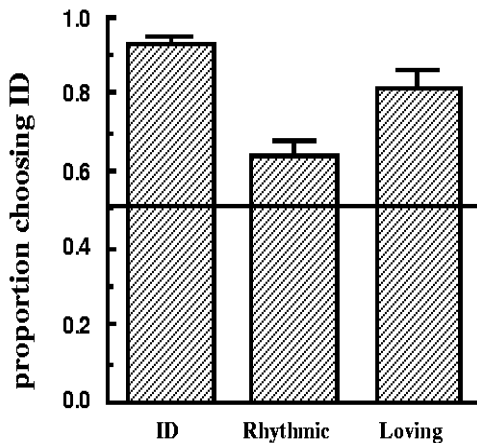


Fig. 1. Proportions of adults (and SEs) identifying the infant-directed (ID) over the infant-absent (IA) versions when asked to identify the ID version, the more rhythmic version, and the more loving version (Experiment 1).

bies, and were thus classified as neutral songs. This classification into song type parallels that for mothers' ID singing (Trainor, 1996). Raters indicated that songs chosen as play songs were sung "with intensity and stimulation" and rendered in a "happy excited voice." Those chosen as lullabies were typically described as "soothing" as well as "quieter, slower, more drawn out."

For songs identified as play songs ( $n = 5$ ), the ID version was judged more rhythmic on 70.00% ( $SE = 5.48$ ) of trials, whereas for songs identified as lullabies ( $n = 3$ ) the ID version was judged more rhythmic on only 46.7% ( $SE = 3.35$ ) of trials—a significant difference,  $t(6) = 3.03, p < .02$ . Only for play songs were ID versions rated as significantly more rhythmic than the IA version,  $t(4) = 3.65, p < .02$ . In line with Trainor's (1996) findings for mothers, there was a significant correlation between how often each ID recording was classified as a play song versus a lullaby and how often that ID version was rated as more rhythmic than its IA counterpart,  $r = .72, n = 8, p < .05$ .

Mothers' (from Trainor, 1996) and fathers' songs received mean appropriateness ratings of 4.94 ( $SE = .16$ ) and 4.78 ( $SE = .14$ ), respectively. An analysis of variance (ANOVA) with parent (mother/father) and singing condition (ID/IA) as factors indicated that fathers' and mothers' songs were rated as equally appropriate for an infant audience,  $p > .4$ . ID songs were rated as significantly more appropriate for an infant audience than were IA songs,  $F(1, 54) = 6.95, p < .01$ , and there was no interaction between parent and singing condition (Figure 2).

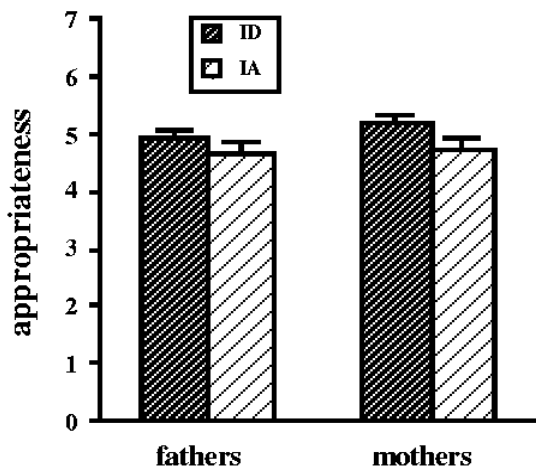


Fig. 2. Mean ratings (and SEs) of the appropriateness of the infant-directed (ID) and infant-absent (IA) samples for infants.

In sum, adults' perceptions of fathers' ID versus IA singing were similar to previous reports of adults' perceptions of mothers' singing.

## Experiment 2

Experiment 1 replicated the previous report of adults' ability to distinguish fathers' ID versions from their IA versions (Trehub, Unyk, et al., 1997). Moreover, adults perceived rhythmic and emotional aspects of fathers' ID versus IA singing similarly to previous reports on mothers' singing (Trainor et al., 1997). In Experiment 2, we asked whether infants would choose to listen to fathers ID over IA singing.

### METHOD

#### Participants

The participants were 80 infants 6 to 7 months of age (mean age = 6 months, 18 days; 32 girls, 48 boys). All infants were healthy and born at term (38–42 weeks, >2500 g); no infant had a history of frequent ear infections or a familial history of hearing impairment. After 13 infants were excluded for fussiness and a further 7 because of computer problems during testing, the final sample consisted of 60 infants who participated in one of 16 conditions (3 or 4 infants per condition).

#### Stimuli

Four ID/IA song pairs were chosen on the basis of results obtained in Experiment 1. The ID version of all four song pairs had been correctly identified by raters at a high level of accuracy (100%, 90%, 90%, 80%). Moreover, all ID songs were rated as having a more loving tone than their IA counterparts (90%, 90%, 80%, 100%). One of the songs ("Old MacDonald") had been judged by 100% of listeners as a play song and one (Itsy Bitsy Spider) by 80% of listeners as a lullaby. Two of the songs (two different versions of "Twinkle-Twinkle Little Star"), which were rated as play songs or lullabies 50% of the time, were designated neutral song 1 and neutral song 2. The recordings varied in duration from 18 to 30 s. All IA versions of these songs contained a prerecorded track of infant vocalizations and rustling noises that mapped onto corresponding noises in the infant-present versions (see Stimuli, Experiment 1).

#### Apparatus

Digitized versions of the recordings (see Experiment 1) were presented via a Macintosh IICI through a Denon amplifier (model PMA-480R) to two loudspeakers (GSI) located in a sound-attenuating chamber (Industrial Acoustics Co., Bronx, NY). Speakers were located on the right and left sides of the infant on top of smoked Plexiglas-fronted boxes, each of which contained an identical toy (a white dog) that was visible only when illuminated. A custom-built box connected a button box and the lights to the computer through a Strawberry Tree IO card.

#### Procedure

The procedure was identical to that of Trainor (1996). Infants were tested individually. Each infant listened to one of the four fathers' ID and IA singing excerpts. For each father's



singing, initial side of presentation (left/right) and initial version heard (ID/IA) were counterbalanced across infants, resulting in four conditions per father. The two versions (ID and IA) were played in alternating trials through the left and right speakers. For each infant, the ID version was always presented on one side and the IA version on the other.

The infant was seated on his or her parent's lap inside the sound-attenuating booth, directly facing the experimenter, who was seated behind a small table. The experimenter and parent both wore headphones and listened to masking music throughout the experiment. The experimenter activated the auditory stimuli and lights with the button box connected to the computer. To begin a trial, the experimenter centered the infant's attention. When the infant looked directly at the experimenter, she pressed a button to activate a flashing light inside one of the Plexiglas-covered boxes (left or right side) to reveal a toy dog. When the infant looked at the light, the experimenter pressed a second button to signal the computer to illuminate the dog and play one version of the song pair. The experimenter continued to press the button as the infant looked at the dog. The experimenter released the button whenever infants looked away and resumed button pressing whenever they returned their gaze. The song continued to play until the infant looked away for at least 2 seconds, at which time the computer automatically shut off the light and sounds, terminating the trial. Thus, the length of presentation was contingent on infants' looking behavior. (The length of presentation also depended on the accuracy of the experimenter's button pressing, of course, but any variance in this factor would be expected to be distributed equally across the conditions.) ID and AD trials alternated, each presented consistently from the left or right side, with trials beginning as soon as the experimenter gained the infant's attention. For all ID and IA trials, the song continued from where it had stopped on the previous trial of that type.

The computer was programmed to play each song (repeating it, as necessary) whenever the button was pressed. All looking times were recorded by the computer. Testing ended when the infant completed 20 trials (10 of each version).

## RESULTS AND DISCUSSION

The proportion of looking time during the ID version was calculated for each infant by dividing looking time during the ID version by the total looking time. Each infant was tested with one of the song pairs. The average proportions of looking time to the ID versions for each song pair were .50 ( $SE = .034$ ), .51 ( $SE = .031$ ), .52 ( $SE = .042$ ), and .57 ( $SE = .035$ ). One-tailed  $t$ -tests revealed that only one of these proportions (.57) differed significantly from chance (.50),  $t(15) = 2.05$ ,  $p < .03$ .

Average looking time per trial was 15.20 s ( $SE = .95$ ) during the first 10 trials and 8.01 s ( $SE = 2.5$ ) during the second 10 trials. Collapsed across fathers, this difference was statistically significant,  $t(59) = 8.32$ ,  $p = .0001$ , indicating that some habituation occurred over the course of the 20 trials. For the one father's song pair that elicited an overall significant preference for the ID version,  $t$  tests conducted on the first and second 10 trials separately indicated that this preference occurred only during the second 10 trials,  $t(15) = 2.65$ ,  $p < .009$ . For the other 3 song pairs, no preference was evident during the first 10 or second 10 trials (Figure 3).

When looking times during fathers' ID and IA songs were compared with looking times during mothers' ID and IA songs from Trainor (1996), fathers' songs yielded more sustained visual attention than did those of mothers,  $t(122) = 4.28$ ,  $p < .0001$ ,  $t(122) = 6.81$ ,  $p < .0001$  for ID and IA

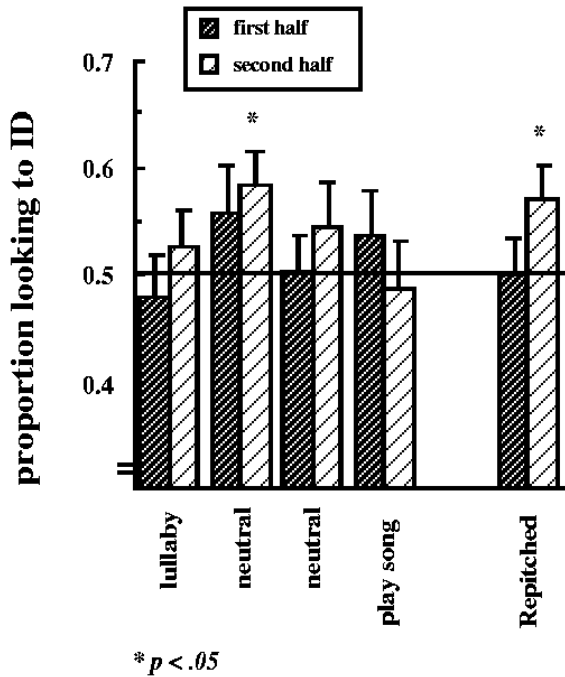


Fig. 3. Proportion of total looking time (and *SE*) during the initial 10 trials and final 10 trials of the lullaby, neutral songs, play song (Experiment 2), and repitched play song (Experiment 3) conditions.

versions, respectively. Average looking times per trial were 12.55 s ( $SE = .93$ ) for fathers' ID songs and 9.0 s ( $SE = .78$ ) for mothers' ID songs, and 10.67 s ( $SE = .58$ ) for fathers' IA songs and 6.4 s ( $SE = .58$ ) for mothers' IA songs.

Unlike the demonstrated preference for mothers' ID over IA singing (Trainor, 1996), infants in the present study showed no overall attentional preference for fathers' ID over IA singing. This finding contrasts with infants' demonstrable preference for fathers' ID over IA speech (Pegg et al., 1992; Werker & McLeod, 1989) and with adults' differential judgments of fathers' ID and IA singing (Experiment 1 of the present report). Moreover, infants in the present experiment exhibited more sustained attention during fathers' sung performances than did Trainor's (1996) infants during mothers' sung performances, a finding that contrasts with infants' greater responsiveness to mothers' speech than to that of fathers (Werker & McLeod, 1989).

One possible explanation for the present findings implicates infants' relative unfamiliarity with men's singing. In a diary study of singing in the infant's environment (Trehub, Unyk, et al., 1997), nearly 75% of all in-

stances of singing to infants were provided by mothers and less than 15% by fathers. Perhaps the novelty of men's singing enhanced infants' overall responsiveness, obscuring subtle differences between ID and AD versions. Thus, the preference for one man's ID over IA singing in the second 10 trials is consistent with preferences for ID singing after a period of familiarization with men's singing voices. Infants' enhanced attention to men's singing relative to that of women coupled with no differential responsiveness to ID cues might result from a very lively style of singing that is not especially sensitive to infant cues. If fathers had been appropriately sensitive to their young audience, one would have expected their ID versions to be differentially engaging for infants.

An alternative explanation implicates acoustic properties that differentiate fathers' singing from mothers' ID singing. In general, mothers' ID singing, whether recorded in the laboratory or at home, is slower in tempo and higher in pitch than their IA singing (Trainor et al., 1997; Trehub, Unyk, et al., 1997). The laboratory setting of the present sample yielded tempos that were also significantly slower for ID than for IA renditions,  $t(11) = 1.87$ ,  $p = .04$ , with mean beats per second of 1.72 ( $SE = .14$ ) and 1.80 ( $SE = .15$ ), respectively. Moreover, there were no tempo differences between fathers' song samples in the present study and mothers' song samples from Trainor et al. (1997).

However, the present sample of fathers' singing differed in pitch from previous samples of mothers' singing. The pitch of each song was determined by averaging the pitch of the first and last syllable of each song. Pitch extractions were done with the FFT-Comb routine of Signalyze software on approximately 300 ms from the middle of each vowel. The pitch was calculated every 5 ms (outliers were eliminated by rejecting the upper and lower 25% of values), and the average of eight 5-ms windows was defined as the pitch at that point. The pitch of the vowel was then defined as the average of the highest and lowest pitch over the 300 ms. In absolute levels, fathers' singing was significantly lower in pitch level than was mothers' singing (mean pitches for the 12 fathers for ID and AD renditions were 143.9 Hz and 139.5 Hz; for the mothers from Trainor et al. [1997], mean pitches for ID and IA renditions were 253.6 Hz and 224.5 Hz, respectively). In terms of the pitch difference between ID and IA renditions, fathers' mean ID singing was less than a semitone higher than their mean IA singing, a difference that approached but did not reach conventional levels of significance,  $t(11) = 1.40$ ,  $p = .10$ . By contrast, the difference between mothers' ID and IA samples in Trainor et al. (1997) averaged 2.68 semitones. Interestingly, the sole song pair that yielded an ID preference in Experiment 2 was the only one (of the four pairs) whose ID pitch exceeded its IA pitch. It is possible, then, that the absence of consistent pitch cues in the present sample of fathers' songs contributed to infants' lack of preference

for men's ID versions. Indeed, infants' demonstrable preference for higher over lower-pitched renditions of women's songs (Trainor & Zacharias, 1998) may also apply to men's songs.

### Experiment 3

Several researchers have suggested that the preference for ID over IA speech is mediated, in part, by infants' sensitivity to fundamental frequency cues (e.g., Fernald, 1991; Fernald & Kuhl, 1987). For example, speech with an elevated pitch level effectively recruits infants' attention; comparable speech with a lowered pitch level does not (Patterson, Muir, & Hains, 1997). Similarly, an elevated pitch level in women's songs enhances infant attention (Trainor & Zacharias, 1998).

In the present experiment, we examined whether fathers' lower pitch might contribute to infants' lack of preference for fathers' ID singing. To do so, we selected one father's ID and IA songs. The two song versions, which had identical pitch levels, had yielded comparable levels of infant visual attention in Experiment 2. The pitch of the ID version was digitally increased by four semitones ( $1/3$  of an octave), and the pitch of the IA version was lowered by one semitone ( $1/12$  of an octave). On the basis of previous findings with women's singing (Trainor & Zacharias, 1998), infants were expected to show a preference for the repitched ID version over the repitched IA version.

#### METHOD

##### Apparatus and Procedure

The apparatus and preference procedure were identical to those of Experiment 2.

##### Participants

The participants, who were 6 to 7 months old (mean age = 6 months, 14 days; 7 boys, 7 girls), were born at term (38–42 weeks, >2500 g), had no known hearing problems, and were healthy on the day of testing (i.e., no colds). After excluding two infants for fussiness during testing, the remaining 12 infants participated in one of 4 conditions.

##### Stimuli

One ID/IA song pair from Experiment 2 ("Old MacDonald") for which infants did not demonstrate an attentional preference was chosen. The ID version had been correctly identified by 90% of adults in Experiment 1. Both the ID and IA versions were repitched with Kyma software such that frequency information was altered, but temporal information was maintained. The pitch of the ID version was increased by 4 semitones (from 172 Hz to 215 Hz). The pitch of the IA version was decreased by 1 semitone (from 172 Hz to 161 Hz) to exaggerate the pitch difference and to control for any distortion introduced by the repitching process.

## RESULTS AND DISCUSSION

Overall looking times were significantly greater during the first 10 trials than during the second 10 trials,  $t(11) = 5.91$ ,  $p < .0001$ , indicating that infants habituated over the course of the 20 trials. The proportion of looking time to the ID version (calculated as in Experiment 2) was significantly greater than chance during the second 10 trials,  $t(11) = 2.14$ ,  $p < .03$  (mean = .57,  $SE = .032$ ), but not during the first 10 trials (mean = .50,  $SE = .032$ ) (see Figure 3).

These results confirm that pitch height is a salient feature of ID singing for infants. The restriction of the preference to the second 10 trials, while difficult to interpret, is nevertheless consistent with the preference shown for one father's ID version in Experiment 2. As noted, the ID-IA preference may depend on some degree of familiarization with the type of stimuli in question (fathers' singing, in this case). Regardless, ID and IA samples that were identical to the original versions except for the artificial alterations in pitch generated a preference for the altered ID over IA versions. This finding implies that the pitch height of ID singing plays a critical role in the elicitation of infant attention.

## General Discussion

Fathers in the present study modified their singing in the presence of their infants, as had fathers who were recorded previously in their own homes (Trehub, Unyk, et al., 1997). Fathers' ID and IA renditions were distinct, as indexed by adults' 92.4% correct identification of ID versions compared with previous findings of 92.7% correct identification of mothers' ID versions (Trainor, 1996). Adult listeners also rated fathers' renditions as more loving than their IA versions, as had been the case for mothers (Trainor, 1996). In the present sample of fathers' songs and the previous sample of mothers' songs (Trainor, 1996), two thirds of the ID performances were judged as lullabies or play songs. Moreover, mothers' and fathers' ID play songs, but not lullabies, were rated as more rhythmic than their IA counterparts. Finally, ratings of the appropriateness of ID and IA versions for an infant audience were comparable for fathers' and mothers' songs. In short, the judgments of naïve adult listeners revealed considerable comparability between fathers' and mothers' singing to infants. It is clear, then, that the vocal modifications associated with ID singing are not limited to women (Trainor, 1996; Trehub, Unyk, & Trainor, 1993a, 1993b; Trehub, Unyk, et al., 1997) and children (Trehub et al., 1994). In effect, the presence of an infant seems to elicit vocal modifications that are apparent in caregivers' singing.

Despite similar modifications in mothers' and fathers' singing, no overall preference was apparent for fathers' ID over IA singing. What is notable, however, is that infants responded with greater visual attention for fathers' sung performances—whether it was ID or IA in style—than they had for mothers' performances (Trainor, 1996). Perhaps fathers' unconventional style of play (Labrell, 1996; Yogman, 1981) extends to their singing as well. Informal observations in our laboratory revealed some self-consciousness on the part of fathers. For example, they tended to “ham” for the microphone, as if performing for a listening audience that went beyond their infant (or themselves). Kitamura and Burnham (1998) have shown that infants prefer utterances with high positive affect over those with more neutral affect. This preference for high vocal affect could account for infants' greater attention to fathers' vigorous, exuberant singing over mothers' more restrained singing. Alternatively, infants' long looking times to fathers' singing might reflect the relative novelty of this singing for infants. Although the recorded songs were sung by fathers who sang regularly to their infants, the infant listeners (who were not the offspring of the fathers who sang) were presumably less familiar with male than with female ID singing, given mothers' much greater propensity to sing to infants in general (Trehub, Unyk, et al., 1997). Perhaps the relative unfamiliarity of men's singing contributed to infants' long looking times during fathers' IA and ID renditions. Thus, a preference for fathers' ID over IA singing might emerge only after the songs lost the portion of their appeal that was attributable to novelty. Consistent with this interpretation, the two instances that revealed an ID over IA preference appeared during the second half of the test session.

Although fathers' ID versions contained many of the characteristic features of ID speech and song, they were not consistently sung at a higher pitch level than the IA versions. This finding contrasts with previous samples of mothers' singing, either at home (Trehub, Trainor, & Unyk, 1993; Trehub, Unyk, et al., 1997) or in the laboratory (Trainor, 1996), and with fathers' singing at home (Trehub, Unyk, et al., 1997). Three of four fathers in Experiment 2 did not use higher pitch in their ID singing. What is especially interesting is that the father from Experiment 2 with a higher ID than IA pitch level generated the only infant preference for ID over IA singing among the four fathers. Moreover, the transformation from no preference (Experiment 2) to an ID preference by artificially raising the pitch level of the ID version and lowering that of the IA version (Experiment 3) highlights the importance of pitch level for infant listeners.

Although pitch level is believed to play a key role in infants' preference for ID over AD speech (Cooper & Aslin, 1994; Fernald & Kuhl, 1987; Fernald & Mazzie, 1991; Fernald et al., 1989; Jacobson, Boersma, Fields, & Olson, 1983; Papoušek et al., 1991) and their greater responsiveness to

women's over men's speech (Werker & McLeod, 1989), the direct consequences of pitch differences are rarely investigated. In one study, however, infants attended to the same female stranger's speech in a high-pitched voice but not in a lower-pitched voice (Patterson et al., 1997). In another study, infants preferred higher pitched to lower pitched renditions of the same non-ID song (Trainor & Zacharias, 1998). High pitch may be particularly important for infant preferences because it is associated with the vocal expression of joy (Scherer, 1986; Trainor et al., 1997, 2000; Trainor & Zacharias, 1998).

In summary, fathers appear to make many of the modifications that mothers do when singing to their infants. Nevertheless, fathers' ID singing differs in some respects, notably in its relative effusiveness, regardless of context, and in the absence of pitch differences across contexts. The differences may be attributable, in part, to the laboratory environment having differential effects on mothers and fathers and, in part, to a culture that accords a relatively smaller nurturing role to fathers. Indeed, a greater influence of societal values on fathers' than on mothers' caregiving behavior is evident in the gender stereotyping that characterizes fathers' singing style for infant boys and girls (Trehub, Hill, et al., 1997). For their part, infants showed a preference for fathers' ID over IA singing only when the ID versions were higher in pitch than the IA versions, whether naturally, as was the case for one of the four fathers in Experiment 2, or artificially, as was the case in Experiment 3. Infants' responsiveness to ID singing may also have intrinsic as well as experiential components. Infants may have inherent preferences for some properties of ID speech and song (Fernald, 1991, 1992; Trehub & Trainor, 1998), but their preference in any particular situation may depend, in part, on familiarity with some of the vocal features. Finally, although infants exhibited more sustained attention to fathers' singing than was apparent in previous research with mothers' singing (Trainor, 1996), it remains to be determined whether such preferences would prevail in the real world where the auditory components of infant-directed songs are accompanied by visual, gestural, and vestibular stimulation.<sup>1</sup>

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