Infant Preferences for Infant-Directed Versus Noninfant-Directed Playsongs and Lullabies

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Each of 15 mothers was recorded singing a song of her choice to her 4- to 7-month-old and singing the same song alone. Adult raters were very accurate at distinguishing infant-directed from infant-absent versions, and the former were independently rated as more loving than the latter. Most of the songs were consistently classified as either playsongs or lullabies. The infant-directed playsongs were rated as relatively more rhythmic than the infant-directed lullabies, in comparison to the infant-absent versions. These results suggest that playsongs and lullabies may be distinct and used to communicate different information. Infant preferences were tested for three playsong and three lullaby pairs in a preferential looking paradigm. Infants preferred the infant-directed over infant-absent versions for five of the six pairs. Furthermore, the degree of preference was correlated with the adult ratings of loving tone of voice. The results indicate that mothers modify their singing in the presence of their infants, that infants attend to these changes, that playsongs and lullabies are likely distinct musical styles differing in their rhythmic quality, and that what adults perceive to be a loving tone of voice is highly salient to infants.

music   infant-directed singing   preference   lullaby   playsong

Both music and language are complex communication systems. The spontaneous use of music and language is universal and unique to human culture. However, most developmental research has focused on the language system. Preverbal infants are very responsive to speech, even though individual words do not have meaning for them (e.g., Fernald, 1991; Papoušek, 1992; Papoušek & Papoušek, 1991). In turn, caregivers talk to their infants, although they realize that the infants are not able to discern the semantic content of that speech. Recent research has shown, however, that such interchanges involve considerable communication. In particular, young infants attend to the intonation patterns of the mother's voice (Fernald & Kuhl, 1987), and these do appear to have at least affective meaning for them (e.g., Fernald, 1993; Papoušek, Bornstein, Nuzzo, Papoušek, & Symmes, 1990). For example, falling pitch contours are soothing, rising contours elicit attention, bell-shaped contours reward and encourage, and short, low, narrow contours inhibit or stop an action (Fernald, 1991).

It is well documented that infants prefer to listen to infant-directed over adult-directed speech (e.g., Cooper & Aslin, 1990; Fernald, 1985). Furthermore, the differences between the two types of speech appear to involve musical characteristics. Infant-directed speech in most, if not all, cultures is more rhythmic, higher in pitch, and contains slower, more exaggerated pitch contours than adult-directed speech (e.g., Fernald, 1991). Thus, infants' response to speech is based on musical qualities: The melody is the message (Fernald, 1989).

Several functions have been proposed for infant-directed speech, including directing infant attention (e.g., Cooper & Aslin, 1990; Werker & McLeod, 1989), communicating emotion (e.g., Fernald, 1993; Werker & McLeod, 1989), and aiding language learning by highlighting linguistic structures such as phrase and clause boundaries (e.g., Bernstein Ratner, 1986; Jusczyk et al., 1992) and important words (e.g., Fernald & Mazzie, 1991; Gleitman & Wanner, 1982).

Two aspects of music for infants have been studied: *performance characteristics*, that is, the *style* or manner in which the song is rendered, and *structural* or *form* characteristics, that is, the basic pitch and duration relations that are invariant across different performances (Trehub, Trainor, & Unyk, 1993; Trehub, Unyk, & Trainor, 1993a, 1993b; Unyk, Trehub, Trainor, & Schellenberg, 1992). Lullabies and adult

songs may be structurally distinct. Trehub et al. (1993a) collected pairs of lullabies and adult songs from field recordings from around the world. The pairs were matched for tempo, singing style, and orchestration. Western adult raters were above chance levels at identifying the lullaby in each pair, and there was no difference between performance on Western versus non-Western selections. Furthermore, the same pattern of results emerged when performance characteristics were systematically removed by filtering out the higher frequencies or by playing the tunes on a synthesizer. Listeners cited simplicity and repetitiveness as criteria for lullaby identification, and independent ratings, gathered in a subsequent study, revealed that lullabies were rated as more simple in structure than their adult matches (Unyk et al., 1992).

To examine the effects of performance modifications made in the presence of infants, Trehub et al. (1993b) recorded English-speaking and Hindi-speaking mothers singing a song of their choice to their infant and singing the same song in the absence of their infant. Adult raters were able to distinguish which versions were infant directed, although performance was superior when mothers and raters had the same cultural background. Interestingly, English-speaking mothers tended to sing arousing songs and play with their infants, whereas Hindi-speaking mothers tended to sing soothing songs, suggesting that there may be distinct types of singing to infants. The precise differences between infant-directed and noninfant-directed singing remain somewhat mysterious. However, one study revealed that mothers' infant-directed singing is slower in tempo and rendered in a more "smiling tone of voice" (as rated by adults) than noninfant-directed singing (Trehub et al., in press).

Although research on infants' *response* to music is scanty, there is considerable anecdotal and cross-cultural evidence that music is important in infancy. Anthropological sources suggest that the lullaby is a musical form that is found around the world, in cultures as diverse as Vietnamese, Hazara (central Afghanistan), Columbian, and North American Indian (Trehub et al., 1993a). The purpose of a lullaby is literally to lull an infant to sleep. This suggests, then, that music has the power to alter infants' state.

Music is found in every known human society. When the role of music in human culture in general is considered, it is perhaps not surpris-

ing that infants respond to music and that infants initially pay attention to the musical elements of speech. Music is closely linked to emotional expression (e.g., Bever, 1988; Cooke, 1959; Langer, 1957; Meyer, 1956). Music can both communicate information about emotion and evoke a direct emotional response (Thompson & Robitaille, 1992; Trainor & Trehub, 1992). It is the direct emotional response that sets music and language apart. Music is associated with physiological responses, such as pulse rate, respiration rate, blood pressure, and electrical resistance of the skin (e.g., Winner, 1982), as well as physical responses, such as shivers down the spine, laughter, tears, and lump in the throat (Sloboda, 1991). Across many societies, music is associated with magical powers, medicine, and healing (Schullian & Schoen, 1971; Tyson, 1981). The field of music therapy is flourishing in contemporary Western society, offering help to the mentally retarded, elderly, physically disabled, autistic, learning disabled, and those with various psychiatric and medical conditions such as sensory disorders, stroke, and traumatic brain injury (Davis, Gfeller, & Thaut, 1992). In pediatrics, music is being used to stimulate and pacify premature infants (Standley, 1991), reduce anxiety and manage pain during labor (Gonzalez, 1989), and decrease stress in hospitalized infants and toddlers (Marley, 1984).

What is the function of infant-directed singing? First, an infant preference for infant-directed over noninfant-directed singing would suggest that the former serves to attract the infant's attention to the caregiver. Second, the close ties between music and emotion and the cross-cultural prevalence of the lullaby suggest that infant-directed singing may function to regulate infant state. In this case, it would be expected that different styles of infant-directed singing would be used under different caretaking circumstances and would convey different affective meanings to the infant. In particular, one type of singing might be designed to soothe (lullabies), and another might be designed to arouse and engage the infant in play (playsongs). In speech, emotion can be carried by both voice timbre and prosodic features (e.g., Frick, 1985; Kappas, Hess, & Scherer, 1991; Scherer, 1986). Infants can discriminate emotional expressions conveyed in speech (Caron, Caron, & MacLean, 1988) as well as abstract

auditory patterns, such as an ascending versus a descending tone (Phillips, Wagner, Fells, & Lynch, 1990). In music, the pitch is relatively fixed, so different emotions would presumably be conveyed by such features as overall musical structure, rhythmic variation, voice timbre, amplitude fluctuations, or small pitch perturbations and glides.

A third possible function of infant-directed singing is to teach infants about auditory pattern structure, that is, about phrase structure, rhythm, and expectancy. In this case, one might expect infant-directed singing to be characterized by features such as exaggerated rhythm and longer pauses between phrases. It has been established that infants encode the phrase structure of simple musical excerpts (Krumhansl & Jusczyk, 1990), discriminate various rhythmic patterns (Allen, Walker, Symonds, & Marcell, 1977; Demany, McKenzie, & Vurpillot, 1977; Mendelson, 1986; Morrongiello, 1984), and categorize on the basis of rhythm (Trehub & Thorpe, 1989). Furthermore, infants produce rhythmic sequences (babbling) early on (Kent, Mitchell, & Sancier, 1991), and their reduplicative babbling reflects the rhythmic stress structure of their language of exposure (Levitt & Wang, 1991). English-learning infants prefer to listen to two-syllable utterances with a strong/weak stress pattern (the predominant stress pattern of English) over a weak/strong stress pattern (Jusczyk, Cutler, & Redanz, 1993). As well, infants more readily detect pauses inserted within a clause than between clauses, suggesting sensitivity to clause boundaries (Hirsh-Pasek et al., 1987). Exaggerated rhythm in infant-directed singing might function both to attract infant attention and elucidate the temporal structure of the music.

The main purpose of this research was to test infant preferences for infant-directed versus noninfant-directed singing. Adult ratings of various aspects of naturalistic recordings of mothers singing were obtained in Experiment 1. On the basis of these results, three lullaby and three playsong pairs were selected for the infant preference test in Experiment 2.

EXPERIMENT 1

Experiment 1 had two main goals. The first was to obtain naturalistic recordings of mothers singing the same song to their infant and in the absence of their infant for use in a subsequent

infant preference test. The second goal was to use adult ratings to examine possible distinctions between infant-directed songs with different functions, specifically between lullabies and playsongs. Adults were asked to identify which samples were infant directed. As well, different groups of adults rated whether the samples were lullabies or playsongs, and whether the infant-directed versions were more rhythmic and rendered in a more loving tone of voice than their noninfant-directed matches.

Method

Participants

The participants were 50 undergraduate students (36 females, 14 males) whose mean age was 23 years (range = 18–49 years). There were no systematic differences between the performance of male and female participants.

Stimuli and Apparatus

Fifteen mothers, recruited from local hospital maternity wards, were recorded singing a song of their choice (it was not necessary to offer suggestions) to their infant and singing the same song in the absence of their infant, with the order (infant present/absent) counterbalanced across mothers. The mothers ranged from 20 to 39 years of age ($M = 29$ years), and their infants were between 4 and 7 months of age ($M = 4.9$ months). Mothers were not aware of the hypotheses of the experiment. Mothers who first sang to their infant were simply asked to sing the same song afterwards (without their infant) so we could obtain another recording. Mothers who first sang in the absence of their infant were told we wanted recordings of songs normally sung to infants. No indication was given as to whether we desired a lullaby or a playsong. Recordings were made in a comfortable, quiet room in the laboratory with a high-quality portable tape recorder (Marantz PMD 420) using a lapel microphone (Sony ECM 155). Most mothers chose to hold their infant while singing, although an infant seat was available. All infants were healthy, born at term, and both mothers and infants were free of colds at the time of the recording. An additional 7 recordings were unusable: 5 because the mother failed to sing in the absence of her infant, or sang a different song in the infant-present and infant-absent conditions; 1 because the mother sang too quietly to be recorded; and 1 because the infant cried during the entire song.

To create the tapes, portions of the two recordings (infant present/absent) of each mother were digitized, using Sound Edit Pro on a Macintosh IIci computer with an Audiomedia II card (Digidesign). These samples included as much of the original recordings as possible, provided that there was not excessive infant noise, and exactly the same phrases were included in both the infant-present and infant-absent versions. The recordings varied in duration from 8 to 45 s ($M = 22.4$ s). Some infants responded to their mother's singing with occasional vocalizations. To avoid the use of this cue by adult raters, similar infant sounds were digitally added to the infant-absent samples, in the identical locations to those in which they occurred in the infant-directed samples.

For the paired comparison ratings, two tapes were created in which each of the 15 paired comparison trials con-

sisted of the two versions (infant present/absent) of one mother. Each tape used a different random order of the recordings, both within trials (infant-present/absent conditions) and across trials (mothers).

An additional four tapes were created for the single sample ratings, two consisting of different random orders of the infant-present recordings only, and two consisting of different random orders of the infant-absent recordings only. Again there were 15 single sample trials (mothers) on each tape. Tapes were presented to adult raters through the Marantz PMD 420 tape recorder and audiological headphones (Telephonics TDH 49P).

Procedure

Five groups of adults (10 per group) rated different aspects of the singing samples. Three of the groups used the paired comparison tapes (see Stimuli and Apparatus section). Participants in the first group were told that some songs were recorded in the presence of an infant and others were not. On each of the 15 trials, they were asked to indicate whether the first or second sample of singing was recorded in the presence of an infant. The second and third groups of adults were not informed of the nature of the recordings, that is, that some were recorded in the presence of an infant, whereas others were not. The second group was asked to rate which of the two singing samples on each trial was most rhythmic. The third group was asked to rate which of the two singing samples was rendered in the most loving tone of voice. Half of the participants in each group (i.e., 5) listened to one paired comparison tape, while the other half listened to the other, to reduce any systematic effects of stimulus order.

The fourth group of adults listened to the tapes of infant-present single sample trials, and the fifth group listened to the tapes of infant-absent single sample trials. On each trial, they were asked to rate whether the singer was attempting to put an infant to sleep (subsequently designated *lullaby*) or to arouse and play with an infant (subsequently designated *playsong*).

Results and Discussion

Preliminary ANOVAs with tape (order) and mother as factors revealed no significant differences between performance on the two tapes in any condition, so all subsequent analyses were collapsed over tape.

To examine whether adult raters were significantly above chance levels at identifying which samples were infant directed, the percent correct across raters in Group 1 was calculated for each trial (mother). Performance was high (M = 92.7% correct, SD = 9.6) and significantly above chance, $t(14) = 17.19, p < .0001$.

Similar analyses were conducted to determine whether the infant-directed samples were rated as more loving. The percentage of adults in Group 2 who rated the infant-directed version as more loving was calculated for each trial. Overall, the infant-directed versions were rated as more loving 82.7% of the time (SD =

22.5), which was significantly above chance levels, $t(14) = 5.62, p < .0001$.

To test whether infant-directed versions were rated as more rhythmic, the percentage of adults in Group 3 who rated the infant-directed version as more rhythmic was calculated for each trial. There was no significant difference between the infant-present and infant-absent conditions, $t(14) = 1.05, p > .15$. Overall, the infant-directed versions were rated as more rhythmic 57.3% of the time (SD = 27.1).

The raters in Group 4 heard only the infant-directed versions and were asked to classify them according to their perceived function, here designated as lullabies or playsongs. Three of the recordings were classified as playsongs by 100% of the raters, and a further 3 recordings by 90% of the raters. Two of the recordings were classified as lullabies by 100% of the raters, and a further 2 recordings by 80% of the raters. Thus, for 10 of the 15 recordings, at least, there was high consistency among raters in classifying the function of the song. To examine whether these differences could be quantified further, the correlation between how often each infant-directed recording was classified as a playsong versus as a lullaby (Group 4) and how often that infant-directed version was rated as more rhythmic than its infant-absent pair (Group 3) was calculated. This correlation was significantly above chance levels, $n = 15, r = .60, p < .02$, indicating that infant-directed playsongs tended to be rated as relatively more rhythmic than infant-directed lullabies in comparison to infant-absent versions. The infant-directed versions of the 6 playsongs identified above were rated as more rhythmic than their infant-absent pairs 73.3% of the time (SD = 20.7), whereas the infant-absent versions of the 4 lullabies were rated as more rhythmic 60.0% of the time (SD = 23.1)

Was the playsong/lullaby classification based solely on the choice of song (i.e., structural or form characteristics), or did the singing style (i.e., performance characteristics) make a contribution? As can be seen in Table 1, those infant-directed versions rated as playsongs were generally playsongs in form. However, *Row, Row, Row Your Boat* (designated as a playsong) would normally be expected to be soothing. On the other hand, only one of those rated as a lullaby was actually a lullaby in form (*Rock-a-Bye Baby*). This

indicates that the lullaby/playsong classifica-
tion was not based solely on the form of the
song; rather, the singing style made a contribu-
tion as well. In this context, it is of interest to
ask whether the perceived function of the song
sung by a mother ever changed between the
infant-present and infant-absent versions. The
raters in Group 5 heard only the noninfant-
directed versions and were asked to classify
them as playsongs or lullabies. There was a
high correlation, $n = 15$, $r = .80$, $p < .0005$,
between the perceived function of the infant-
present and infant-absent versions. This is not
surprising, as mothers generally chose a song
they were used to singing to their infant and
likely had considerable practice singing it in a
particular style. At the same time, the rated
function of one song reversed completely:
Row, Row, Row Your Boat was rated as a
playsong by 90% of raters in the infant-present
version, but it was rated as a lullaby by 90%
of raters in the infant-absent version. With the
current experimental design, it is not possible
to examine the relative contributions of singing
style and musical form to the perceived func-
tion, but both appear to be involved.

The correlation between how often an
infant-directed recording was classified as a
playsong versus a lullaby (Group 4) and how
often that infant-directed version was rated as
more loving than the infant-absent version
(Group 2) was not significant. The infant-
directed versions of both playsongs and lulla-
bies were rated as more loving than the infant-
absent versions.

In summary, adult raters were very accurate
at distinguishing infant-directed from infant-
absent versions sung by the same mother, repli-
cating Trehub et al. (1993b). Furthermore, the
infant-directed versions were independently
rated as more loving than the infant-absent ver-
sions. There also appeared to be considerable
consistency among raters as to whether the
intent of the singer was to lull an infant to sleep
or rouse and play with an infant. Furthermore,
those recordings that were rated as playsongs
were also rated as more rhythmic than their
infant-absent pairs, whereas those recordings
that were rated as lullabies were also rated as
less rhythmic than their infant-absent pairs.
These results indicate not only that lullabies and
playsongs may be distinct, but that they likely
differ with respect to their rhythmic qualities.

TABLE 1
Classification of Songs Sung by Mothers

**Songs Classified as Playsongs by 80%
or More of Raters**
Baa Baa Black Sheep
Inky Dinky Spider
Row, Row, Row Your Boat
Skinamerink
Skinamerink
Skinamerink

**Songs Classified as Lullabies by 80%
or More of Raters**
Barney's Theme Song
Puff the Magic Dragon
Rock-a-Bye Baby
You Are My Sunshine

Remaining Songs
ABCD
Barney's Theme Song
Five Little Ducks
Inky Dinky Spider
There's a Hole in My Bucket

EXPERIMENT 2

In Experiment 2, infant preferences for infant-
directed versus infant-absent versions of the
same song sung by the same mother were test-
ed using six of the pairs of recordings from
Experiment 1. Trials of infant-directed music
(presented from a loudspeaker on one side of
the infant) and infant-absent music (presented
from a loudspeaker on the other side) alternat-
ed, with the initial type of music and side of
presentation randomized across infants. Infants
controlled the length of each trial, as the music
remained on until the infant looked away. Thus,
the amount of time each type of music was
played reflected infant preferences.

Method

Subjects

Sixty infants between the age of 5 months, 8 days and
6 months, 29 days ($M = 5$ months, 29 days) were tested. All
were healthy, born at term (38–42 weeks, over 2,500 gms),
and were free of colds on the day of testing. A further
2 infants were excluded due to fussiness.

Stimuli

Six infant-present/infant-absent pairs of recordings from
Experiment 1 were chosen, based on the adult rating results
of Experiment 1, according to the following criteria. Three
were rated highly as playsongs (by 100%, 90%, 90% of
raters in Experiment 1) and three as lullabies (by 100%,
100%, 80% of raters). In all cases, the infant-present/infant-
absent conditions were clearly distinguished (100%, 100%,
90% accuracy for the playsongs; 100%, 100%, 80% for the
lullabies). The recordings varied in duration from 16 to 41 s
($M = 25.4$ s). Within each pair, durations were approxi-

mately equal. Recall that in all cases, occasional infant vocalizations in the infant-directed versions were matched in the infant-absent versions by digitally adding similar infant sounds, in identical positions, to the latter.

Apparatus

The digitized versions of the recordings (see Experiment 1) were presented via the Macintosh IIci computer through a Denon amplifier (PMA-480R) to audiology loudspeakers (GSI) located in a sound-attenuating chamber (Industrial Acoustics Company). One speaker was located on the infant's right and the other on the infant's left. Under each speaker was a toy in a box with a smoked Plexiglas front, such that when a light was illuminated inside the box, the toy became visible. The computer controlled the experimental procedure. A custom-built interface box connected the button box (used by the experimenter to signal to the computer) and lights to the computer.

Procedure

Infants were tested individually in a preference procedure modified from Fernald (1985). The two versions of one song (infant present/infant absent) were played in alternation, with the length of each presentation contingent on the infant's head-turning behavior. There were six groups of 10 infants; each group was presented with one of the six pairs of recordings. Infants sat on their parent's lap in the sound-attenuating chamber, facing the experimenter. Both the parent and the experimenter listened to masking music presented through headphones, so they were unaware of what the infant was hearing. Furthermore, the experimenter was not aware of which music was being presented on which side for each subject. During each experiment, infant-directed singing was always presented on one side (right or left) and infant-absent singing on the other, with half of the infants receiving infant-directed singing on the right and half on the left. The side of presentation alternated between trials, with the initial side (right/left) randomized across subjects, and crossed with which type of singing was presented on each side. The sound stimuli and lights were controlled by the computer. When the experimenter had the infant's attention (i.e., the infant faced forward), she pressed one button on the button box (held under a small table out of the infant's view) to initiate a trial. This caused the light on one side to begin flashing (400 ms off, 400 ms on), illuminating the toy in the box under the speaker. When the infant turned to look at the light and toy, the experimenter pressed a second button which resulted in the presentation of the appropriate singing for that side. The light remained on but ceased to flash during the sound presentation. The experimenter held down the button while the infant looked at the toy. The sound presentation continued until the infant looked away for at least 2 s, and the looking time was recorded by the computer. The light (which could be seen by the experimenter) and sound were extinguished at the end of the trial. The next trial was initiated when the experimenter again had the infant's attention forward. Subsequent trials of the same music continued from where the previous trial of that type had ended, and when the end of the excerpt was reached, it began again from the beginning. Testing ended when the infant completed 20 trials (10 of each version) or accumulated 6 min of total looking time.

Results and Discussion

All infants completed 20 trials. The looking time varied from 0.0 to 55.7 s per trial (*M* =
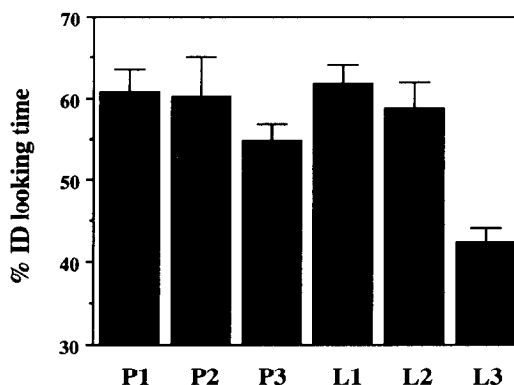

Figure 1. The mean percentage of infants' total looking time that produced the infant-directed (ID) version for the three playsong (P1, P2, P3) and three lullaby (L1, L2, L3) pairs. Error bars represent the standard error of the mean.

7.5 s). There were no significant differences across the six mothers in mean looking time to either the infant-present or the infant-absent versions. Analyses were conducted on the proportion of time the infant-directed version was played across the 20 trials for each infant, that is, the amount of time the infant looked in response to the infant-directed version was divided by the amount of time the infant looked to both versions. For the playsongs, an ANOVA revealed that there were no significant differences between the three groups of infants, that is, between the infants' preferences across the three mothers (see Figure 1). Thus, the data were collapsed across mothers. A two-tailed *t* test revealed that infants looked significantly longer to the infant-directed versions (i.e., proportion of infant-directed looking time compared to chance level of .50), $t(29) = 6.12$, $p < .0001$ (*M* infant-directed proportion looking time = .59, $SD = .076$).

For the lullabies, an ANOVA showed that infant preferences varied across the three groups of infants, $F(2,27) = 18.13$, $p < .0001$ (see Figure 1). Infants preferred the infant-directed version of two of the three lullaby pairs, $t(9) = 5.18$, $p < .0006$, $t(9) = 2.91$, $p < .016$ (*M* infant-directed proportion looking times = .62, .59, $SDs = .07$, .10, respectively). For the third pair of lullabies, however, infants strongly preferred the infant-absent version, $t(9) = -4.12$, $p < .0026$ (*M* infant-directed proportion looking time = .42, $SD = .06$). (With

the Bonferroni correction for three tests, the significance level is .017.)

The infant-absent preference for the one lullaby pair is somewhat puzzling. One possibility is that the lullaby message (i.e., go to sleep) did not match the mood of the infants being tested, who are typically wide awake and alert in the laboratory setting. However, this does not explain the dramatic differences in the effects of the three lullaby pairs. It should be noted that all three infant-directed versions were easily identified and consistently rated as lullabies by the adults in Experiment 1. In fact, for the pair in which infants preferred the infant-absent version, adult performance was 100% correct at identifying the infant-directed version, and 100% of adults rated it as a lullaby. These results indicate that adult ratings must be treated with caution, as they may or may not correspond precisely with infant perceptions.

To look for possible differences between the lullaby pairs, the other adult ratings of Experiment 1 were examined. The infant-directed versions of the two pairs for which the infants preferred that version received high loving-tone-of-voice ratings (rated as more loving 100% and 70% of the time), whereas the infant-directed version of the pair for which infants preferred the infant-absent version was rated as more loving only 50% of the time, which was in fact the lowest loving rating of all 15 excerpts. Furthermore, when all six pairs of Experiment 2 were considered, there was a significant correlation between the mean percent infant-directed looking time and rated loving tone of voice, $n = 6$, $r = .88$, $p < .02$. This association between infant preference and loving tone of voice suggests that the loving tone of voice may be highly salient to infants.

DISCUSSION

In general, the infants preferred to listen to infant-directed over noninfant-directed singing. This lends support to the notion that one function of singing to infants is to attract their attention. It is interesting that caregivers modify both their speech and their singing when addressing infants. However, the extent to which such modifications are in common across both systems is not clear. Obviously, the exaggerated pitch contours of infant-directed speech are not possible in infant-directed singing, because the pitch is highly constrained

by the musical structure in the latter case. On the other hand, rhythmic modifications, including final-phrase syllable lengthening and duration/intensity increases on important words or notes, may operate in a similar fashion across the two systems.

Adult raters showed high consistency in classifying most of the 15 infant-directed samples as either playsongs or lullabies, suggesting that playsongs and lullabies may be distinct in function. Further support for this distinction comes from the independent ratings of rhythm. Those samples classified as lullabies were rated as less rhythmic than their noninfant-directed matches, whereas those classified as playsongs were rated as more rhythmic. This result may seem surprising in light of the popular notion that rhythmic movement and sound puts infants to sleep, for example, rocking an infant in a position where he or she can hear the caregiver's heart beat. Rhythm is a very difficult term to define (Fraisse, 1982), although people appear to have an intuitive notion of rhythm (Gabrielsson, 1993). Rhythm has a number of aspects. It is important to distinguish regularity, as in repeating isochronous intervals or beats, and rhythm as accentuation, as in exaggeration of the underlying grouping structure (i.e., a differentiation of stronger and weaker beats). In the latter case, rhythm serves the function of segmenting a sequence of elements into hierarchical groups (Martin, 1972), by differentiating the elements (e.g., every fourth element louder, longer, or different in pitch). Thus, high regularity of beat (e.g., heart beat) does not lead to the perception of high rhythmicity; rather, differentiation of the elements is necessary. Trehub et al. (1993a) found that lullabies were highly repetitive. This does not mean, however, that the rhythm (accentuation) was exaggerated or highly salient. In this light, the high rhythmicity ratings assigned to the playsongs may be interpreted as the highlighting of the grouping or phrase structure of the songs. Thus, this rhythmic exaggeration may serve a didactic function. The low rhythmicity ratings assigned to the lullabies may be interpreted as an increase in regularity achieved by a decrease in differentiation of elements.

Although adult raters appeared to be consistent in their lullaby/playsong classifications, further research is needed to establish whether these types of singing are in fact used in differ-

ent caretaking contexts, whether they are effective in changing infants' states, and whether acoustic analyses can reveal reliable differences between them. Further research is also needed to examine whether lullabies and playsongs are structurally distinct, or whether they simply represent different styles of performance. For example, it would be interesting to observe what type of song a caregiver chose to sing when instructed to either play with their infant or try to put their infant to sleep, in cases where this was either consistent or inconsistent with the infant's state. These recordings could be compared to recordings where mothers were instructed to sing the same song in the opposite caretaking context, that is, to compare lullaby-style and playsong-style versions of the same song sung by the same mother. Recent evidence suggests that the types of modifications made in infant-directed speech change with the age and competencies of the infant (Papoušek, 1993). Similar changes may occur in infant-directed singing. The needs and competencies of young infants (e.g., they sleep a lot and are less interested in exploring the world) in comparison to older infants (who are more actively responsive) may lead to more soothing singing to young infants and more rousing, rhythmic singing to older infants.

The mothers in this study adopted a more loving tone of voice when singing to their infants in comparison to singing in the absence of their infants. The infant-directed versions of both playsongs and lullabies were rated as more loving than the noninfant-directed versions 83% of the time. Furthermore, these values ranged between 70% and 100% for 14 of the 15 sample pairs. The significant correlation between infant looking preference and adult loving ratings suggests that infants responded to the loving tone of voice. Furthermore, the adult loving rating for the 1 pair in which infants preferred the noninfant-directed version was only 50%.

These results suggest that the positive emotion conveyed by the mother's tone of voice is highly salient to infants. Acoustic analyses are underway to examine the physical basis of this effect. In particular, there is reason to believe that the formant structure of the vowels may be altered in the infant-directed versions. It is quite reasonable to expect that mothers smile when singing to their infants. Tartter (1980)

and Ohala (1980) found that smiling alters the shape of the vocal tract, resulting in higher fundamental and formant frequencies in speech. In singing, the fourth formant appears to be a particularly important determinant of voice quality (Sundberg, 1987). In addition, perturbations of the fundamental frequency (jitter and shimmer) likely increase with emotional intensity (Kappas et al., 1991; Scherer, 1986).

It can be concluded that mothers alter their singing in the presence of their infant, and that infants prefer to listen to infant-directed over noninfant-directed singing. Further research is needed to confirm the functions of these modifications. However, the evidence suggests that infant-directed singing attracts infants' attention, and that mothers use the emotional qualities of singing to regulate their infant's state, arousing their infant in some circumstances and soothing their infant in others. In both cases, mothers appear to convey positive emotions, singing with a loving tone of voice. The relations between infant-directed speech and infant-directed singing remain unclear. However, it is likely that both serve some common functions, such as using rhythmic devises to highlight phrase structure and important words and tones. These in turn may aid the infant in learning to parse the complex auditory streams that are speech and music.

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