CHAPTER 24

INFANT MUSICALITY

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What can we learn about music and about musicality from infants? Skeptics may question the possibility of deriving fruitful answers to such questions from immature beings whose hearing is deficient (relative to adults) and whose exposure to "good" music, even conventional music, is limited. This chapter is aimed at less skeptical readers—those who are open to the possibility of *nature* and early *nurture* contributing to musical beginnings and subsequent musical development. It is presented as lessons that emerge from empirical research over the past few decades.

Early Caregiving is Musical

Preverbal infants typically hear a steady stream of incomprehensible but highly melodious speech. This speech, known variously as *motherese, parentese*, or infant-directed speech, is characterized by exaggerated prosody, including elevated pitch, expanded pitch contours, large dynamic range, and rhythmic regularity (Fernald, 1991). The most striking aspects of maternal speech—its effusiveness and positive affective quality—are also the most difficult to quantify. At periodic breaks in this flow of mellifluous speech, infants sigh, yawn, gurgle, or coo, which caregivers interpret as contributions to the dyadic conversation.

Research to date has emphasized common melodic and rhythmic features (Fernald et al., 1989) and expressive intentions (Bryant and Barrett, 2007; Fernald et al., 1989) in caregivers' speech across cultures. It has become clear, however, that unique or person-specific musical features are also evident in speech to infants. In one study (Bergeson and Trehub, 2007), sequences of intervals, or tunes, were transcribed from recordings of several mothers as they interacted with their infants (4–7 months of age) on different occasions. The observed intervals in maternal speech tunes were unrelated to conventional musical intervals. Nevertheless, mothers repeatedly used a limited number of tunes, often with different verbal content. Although mothers' global pitch contours were similar to one another, their tunes (i.e., relative pitch patterns) were individually distinctive, justifying their designation as *signature tunes* (Bergeson and Trehub, 2007). It is fair to say, then, that infants receive regular exposure to person-specific speech melodies from their primary caregiver.

Aside from the musical speech that infants hear, they also hear a great deal of singing (Trehub and Gudmundsdottir, in press; Trehub et al., 1997). Mothers (and many fathers and grandparents) the world over sing to infants in the course of providing care (Trehub and Trainor, 1998). For the most part, caregivers use a distinct musical genre for this purpose—lullabies and play songs—but some of them modify their favorite songs or invent songs for infants. Although music for adults often differs substantially from one culture to another, music for infants has a number of cross-cultural similarities. For example, lullabies from foreign musical cultures are readily identified as lullabies (Trehub, Unyk and Trainor, 1993a), perhaps because of their simplicity, repetitiveness, and falling pitch contours (Unyk, Trehub, Trainor and Schellenberg, 1992).

Even more distinctive than the musical material for infants is the manner of singing to infants. Such singing has playful or soothing intentions, and it also serves social bonding functions. Although songs have prescribed pitch intervals and rhythms and speech does not, infant-directed singing shares a number of features with infant-directed speech to preverbal listeners, including elevated pitch, slow tempo, slurred articulation of words, positive vocal tone, and enhanced rhythmicity (Corbeil, Trehub and Peretz, 2013; Longhi, 2009; Trainor, Clark, Huntley and Adams, 1997; Trehub et al., 1997). Perhaps not surprisingly, the singing of depressed mothers is less finely tuned to infants than that of non-depressed mothers (de l'Etoile and Leider, 2011).

Casual listeners readily distinguish infant-directed from non-infant-directed versions of the same song by the same singer (Trehub, Unyk and Trainor, 1993b, Trehub et al., 1997). Moreover, many mothers perform their songs at nearly identical pitch level and tempo on different occasions (Bergeson and Trehub, 2002). The familiar songs and familiar manner of performance provide security and pleasure to the infant audience.

Maternal Performances are Irresistible

Presumably, the maternal style of speech and singing would not have persisted across cultures and historical periods if it did not achieve its intended goals, for example, soothing or accelerating sleep in the case of lullabies and joyful engagement in the case of play songs. Investigators have documented infants' responsiveness to the maternal type of speech and singing by means of simple procedures designed to reveal infants' listening preferences. In one of these procedures, infants control the time spent listening to each of two sound patterns by looking in one direction or another. When they look at a loudspeaker on their left, they hear one musical selection, which stops when they look away. When they look at a loudspeaker on their right, they hear a contrasting musical selection until they look away. After 5–10 minutes, infant listening times for each selection are accumulated. Longer listening to one selection implies greater *interest* in that selection, which may not correspond to adult-like aesthetic judgments (Trehub, 2012).

Procedures such as these have revealed greater infant attention to melodious motherese than to conventional adult speech (Cooper and Aslin, 1990; Fernald, 1985; Werker and McLeod, 1989). Familiarity with the maternal speaking style is likely to contribute to these listening preferences. Despite the popular notion that familiarity breeds contempt, the familiarity of music actually enhances its appeal (Szpunar, Schellenberg and Pliner, 2004).

Infants also exhibit listening preferences for infant-directed over non-infant-directed versions of the same song by the same singer (Trainor, 1996), even in the newborn period (Masataka, 1999). These and other findings are consistent with a *natural* or inborn preference for the maternal style of speech and singing, but one cannot rule out potential contributions from prenatal exposure (Parncutt, Chapter 23, this volume). The happy-sounding quality of infant-directed speech and play songs also makes important contributions to infants' listening preferences (Corbeil et al., 2013; Singh, Morgan and Best, 2002).

Infants are rather poor at regulating their own state or arousal, so bouts of fussing and crying are frequent occurrences. At such times, caregivers intervene with nonverbal sounds (e.g., *shush*, tongue clicks), singing, rocking, patting, jiggling, feeding, or some combination of these. Singing is particularly effective at arresting, even preventing, infant fussing. For example, maternal singing modulates the arousal levels of contented infants (Shenfield, Trehub and Nakata, 2003), and it reduces the arousal levels of distressed infants more effectively than maternal speech (Ghazban, 2013).

Media reports and deceptive advertising—none of it based on solid scientific evidence—have led many parents to consider the possibility that recordings of classical music (Mozart in particular) are better for infants their own humble singing. Such parents have concrete evidence that their songs "work" in the sense of bringing comfort and joy to their offspring, but they worry needlessly that their performances lack the nutrients for the developing brain that are purportedly present in "good" music.

Infants See and Hear Music

The prevalence of recorded music may make it appear that music is a mere auditory phenomenon. For most of history, however, and for many small communities around the world, music has been experienced through live performances that involve widespread participation (e.g., singing, dancing) or highly engaged listening. For such engaged listeners, the visual gestures of performers are as critical as the sounds produced, and the audience often moves in time with the music. Visual gestures (head and body motion), touch (e.g., holding, stroking), and movement (rocking, swaying) are also integral to mothers' sung and spoken performances (Ghazban, 2013). Audiovisual recordings of mothers' speech and singing have potent consequences for infants, who become quite still and stare at their mother's image for extended periods, but their engagement in such circumstances is considerably greater for singing than for speech (Nakata and Trehub, 2004). As noted, moreover, live (i.e., multimodal) maternal singing has greater efficacy than maternal speech for relieving infant distress (Ghazban, 2013).

Infants and adults are capable of integrating information from different modalities, which often influences the perception of what they hear, see, or feel. For example, when infants are bounced to an ambiguous drumming rhythm (i.e., no accented beats) on every second beat, they subsequently listen longer to an accented version in duple meter than in triple meter (Phillips-Silver and Trainor, 2005). If they are bounced on every third beat, they subsequently listen longer to the rhythm in triple meter. Simply watching an adult move on every second or third beat without experiencing the movement does not induce the listening preference. Similarly, adults' encoding of rhythms is influenced by their own movement but

not by observations of others' movement (Phillips-Silver and Trainor, 2007). Mothers' joint movement with infants while they sing is likely to have even more potent influences.

Not only do mothers use a distinctive style of speech or singing to infants, they also use distinctive facial and body gestures (Brand and Shallcross, 2008; Chong, Werker, Russell and Carroll, 2003). Surprisingly, infants can identify person-specific cues across auditory and visual modalities. After hearing unfamiliar mothers (i.e., the mothers of other infants) sing or talk in an infant-directed manner for 30 seconds, 6-month-old infants and adults correctly match the previously heard singer or speaker to one of two women presented in successive silent videos (Trehub, Plantinga, Brcic and Nowicki, 2013). Infants' matching behavior is indicated by longer looking at the silent video of the "familiar" woman than at the video of the unfamiliar woman.

Consonance May be Overrated

Simultaneously sounded tones that produce beating or roughness typically sound unpleasant to Western listeners, but they evoke positive or neutral reactions in a number of other cultures. For example, Balinese bronze xylophones are deliberately mistuned (e.g., stretched octaves) to produce beating (Tenzer, 1991), and folk singers in rural Croatia commonly sing duets in parallel seconds (Vassilakis, 2005). Nevertheless, there are persistent claims that the preference for consonance is *natural* and innate. Some studies have documented infant listening preferences for consonant intervals (Masataka, 2006; Trainor and Heinmiller, 1998; Trainor, Tsang and Cheung, 2002; Zentner and Kagan, 1996), providing support for the nativist perspective. Aside from being inconsistent with cross-cultural practices, that perspective is also at odds with the emergence of an explicit preference for consonant intervals at about 9 years of age (Valentine, 1962).

Recent research with 6-month-old infants found no differential responsiveness to consonant and dissonant stimuli unless infants had previous exposure to the stimuli (Plantinga and Trehub, 2014). After hearing consonant stimuli for 3 minutes, infants listened longer to the consonant than to the dissonant stimuli. After comparable exposure to dissonant stimuli, infants listened longer to the dissonant stimuli. These findings, in conjunction with the cross-cultural and developmental evidence, are consistent with the view that familiarity is primarily responsible for the Western preference for consonant intervals (McLachlan, Marco, Light and Wilson, 2013).

They Remember the Music They Hear

There have been no attempts to assess infants' memory for the songs that mothers sing, but it is clear that infants retain information about the music that they hear regularly. After infants are exposed to a Mozart sonata periodically during a 2-week period, they subsequently distinguish it from a novel Mozart sonata (Saffran, Loman and Robertson, 2000). Similar at-home exposure to synthesized folk melodies results in infant memory for the melodies (Trainor, Wu and Tsang, 2004) but not for the pitch level at which they were heard initially

(Plantinga and Trainor, 2005). The salience of the music and the expressiveness of the performance style are likely to influence infants' long-term memory for musical details. For example, infants exhibit long-term memory for the pitch level of expressively sung lullabies (Volkova, Trehub and Schellenberg, 2006). Their short-term memory for music is influenced by a number of factors including its tonality (Trehub, Thorpe and Trainor, 1990), its temporal regularity (Bergeson and Trehub, 2006; Trehub and Hannon, 2009), and its consonance (Schellenberg and Trehub, 1996; Trainor and Trehub, 1993).

From Universal to Culture-Specific Listening

For the most part, infants approach music with open or universal ears in the early months of life. Like their adult counterparts, they perceive the equivalence of melodies across changes in pitch level (Chang and Trehub, 1977; Trehub, Thorpe and Morrongiello, 1987) and tempo (Trehub and Thorpe, 1989). Unlike their adult counterparts, who are differentially sensitive to familiar diatonic scales, infants experience no more difficulty detecting changes to melodies based on the Javanese pelog scale than to those based on Western diatonic scales (Lynch, Eilers, Oller and Urbano, 1990). Similarly, they perform as well on invented scales as on the major scale, provided the invented scales incorporate the universal or near-universal feature of unequal step size (Trehub, Schellenberg and Kamenetsky, 1999).

Although infants are surprisingly proficient at detecting melodic changes (Trehub, 2000), they are unlike adults in their insensitivity to the implications of key membership or harmony (Trehub and Trainor, 1992). Such sensitivity seems to require a number of years of culture-specific exposure to music. The relevant skills emerge between 4 and 7 years of age (Corrigall and Trainor, 2014; Trainor and Trehub, 1994) with further improvement evident in subsequent years (Lamont and Cross, 1994).

Infants exhibit some fundamental principles of rhythm perception such as the grouping of notes based on similarities in pitch, loudness, timbre, and temporal proximity (Thorpe, Trehub, Morrongiello and Bull, 1988; Thorpe and Trehub, 1989). When pauses are inserted into musical passages, infants listen longer to versions in which the pauses are inserted *between* phrases rather than *within* phrases, indicating their sensitivity to musical phrase structure (Jusczyk and Krumhansl, 1993).

Simple meters with isochronous timing (i.e., equal durations between strong beats) such as duple and triple meter, which are prevalent in Western music, are thought to be inherently easier for listeners than the complex meters that are evident elsewhere (e.g., Eastern Europe, South Asia, and Africa). Recent evidence suggests otherwise. For example, Western 6-month-old infants detect timing changes equally well in Balkan music with simple or complex meters (Hannon and Trehub, 2005a) even though they choose to listen longer to the meters of their own culture (Soley and Hannon, 2010). When Western adults are exposed to comparable materials, they detect metrical changes only in the context of simple meters, in contrast to Balkan adults, who detect both types of changes (Hannon and Trehub, 2005a). These findings negate the view of biologically based advantages for the perception of simple meters. They suggest, instead, that experiential factors are relevant. For example, adults' implicit knowledge of Western rhythms is likely to interfere with their perception of foreign rhythms.

By 12 months of age, Western infants exhibit adult-like difficulties with complex meters (Hannon and Trehub, 2005b). With limited exposure to complex meters, they can overcome these difficulties, unlike their adult counterparts whose difficulties persist after comparable exposure. Adults' long-term experience not only interferes with their perception of foreign rhythms, it also interferes with their ability to learn such rhythms. Although passive listening is sufficient for 12-month-olds, adults may require more active listening, perhaps accompanied by movement. Guided movement to music, which influences adults' encoding of simple rhythms (Phillips-Silver and Trainor, 2007), may assist adults in mastering the nuances of metrically complex music.

Moving and Being Moved

Rhythmic music commonly prompts listeners to move rhythmically. From as early as 5 months of age, infants exhibit more rhythmic movement when listening to music or to rhythmically regular sounds than to the sounds of speech (Zentner and Eerola, 2010). Their movements are not synchronized with the music, but their tempo of movement is somewhat faster for music with a faster tempo (Zentner and Eerola, 2010). With each passing month, infants engage in more and more "dancing" in their home environment but not necessarily in unfamiliar settings.

Infants experience considerable passive movement in the course of being held, rocked, or walked. As noted, patterns of passive movement such as bouncing influence what 7-month-old infants hear or remember (Phillips-Silver and Trainor, 2005), which confirms their precision of encoding such movement. By 14 months of age, infants recognize when adults are bouncing synchronously with their own bouncing, and they subsequently offer more help to synchronous than to asynchronous bouncers (Cirelli, Einarson and Trainor, 2014). Toddlers' prosocial behavior in these circumstances is consistent with adults' greater trust and generosity in relation to other adults who engage in synchronous action as compared with those who do not (Fischer, Callander, Reddish and Bulbulia, 2013; Wiltermuth and Heath, 2009).

Becoming Singers

After their first birthday, many toddlers start adding word-like sounds here and there in the course of their mother's singing, progressively singing longer and longer passages, and eventually singing independently and spontaneously (Trehub and Gudmundsdottir, 2015). They commonly invent songs as well as reproducing standard songs (Barrett, 2011; Whiteman, 2001). Although some scholars characterize toddlers' singing as lacking fixed pitches (Davidson, 1985) and being monotonic (McKernon, 1979), recent case studies reveal recognizable melodies in conjunction with unrecognizable words (Barrett, 2011; Stadler-Elmer, 2012). The reverse pattern—recognizable words with unrecognizable melodies—has been described more frequently, even in the preschool period (Welch, Sergeant and White, 1998). Individual differences in the onset and progress of singing are

likely to be substantial, depending, among other things, on the quantity, quality, and context of exposure to singing.

Lessons Learned

In general, primary caregivers from middle-class families provide a rich palate of multimodal musical performances that are finely tuned to infants' social and emotional needs. For their part, infants are highly proficient listeners, being sensitive to the pitch and rhythmic patterning of music and to the expressive nuances of performance. Initially, they are equally adept at perceiving music from other cultures as well as their own. Their interest in music and their receptive skills increase over the months, but those developments are paralleled by somewhat diminished sensitivity to foreign-sounding music. Even when such perceptual narrowing occurs in culturally appropriate ways, infants remain flexible listeners and learners, open to the opportunities available to them. Their motivation and receptive abilities enable them to make the most of the musical offerings in their environment.

Within months of their first birthday, infants become enthusiastic producers as well as consumers of music, singing and dancing in rudimentary ways. Such behaviors provide them with tools for play, social interaction, and emotional self-regulation. This developmental progress unfolds naturally although the timing of milestones may be accelerated in some environments (Gerry, Unrau and Trainor, 2012; Kelley and Sutton-Smith, 1987), but there is no indication that any acceleration in infancy is enduring. In fact, there is no unambiguous evidence of critical or sensitive periods for the development of musical skills with the possible exception of absolute pitch (Trainor, 2005). Even proponents of sensitive periods for music training (e.g., Penhune, 2011; White, Hutka, Williams and Moreno, 2013) do not contend that interventions in infancy affect subsequent performance in musical or nonmusical domains.

The acquisition of language, receptive and productive, is acknowledged to be rapid and effortless, but the acquisition of music is generally characterized as slow and effortful (Patel, 2008; Pinker, 1997). Such comparisons between language and music are based, inappropriately, on language skills acquired as a byproduct of social interaction and instrumental music skills acquired by formal study. In cultures where communal musical activities, including music-making, are frequent, musical skill levels are likely to exceed those observed elsewhere. In those circumstances, the acquisition of musical skill is a byproduct of social interaction, as is the acquisition of language. Although musicality, or the capacity for music, is a universal human trait with a biological basis (Trehub, 2003), cultural or experiential factors have a profound influence on the expression of that trait.

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