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Singing as Inter- and Intra-personal Communication

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Abstract and Keywords

Human vocalization contains key essences of our musical development and fosters our earliest abilities to communicate musically. Speech melodies are the first linguistic elements experienced and mastered, and are indistinguishable from the melodic precursors of singing as essential elements in intra- and inter-personal musical communication. Singing as communication originates in vocal pitch contours whose musical intervals are exploited by caregivers in infant-directed speech to foster language development. Similar, but more explicit, features are evidenced in caregivers' infant-directed singing, such as in lullabies and play songs. These basic musical elements of communication can be perceived in utero and underpin the infant's subsequent vocalizations and musical behaviors. Additionally, the underlying integration of emotion with perception and cognition generates a network of linked vocal and emotional behaviors that are central to human communication. The chapter will examine the growing evidence for musical communication as integral to human vocalization and emotional expression.

Keywords: human vocalization, musical communication, speech melodies, emotional expression, infant-directed speech, infant-directed singing

Introduction: the significance of voice in the ontogeny of communication

Vocal sound is one of the defining features of humanity.[1] Its commonality, plurality, and development distinguish the species. Within the wide range of sounds that humans make with their voices, there are two constellations that have the greatest socio-cultural significance: these are categorized as speech and singing. However, there is a significant overlap between the two because both sets of behaviors are generated from the same anatomical and physiological structures and initiated/interpreted by dedicated neuropsychobiological networks whose development and function are shaped by cultural experience.

Our predisposition to perceive particular vocal sounds as singing or speech is dependent on the dominant acoustic features, as well as experience. Perception begins when the sensory system is stimulated by acoustic information that is filtered according to principles of perceptual organization which group the sounds together according to key features, such as pitch range, temporal proximity, similarity of timbre, and harmonic relationships (Patel 2008).

The perception of sounds as music or language is contextualized by the listener's age, family, community membership, enculturation, and development. The first few months of life, for example, are often characterized by vocal play ("euphonic cooing," Papoušek, H. 1996) in which the growing infant's vocalizations could be interpreted as musical *glissandi*, as well as the precursors of prosody in speech. Such categorical perceptions of vocal sound as being either "musical" or "speech(like)," however, are a product of the layers of enculturation that inform our socially constructed interpretations.

To the developing infant, any such distinction is relatively meaningless, because speech and singing have a common ontogeny. As far as sound *production* is concerned, infant vocal behaviors are constrained by the limited structures and behavioral possibilities of the developing vocal system (Kreiman and Sidtis 2011). The first vocalizations are related to the communication of an affective state, initially discomfort and distress (crying), followed by sounds of comfort and eustress (positive moods). The predisposition to generate vocal sounds that have quasi-melodic features first emerges around the age of two to four months (Stark et al. 1993), with increasing evidence of control during the three months that follow (Vihman 1996). These pre-linguistic infant vocalizations are characterized by a voluntary modulation and management of pitch that emulates the predominant prosodic characteristics of the mother tongue (Flax et al. 1991; Mampe et al. 2009), while also exploring rhythmic syllabic sequences with superimposed melodies and short musical patterns (Papoušek, H. 1996)—see Parncutt (2016) for a comprehensive review on prenatal and early musical development.

With regard to sound *reception*, hearing is normally functioning before birth in the final trimester of pregnancy (Kisilevsky et al. 2004) and the newborn enters the world capable of perceiving tiny differences in voiced sound (Trainor and Zatorre 2016). Infants are "universalists" (Trehub 2016) in the sense that they are perceptually equipped to make sense of the musics and languages of any culture. This predisposition will lead developmentally to the discrimination of vowel categories and consonantal contrasts in the native language by the end of the first year (Escudero et al. 2014). During these initial 12 months of life, it is the prosodic (pitch and rhythm) features of "infant-directed" speech (also known as "motherese" or "parentese" (Werker and McLeod 1989; Saint-Georges et al 2013) that dominate early communication from parent/caregiver to child

(Fernald and Kuhl 1987; Papoušek, H. 1996). The prosodic envelopes that define spoken phrases are thought to be essential perceptual building blocks in the infant's developing comprehension of language (Kreiner and Eviatar 2014).

The mother's infant-focused utterances are also typified by having a regulation of pulse, vocal quality and narrative form, theorized collectively as a "communicative musicality" (Malloch 2000) that engages with an "intrinsic motive pulse," an innate ability to sense rhythmic time and temporal variation in the human voice (Trevarthen 2016). The expressive prosodic contours, pitch glides, and prevalence of basic harmonic intervals (thirds, fourths, fifths, octaves) of "infant-directed speech" (Fernald 1992); Papoušek, H. 1996) occur alongside the mother's "infant-directed singing" (Delavenne et al. 2013—see also "Mothers as Singing Mentors for Infants," by Trehub and Gudmundsdottir, this volume), a special limited repertoire of lullaby and play song which is characterized by structural simplicity, repetitiveness, higher than usual pitches (somewhat nearer the infant's own vocal pitch levels), slower tempi, and a more emotive voice quality.

> In general, the maternal repertoire of songs for infants is limited to a handful of play songs or lullabies that are performed in an expressive and highly ritualized manner. From the neonatal period, infants prefer acoustic renditions of a song in a maternal style (performances from mothers of other infants) to non-maternal renditions of the same song by the same singer. Moreover, they are entranced by performances in which they can both see and hear the singer, as reflected in extended periods of focused attention and reduced body movement in the infant.
>
> (Trehub 2003, p. 671)

Early vocalization is intimately linked to perception (Vihman 1996) in which the primacy of developing pitch control in infant utterances occurs alongside adult-generated sounds that are dominated perceptually by melodic contour. As such, although the "precursors of spontaneous singing may be indiscriminable from precursors of early speech" (Papoušek, M. 1996, p. 104), the weight of available evidence on the origins of language and music in the child suggests a common dominance of "the tune before the words" (Vihman 1996, p. 212) related both to the developing child's own "tunes" and the "tunes" of others.

The text that follows focuses on making sense of the nature of intra- and inter-personal communication in singing.

A theory of intra- and inter-personal communication in singing

Neuropsychobiological perspectives

Technological advances in brain imaging over the past decade have provided valuable insights into the neural basis of a variety of cognitive and affective functions, including those related to music. For example, neural areas and networks have been identified in the perception of tonal structures (Janata et al. 2002), features of musical "syntax" (Maess et al. 2001; Patel 2003), relative and "absolute" pitch processing (Zatorre et al. 1998), temporal processing (Strait et al. 2014), and how practice produces change in the motor cortex (Altenmüller and Schlaug 2015).

Hemispheric asymmetries are often evidenced, as are relative biases toward particular neural locations, depending on the type of musical behavior under consideration and the individual's relative experience and expertise in singing (see "The Neuroscience of Singing," by Kleber and Zarate, this volume). Nevertheless, findings in neurologic music therapy and brain research suggest that musical perception involves cross-hemispheric processing (Altenmüller and Schlaug 2015; Reybrouck and Brattico 2015; Rosslau et al. 2015), such that initial right-hemispheric recognition of melodic contour and meter are followed by an identification of pitch interval and rhythmic patterning via left-hemisphere systems, and even more evident in musically experienced adults. There is also evidence that specific neural circuits are devoted to dissonance computation and that these also link to the emotional systems (either in the paralimbic structures or more frontal areas) (Blood and Zatorre 2001; Blood et al. 1999; Cross 2001—see also "Singing and Emotion," by Coutinho et al., this volume).

Musical behaviors in adulthood appear to depend on specific brain circuitry that is relatively discrete from the processing of other classes of sounds (Zatorre and Krumhansl 2002), such as speech and song lyrics. A modular model of functional neural architecture has been proposed (Peretz and Coltheart 2003), based on case studies of musical impairments in brain-damaged patients, to explain neuropsychobiological musical processing, including that for singing (see Figure 1). Separate systems within the brain are responsible for the analyses of language, temporal organization, and pitch organization (Peretz 2012). These systems relate incoming information to existing knowledge banks (a phonological lexicon and a musical lexicon) as well as previous experience of emotional expression. Song lyrics are assumed to be processed in parallel with song melody and enacted by simultaneous cooperation between areas within the left and right cerebral hemispheres, respectively (Cogo-Moreira et al. 2013), with common cortical processing of the syntactical features of music and language (Maess et al. 2001), alongside an other-than-conscious ability to perceive underlying harmonic structures (Bigand et al. 2001). Further support for the Peretz and Coltheart model may be drawn from other neurological studies that compare song imagery (thinking through a song in memory) with actual song perception (Alonso et al. 2014; Mantell and Pfordresher 2013). Bilateral activation of the temporal and frontal cortex and of the supplementary motor area suggests that an integration of lyrics and melody in song representation is achieved through the combined action of two discrete systems for auditory-tonal and auditory-verbal working memory (Saito et al. 2012). There is also evidence that song imagery alone can activate auditory cortical regions (Oh et al. 2013).

The Peretz and Coltheart model proposes that any acoustic stimulus is subjected to an initial acoustic analysis. This is then “forwarded” to a range of discrete “modules” that are specifically designed to extract different features, namely *pitch* content (pitch contour and the tonal functions of successive intervals) and *temporal* content (metric organization = temporal regularity, and rhythmic structure = relative durational values). Both pitch and temporal outputs are further “forwarded” to a personal “musical lexicon” that contains a continuously updated representation of all the specific musical phrases experienced by the individual over a lifetime. The output from this musical lexicon depends on the task requirements. If the goal is to reproduce a heard song, then the melody from the musical lexicon will be paired with its associated lyrics whose elements are theorized as being stored in the “phonological lexicon” (Peretz and Coltheart 2003).

This is not to say, however, that the resultant sung output would necessarily be an ideal musical “match” to an original stimulus model. A significant proportion of young children often experience difficulty (and for a small minority this can be a long-term difficulty) in performing accurately both the lyrics and melody of songs from their culture, Creel 2015). Analysis of longitudinal empirical data on young children’s singing development (Welch et al. 2012; Niland 2012) indicates that most young children are usually very accurate in remembering and communicating the lyrics of particular songs that they have been taught (or heard informally), but can often be less accurate in reproducing the same songs’ constituent pitches (cf. Welch et al. 1997, 1998). A similar bias is reported in adult singers’ ability to make fewer errors in memorizing the words of new songs compared to the musical elements (Ginsborg 2002). In relation to Peretz and Coltheart’s model (Figure 1), the child singing data suggests that the average five-year-old’s “phonological lexicon” is often more developmentally advanced than their “musical lexicon.” In addition, the child data supports the model’s notion of a pitch “contour” module that has a basic primacy over other perceptual pitch organization. Young children who were rated as “out of tune” when singing particular focus songs were much more pitch accurate vocally when asked to match pitch glides (*glissandi*) that had been deconstructed from the melodic contours of the same songs for the purposes of assessment of singing development.

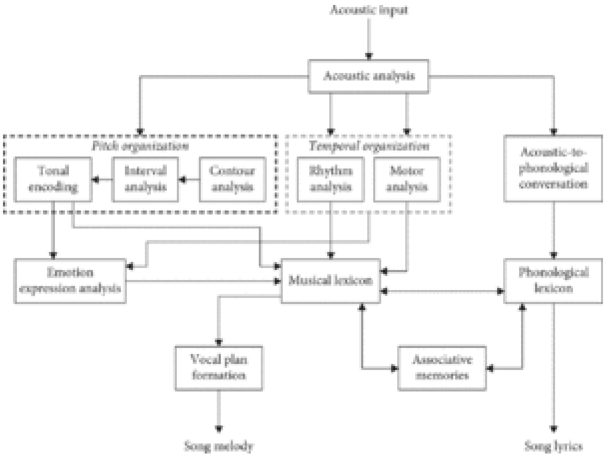

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Figure 1 A modular model of music processing (adapted from Peretz & Coltheart, 2003). Each box represents a processing component and arrows represent pathways of information flow or communication between processing components.

The Peretz and Coltheart neuropsychobiological model also accords with an earlier developmental model of children's singing that drew together a large number of independent studies (Welch 1986, 1998; see also Welch 2016). This developmental model and its associated literature suggest that an important phase in the child's journey toward accurate vocal pitch matching is the ability to match a song's melodic contour (Welch 2009a; Welch et al. 1998; Hargreaves 1996).

Similar findings have been highlighted in the longitudinal research evaluation of the UK Government's National Singing Programme in England "Sing Up" (see http://www.singup.org/ for more details) involving 11,000 pupils from over 180 primary schools across the United Kingdom (Welch 2009a; Welch et al. 2014). These results suggests that singing is subject to a developmental process in which vocal pitch matching (1) improves with age and (2) is subject to accelerated development in an appropriately nurturing environment (see also Welch 2016).

The symbiotic interweaving of singing and emotion

The Peretz and Coltheart model proposes that in parallel, but independently, outputs from the pitch and temporal perceptual modules are fed into an "emotion expression analysis" module (see Figure 1), facilitating an emotional response to the musical sounds. With regard to the emotional evaluation of vocal sounds, various distinct cortical and subcortical structures, primarily (but not solely) in the right hemisphere, have been identified as significant (Peretz et al. 2013). As part of our basic communication, six primary emotions—fear, anger, joy, sadness, surprise, and disgust—are all commonly expressed vocally (Titze and Martin 1998) and are differentiated by strong vocal acoustic variation (Patel 2008). Voice is an essential aspect of our human identity: of who we are, how we feel, how we communicate, and how other people experience us.

The ability to generate concurrent emotional "tags" to vocal outputs (singing and speech) is likely to relate to the earliest fetal experiences of acoustic environment, particularly the sound of the mother's voice heard in the womb during the final trimester of pregnancy. Although speech is partially muffled and the upper frequencies of the sound spectrum are reduced, the pitch inflection of the mother's voice—its prosodic contour—is clearly audible (see Parncutt 2016 for a review). The final trimester is also marked by the fetus developing key functional elements of its nervous, endocrine, and immune systems for the processing of affective states (Dawson 1994). As a consequence, a mother's vocalization with its own concurrent emotional correlate (Peretz and Coltheart 2003) is likely to produce a related neuroendocrine reaction in her developing child (Keverne et al. 1997; Seckl 1998; Thurman 2000; see also "Fetal, Neonatal, and Early Infant Experiences of Maternal Singing," by Woodward, this volume).

The filtered interfacing of the maternal and fetal bloodstreams allows the fetus to experience the mother's endocrine-related emotional state concurrently with her vocal pitch contours (see Figure 2). Feelings of maternal pleasure, joy, anxiety, or distress will be reflected in her vocal contours and her underlying emotional state. Given that singing (to herself, listening to the radio, in the car, with others) is usually regarded as a "pleasurable" activity, this will be reflected in a "positive body state" (Damasio 2006) that is related to her endocrine system's secretion of particular neuropeptides, such as β-endorphin, into her bloodstream (Thurman 2000). Her musical pleasure (expressed vocally and hormonally) will be communicated to her fetus.

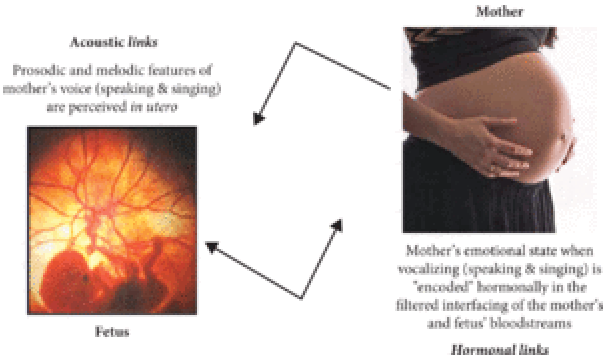

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Figure 2 The shaping of an integrated foetal emotional response to sound through concurrent experience of the mother's prosody, sung melody and affective state.

At birth, neonates are particularly sensitive to the sound of their own mother's voice, which derives from their fetal experiences of their mother's singing and reading aloud (Parncutt 2015). The perceptual salience of maternal pitch contour (Trehub 1987) is also shown in the reported ability of infants aged three to four months to imitate an exaggerated prosodic pitch contour presented by their mothers (Masataka 1992; see "Mothers as Singing Mentors for Infants," by Trehub and Gudmundsdottir, this volume), as well as an ability to imitate basic vowels at the same age after only 15 minutes of laboratory exposure (Kuhl and Meltzoff 1996). Similarly, six-month-old infants demonstrate increased amounts of sustained attention when viewing video recordings of their mothers' singing as compared with viewing recordings of them speaking (Trehub 2003).

Singing as emotional capital

Thus the child enters the world with an emotional "bias" toward certain sounds, linked to their earliest acoustic and affective experiences of the maternal vocal pitch contour. Arguably, this bias will shape the way that developing infants respond to other sounds, supplemented and expanded by concurrent auditory and affective experience of their own voices, beginning with the acoustic contours of their first cries. As suggested above, the available data suggests that there is a priming of the neuropsychobiological system from pre-birth through early infancy in which vocal melodies are associated with various emotional correlates. These associations provide a basis for musical communication across the lifespan, both in the production and reception of voice-based melodies and also for other intra-personal and inter-personal musical communications that draw on similar acoustic features.

This integration of early musical experience with its affective correlates can be construed as basic *emotional capital*, a resource which is employed as developing humans interact with, relate to, deal with, and make sense of their immediate and expanding sonic environments. Auditory experiences can be interrelated with six basic emotions that are evidenced in the first nine months of life. Initial tri-polar emotional states that relate to distress (evidenced by crying and irritability), pleasure (indicated by satiation), and being attentive to the immediate environment lead to the emergence of interest (and surprise), joy, sadness, and disgust by the age of three months, followed by emotional displays of anger and fear by the age of eight months (Lewis 1997). As mentioned above, each of these basic emotions has a characteristic vocal acoustic signature and an acoustic profile that is associated with a strong characteristic emotional state. Sounds that have similar acoustic profiles are likely to generate related or identical emotions. Musical performance relies on expressive acoustic cues, such as changes in tempo, sound level, timing, intonation, articulation, timbre, vibrato, tone attacks, tone decays, and pauses to communicate emotion, such as tenderness, happiness, sadness, fear, and anger (Juslin et al. 2010). Analyses of recorded performances indicate that virtually every performance variable is affected in ways specific to each emotion (Gabrielsson 2016). In performance, the patterns of continuous changes in such variables constitute an "expressive contour" and have been likened to the prosodic contour of speech (Juslin et al. 2010). Thus there appears to be a close correspondence between the acoustic characteristics of voiced emotion in everyday life and the expressive cues used to convey emotion in musical performance (Lavy 2001). For example, a mother suffering from postnatal depression will have a different vocal quality (quieter, lower pitched, longer pauses) than her non-depressed peers (Robb 2000). As children get older, they become more expert at recognizing and expressing intended emotion in singing as well as speaking (Gabrielsson and Örnkloo 2002). Arguably, this correspondence has its roots in mother–fetus/mother–infant vocalization and human neuropsychobiological development from the third trimester of pregnancy.

The acoustic features of the maternal voice and her immediate sonic environment are socially and culturally located, such that the initial generic plasticity demonstrated by the neonate for the discrimination of differences in any group of sounds is soon shaped toward a biased detection of the particular distinguishing features of salient local sounds

(Soley and Sebastián-Gallés 2015). This, in turn, affects related behaviors from a very young age. For example, newborns are also able to produce different accents in their ways of crying as soon as they are born, as suggested in the analysis of the melody and intensity contours of French and German neonates (Mampe et al. 2009). The French group preferentially produced cries with a rising melody contour, whereas the German group preferentially produced falling contours.

It is hypothesized, therefore, that any auditory contour event that is perceived as “alien” to the dominant sound culture (as previously experienced) is likely to be noticed and “tagged” emotionally on a positive/negative continuum, depending on its acoustic profile. These ongoing concurrent experiences act as one of the bases for the generation of musical “preference” within the developing musical lexicon. Reported examples of early musical “preference” in relation to singing are:

- two-day-old neonates who listen longer to audio recordings of women singing in a maternal (“infant-directed singing”) style than to their usual singing style (Masataka 1999);
- infant preferences for higher rather than lower pitched singing (Trainor and Zacharias 1998), which is one of the characteristics of “infant-directed singing”;
- two-to-six-month-old infants that listen longer to sequences of consonant musical intervals than to sequences of dissonant intervals (Trehub 2003);
- endocrine (salivary cortisol) changes in six-month-old infants after listening to their mothers singing (Trehub 2001).

These “preferences” for particular vocal pitch contours, vocal timbres, and interval consonance, linked to underlying endocrine and emotional states, may also be seen as early examples of how musical experience (including singing) is multiply processed within the overall functions of the nervous, endocrine, and immune systems—the integrated human “bodymind” (Thurman and Welch 2000).

Singing as intra-personal communication

Sounds can be self-generated as a basis for *intra-personal* musical communication, such as the earliest melodic vocal sounds that emerge around eight weeks (Papoušek, H. 1996), the vocal play that begins around four to six months (Papoušek, M 1996) and subsequently in pre-schoolers’ spontaneous pot-pourri songs (Countryman et al. 2015; Marsh 2008) and as “outline songs” (Hargreaves 1996) that draw on aspects of the dominant song culture. The sounds can also be part of *inter-personal* communication, such as the interactive and imitative vocal play of infant and parent (Papoušek, M 1996; Tafuri 2008), or adult-initiated song improvisations and compositions (Barrett 2006; see Barrett, this volume). As the human develops social awareness and communicative vocal skills, there is a shift from communication that is biased toward the *intra-personal* to the possibilities of *inter-personal* communication in singing, but the former will always be present.

The developing singer communicates intra-personally in a variety of ways related to the nature of the feedback system. Feedback can be auditory, visual, tactile, kinesthetic, or vestibular (Welch et al. 2005) and it is used in the construction of individual musical identity, both in the sense of "identity in music"—as a musician—as well as in the sense of "music in identity"—as a feature of an individual's overall personal identity (Hargreaves et al. 2002). At one level, there is an internal psychological feedback system that is essentially outside conscious awareness and which relates to a moment-by-moment self-monitoring of the singing behavior (cf. "vocal plan formation"— Peretz and Coltheart 2003). In the first months of infancy, this system is being developed in the vocal behaviors that are the precursors of spontaneous singing and early speech, prior to their use in the emergence of a "coalescence between spontaneous and cultural songs" (Hargreaves 1996, p. 156) from the age of two onwards.

A schema theory of singing development (Welch 1985) proposed that any initiation of a specific singing behavior (termed "voice program" in the original model), such as copying an external song model, would generate expectations of proprioceptive and exteroceptive feedback that are compared to the actual feedback received from the sense receptors and auditory environment (as both bone and air conducted sound) respectively. This internal motor behavior feedback system also provides the basis for self-reflective psychological judgments as to the "appropriateness" of any given example of singing behavior, such as its correspondence to an external song model or to an internal mental representation of a target melody's key, tonal relationships, loudness, and/or timbre. In the absence of evaluative feedback from an external source (termed "knowledge of results"), the singer has to make their own judgment of the "appropriateness" of their sung response compared to their internal model. This comparison is likely to depend on the relative developments within and between their "musical lexicon" and "phonological lexicon" (cf. Peretz and Coltheart 2003), in the sense that accurate reproduction of songs from the dominant culture requires the combination of a range of musical and linguistic skills (Davidson 1994; Welch et al. 1995, 1997, 1998). In some cases, there will be the realization of a mismatch between the intended and actual singing behavior and a subsequent correction can take place (see also "Vocal performance in occasional singers," by Dalla Bella, this volume, concerning the role of a "Vocal sensory motor loop"). Awareness, however, is not a necessary guarantee of vocal accuracy or singing development. "Out-of-tune" singing can persist, for example, because singers do not know how to change their behavior, even though they may realize that something is "incorrect" or "inappropriate." It can also persist because there is no awareness that their singing behavior needs to change.

At a conscious, reflective level, the singer's intra-personal communication is a form of self-monitoring that is essential for the development of skilled performance behavior of diverse pieces in a wide variety of acoustic contexts. Adjustments, both mental and in physical coordination, may need to be made as the performer moves from the individuality of the singing studio to the more public rehearsal environment, as well as in relation to the demands of the actual performance, when stress levels may be higher (Kenny 2011) due to the efferent stimulation of the adrenal gland (Chanda and Levitin 2013; Koelsch 2014). In addition, there are other context effects. Performance behaviors are subject to social and cultural imperatives, as shown in classical singing styles by a shift in emphasis from vocal agility in the eighteenth century to vocal resonance in the late nineteenth century (Mason 2000) and by different cultural stylistics in operatic performance (Rosselli 2000). Practice, particularly deliberate practice, may be regarded as an essential feature of intra-personal communication and the development of performance expertise. Lehmann (1997) suggests that there are three necessary mental representations involved, namely concerning the desired performance goal, the current performance, and the production of the music.

At the other end of the performance skill continuum are those who are less developed as singers (see "Defining and Explaining Singing Difficulties in Adults," by Wise, this volume; see "Vocal Performance in Occaisional Singers," by Dalla Bella, this volume). Some may have experienced extreme disapproval about their singing, usually from a significant person in their life (such as parent, teacher, peer) (Welch 2001, 2017). Their internal representations of themselves as (non-)singers and, by association, as (non-)musicians are constructed by their negative experience of singing, usually in childhood. This self-image is normally sustained by singing avoidance behaviors, at least in public (Knight 1999; Wise and Sloboda 2008), although there is evidence that even those who regard themselves as singing disabled can be improved in an appropriately nurturing environment (Richards and Durrant 2003; Welch 2017). Such labeling can also be environmentally and culturally sensitive, as demonstrated by the woman who had been born in Barbados and moved to the USA when she was four years of age. When questioned as to why she was convinced that she was a "non-singer," she replied: "Now that I think about it, when I go home to Barbados I am a 'singer'. I'm just not a 'singer' in this country" (Pascale 2001, p. 165). She had two different internal representations of a "singer": a USA "singer" was someone who could lead songs, sing solos, and perform easily, whereas a Barbadian "singer" was someone who could sing fast, "upbeat" songs, and who generally participated with others in singing.

However, even less skilled singers may sing alone and to themselves, either as an accompaniment to another activity (such as showering, housework, driving, deskwork, gardening) or just for its own sake. This is further indication of pleasurable intra-personal musical communication, first evidenced in infancy, and of the interrelated nature of singing, emotion, and self. When provided with an appropriately nurturing environment, developing singers are likely to increase their range of vocal behaviors, improve their self-image, and feel generally feel better. For example, 14 weeks of individual, twice-weekly singing and speaking lessons that were aimed at generating a wider range of vocal dynamics and color, alongside greater ease in vocal production, also produced a significant reduction in stress levels (related to both physical health and cognitive stress), an increased sense of personal well-being, more self-confidence, and a more positive self-image (Wiens et al. 2001). “Voice training became a metaphor of self-discovery” (Wiens et al. 2001, p. 231).

Singing as inter-personal, social, and cultural communication

Cross (2001) argues that the essence of music may be found in its grounding in social interaction and personal significance, as well as in its being rooted in sound, movement, and heterogeneity of meaning. Salgardo (2003) goes further by suggesting that the communication of emotion is at the heart of sung performance through the combined use of acoustical (vocal) and visual (facial) expressive cues. He undertook a series of empirical experiments to demonstrate how the singer’s movements and gestures (vocally and facially) facilitate the communication of their interpretation of the intended meaning of the composer’s notation, including its emotional character. Furthermore, such vocal and facial expressions in performance are similar to those used to convey emotional meaning in everyday life. Salgardo (2003) concludes that the emotions portrayed by a singer, although performed, are not “faked,” but are built on the recollections of real emotions. A performance that is regarded as “authentic” or of high quality will have a close correspondence between such vocal and visual gestures and the nature of the original features of the musical structure; it is a form of corroboration.

In addition to the communication of a basic emotional state, the act of singing conveys information about *group membership*, such as age, gender, culture, and social group (see “Children Singing,” by Harding, this volume). Several studies have demonstrated that listeners are able to identify and label certain features of both the singer (as a “child”) and the singing (as “child-like”). Often there is an accurate correspondence between the listener assessment and the acoustic item, but this is not always the case because of the variables involved, both in relation to the listener and to the singer. As outlined above (see “singing as a physical activity”), the vocal performer’s manipulation of the pattern of vocal fold vibration and the configuration of the vocal tract are basic to the act and art of singing. The acoustic output is dependent on the physiological patterning and this, in turn, is closely related to the singer’s age, gender, experience, skill levels, social and cultural background, and the particular musical genre.

With regard to *age*, a study of 320 untrained child singers aged three to 12 years found a highly regular and linear relationship in listener judgments between the estimated age and the true chronological age (Sergeant and Welch 2008). Where listeners made erroneous judgments, they tended to underestimate the age of those singers aged seven years and older, irrespective of gender, suggesting perhaps that there was a categorical perception of child-like vocal quality that influenced judgments toward some notional mean age. The ability to recognize that a singer is a child is closely related to the nature of the acoustic output (Rutkowski 2015). Although development occurs across childhood, the child's vocal apparatus is significantly different in size and structure from that of the adult (Kent and Vorperian 1995; Stathopoulos 2000) and produces a relatively distinctive sung vocal timbre.

At the other end of the age continuum, older voices also have a characteristic acoustic signature both in singing and in speech that relate to changes in the underlying voice mechanism. However, there can be a significant difference between the chronological and biological ages of a singing voice (Welch and Thurman 2000). It is possible for a person to "sound" several decades younger (or older), depending on their lifelong voice use and vocal health (de Aquino and Ferreira 2016; Prakup 2012). "Older-sounding" voices may have relatively weaker vocal musculature and reduced functioning of the respiratory system, leading to qualitative changes in vocal output, such as a more "breathy" sound, reduced loudness, greater variation in pitching, and perhaps vocal tremor on sustained pitches. Nevertheless, older singers are quite capable of leading fulfilling artistic lives as vocal performers if provided with the opportunity (Silvey 2001).

In between these age extremes there are other "ages" of singing, each related to the underlying anatomical and physiological realities of the voice mechanism. These physical realities have acoustic correlates, suggesting that there are at least seven "ages" (Welch 2009b): early childhood (1–3 years), later childhood (3–10 years), puberty (8–14 years), adolescence (12–16 years), early adulthood (15–30/40 years), older adulthood (40–60+ years), senescence (60–80+) years (cf. Stathopoulos et al. 2011, see also http://www.ncvs.org/ncvs/tutorials/voiceprod/tutorial/changes.html). However, there is considerable overlap between these "ages," not least because of individual and sex differences in biological (maturational) and chronological vocal ages.

With regard to *gender*, there is evidence of differences between the sexes in vocal fold patterning across the lifespan from mid-childhood onwards (Kreiman and Sidtis 2011). Females tend to have slightly incomplete vocal fold closure, resulting in a "breathier" production that is acoustically distinctive spectrally, with more "noise" in their vocal products above 4000 Hz (Welch 2005). Males, on the other hand, tend to have stronger vocal fold closure and a steeper spectral drop-off acoustically. Gender appears to be communicated by the amount of perceived "breathiness" and the formant patterning within an overall spectral shape. The aforementioned study of untrained children's singing (Sergeant and Welch 2008) found that listeners made greater sex identification errors for boys aged below seven years. There was a highly significant linear trend in which correct sex identification was closely correlated with boys' ascending age: pre-pubescent boys became perceptibly more "masculine" in their singing as they got older. No such trend was evident with the girl singers, but there were relatively few identification errors for all age groups.

The effects of education and training on the communication of gender in singing provide similar evidence of both distinctiveness and similarity between the sexes. A range of studies (Howard et al. 2002; Welch and Howard 2002) have demonstrated that there is a slight tendency for trained male choristers to be more correctly identified than trained female choristers, but this perception accuracy is sensitive to individual performance, the particular group of singers, their age and experience, the choice of repertoire, and the individual listener. Nevertheless, both acoustic analyses and perceptual outcomes suggest that trained girl singers are capable of singing with a perceptibly “male-like” voice quality. The same singers are also capable of singing in a more characteristically “feminine” manner. There is also evidence of gender confusability in “collective” (choral) as well as solo singing (Welch et al. 2012).

The effects of *experience, training*, and *skill levels* are evidenced in studies of trained singers, child, adolescent, and adult. Singers who have undertaken classical music training tend to produce a more even timbre across their vocal range. The relatively lower larynx position creates a particular perceptual color to the trained singer’s voice, although this is also culturally sensitive (such as may be evidenced in the differences between German and Italian opera performance styles). There is an intriguing interaction between *gender* and *training* at the highest sung pitches. For males, the trained *falsetto* register is distinctive, as in the countertenor voice, being a form of vocal production that uses a particular balance of muscle activity within the male larynx to produce a female sung pitch range. This style of singing is exploited in both classical and popular musics across the world and can communicate a sense of *sexual* ambiguity or androgyny (Koizumi 2001; Parrott 2015). In contrast, the highest sung female register (employing a similar voice coordination as the male—termed the “flute” or “whistle” register) presents challenges in the communication of text in singing because all vowels share approximately the same formant frequencies so that vowel intelligibility becomes problematic (Welch and Sundberg 2002).

There is an extensive literature on different musical genres and singing (for example, see Potter 2000) and there are certain key features about singing as communication with regard to *social* and *cultural* groups, which can be summarized as follows:

- Singing can be a form of group identification and social bonding (see “The Effects of Gender on the Motivation and Benefits Associated with Community Singing in the UK” by Parkinson, this volume). Examples are found in the use of specially composed company songs to reinforce a senior management’s definition of company culture (Vaag et al. 2014) and in many diverse choral settings, such as bringing disadvantaged individuals together to create a “Homeless Males Choir” (Bailey and Davidson 2013), as well as in the traditional choral communities of Iceland and Newfoundland (see “Group Singing and Social Identity,” by Davidson and Faulkner, this volume).

- Singing can also be a transformational activity culturally, in which members or groups evolve new musical styles or sub-genres or modify established performance practices. Examples of such communities of practice are found in the fusion music of South Asian youth groups (Farrell et al. 2000) and also in the recent influx of female singers into the traditionally all-male cathedral choir that offers the potential of a wider “vocal timbre palette” in the performance of the established repertoire (Howard and Welch 2002). Here the messages are about musical innovation, modernity, challenge, and/or social justice, such as in rap or hip hop (Forman 2000; Taylor and Taylor 2007).
- Regular singing activities can communicate a sense of pattern, order, and systematic contrast to the working day and week, such as in use of songs in the special school classroom to frame periods of activity and in the seasonally related rehearsals and performances of the amateur choir/choral society.
- Singing can also be used as an agent in the communication of cultural change, such as in the identification of certain “Singing Schools” by the Ministry of Education in New Zealand (Boyack 2003) as part of their promotion of a new arts curriculum.

In each of these cases, the act of singing, whether as an individual or as part of a collective, can facilitate both musical and non-musical communication, a sense of belonging or of being an “outsider” (cf. Becker 1963).

Therapeutic use of singing

Singing has been used in recent years to mitigate the impact of major societal challenges (World Health Organization 2012). These include the perceived need to keep an expanding aging population active, or in helping to deal with an increasing onset of degenerative illnesses, such as dementia and Alzheimer’s (Vella-Burrows 2012). Formalized singing activities, such as “Singing for the brain”—a popular singing program developed by the Alzheimer Society in the UK (Bannan and Montgomery-Smith 2008), have been devised and rolled out in nursing homes and community centres across the UK with the aim of bringing people together in a supportive and friendly environment and eliciting memories and words through familiar songs and music (Alzheimer’s Society 2016).

The research that has supported the development of such programs suggests that—in people affected by moderate to severe stage Alzheimer’s disease—musical semantic memory can be preserved (Cuddy et al. 2012). Furthermore, for this population, singing newly acquired words learnt in association with a familiar melody has repeatedly led to a better retention of words and to a consolidation in memory, compared to the learning of words without music (Moussard et al. 2012, 2014). The musical association that happens in the brain during the encoding stage appears to facilitate the learning and retention of words in people affected by dementia and Alzheimer's (Palisson et al. 2015). In addition, singing has also been linked to a general improvement of mood and quality of life in people affected by dementia (Camic et al. 2013).

The connection between singing and improvement of mood, social interaction, health related quality of life, mental health, and well-being has been consistently reported in the literature (Ahessy 2016; Clements-Cortés 2015; Pearce et al. 2016; Reagon et al. 2016; Skingley and Bungay 2010; see "Singing and Psychological Needs," by Davidson and Garrido, this volume). Some underlying explanations of these effects have been linked to the neuroendocrine production of oxytocin and cortisol (Kreutz 2014; Weinstein et al. 2016), two hormones that have been traditionally associated with social bonding and stress responses (Sternberg 2001). There has also been increasing evidence highlighting the influence of psychosocial interventions on the neuroendocrine and immune responses of people involved in music-related activities (Fancourt et al. 2014). For example, in a group of adults affected by cancer, group singing has been associated with an increase of particular cytokines[2] and a reduction of inflammation, suggesting a correlation between improved immune response to cancer and singing (Fancourt et al. 2016).

Group singing has also been shown to be effective in reducing social isolation in older people, promoting enjoyment and resulting in improved mental and physical health, as well as increased cognitive stimulation (Clift et al. 2010; Saarikallio 2011; Skingley and Bungay 2010). Specifically, Cohen et al. (2007) carried out a series of non-randomized controlled studies with 166 participants (mean age of 80 years old) taking part in singing workshops, and discovered that in comparison with a control group they reported fewer health issues, fewer falls, fewer doctor's visits, and less use of medication. Clift and his colleagues (2010), in their review of the literature on the benefit of group singing, suggested that group singing promotes social and personal well-being, encourages social participation, and reduces anxiety and depression.

Overall, active engagement with music in general and singing in particular is seen to provide a sense of purpose, community, and independence in the lives of people taking part in music-making activities (Creech, Hallam, McQueen, et al. 2013; Creech, Hallam, Varvarigou, et al. 2013), thus providing them with some key tools to support a healthy aging process, both physically and mentally.

Conclusions

Singing is a diverse behavior that embraces human communication that is multifaceted and concurrent, with different messages being produced and perceived at the same time, within and outside conscious awareness. The singer communicates intra-personally through the moment-by-moment acoustic stream that provides diverse forms of feedback concerning musical features, vocal quality, vocal "accuracy" and "authenticity," emotional state, and personal identity. To the external listener (parent, peer, audience), there is also inter-personal communication that is musical, referential (through the text), emotional, and non-musical, such as in the delineation of membership of a particular social and/or cultural group. To sing is to communicate—singing as communication.

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Notes:

([1]) This is an updated and fully revised version of a chapter originally published as Welch, G.F. (2005). Singing as Communication. In: D. Miell, R. MacDonald, and D. Hargreaves (eds), *Musical Communication*, pp. 239–259. New York: Oxford University Press. doi: 10.1093/acprof:oso/9780198529361.003.0011

([2]) Ctyokines is a general name for a category of small proteins that are important in cell signaling. Their release has an effect on the behavior of cells around them. Their definite distinction from hormones is still part of ongoing research (Wikipedia 2016).

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