Chapter 11

Singing as communication

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Introduction: the significance of voice in the ontogeny of communication

Vocal sound is one of the defining features of humanity. 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 commonly have the greatest socio-cultural significance. These are categorized as speech and singing, but there is potential (and actual) significant overlap between the two, because both sets of behaviours 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. 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. Perception is contextualized by the listener's age, family, community membership, enculturation, and the development of the vocalizer. 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 behaviours are constrained by the limited structures and behavioural possibilities of the developing vocal system (*cf*. Kent and Vorperian 1995). The first vocalizations are related to the communication of an affective state, initially discomfort and distress (crying), followed by sounds of comfort and eustress. 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), whilst also exploring rhythmic syllabic sequences with superimposed melodies and short musical patterns (Papoušek [M] 1996).

With regard to sound *reception*, hearing is normally functioning before birth in the final trimester of pregnancy (Lecanuet 1996) and the newborn enters the world capable of perceiving tiny differences in voiced sound (Eimas *et al*. 1971). Infants are 'universalists' (Trehub 2003) 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 (*cf* Kuhl *et al.* 1992, Vihman 1996). During these initial twelve months of life, it is the prosodic (pitch and rhythm) features of 'infant-directed' speech (also known as 'motherese' or 'parentese') that dominate early communication from parent/caregiver to child (Papoušek [H], *op cit*). The prosodic envelopes that define spoken phrases are thought to be essential perceptual building blocks in the infant's developing comprehension of language (Jusczyk *et al*. 1992).

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 1999) that engages with an 'intrinsic motive pulse', an innate ability to sense rhythmic time and temporal variation in the human voice (Trevarthen 1999). The expressive prosodic contours, pitch glides, and prevalence of basic harmonic intervals (3rds, 4ths, 5ths, octaves) of 'infant-directed speech' (Fernald 1992; Papoušek [H], *op cit*) occur alongside the mother's 'infant-directed singing' (Trehub 2001), 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 ritualised 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, *op cit*) 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], *op cit*: 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, *op cit*: p. 212), related both to the developing child's own 'tunes' as well as the 'tunes' of others.

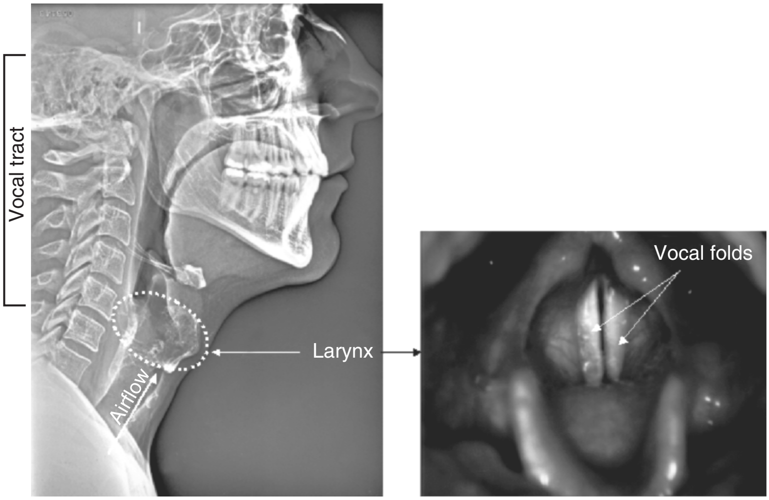
The text that follows focuses initially on the nature of the physical realities involved in singing as a form of communication. These psycho-acoustic features of the singing voice and their development underpin the nature of intra- and inter-personal communication in singing.

Singing as a physical activity: structure and communicative function

Probably because of the ubiquity and bipotentiality of the human voice for speech and singing (both in reception as well as production), the outputs of the vocal instrument are central components in many of the world's diverse performing arts. Examples include hugely popular Bollywood genre of *filmi* music from the Indian subcontinent, virtually all the musics of Africa, in which singing is often the core group activity, other indigenous musics, such as the traditional 'throat musics' of Southern Siberia, Mongolia, and Tibet in which two musical lines are sung simultaneously by a single voice, as well as the musical narrative forms of Japan, such as *Nohgaku* and *Shinnai*, which challenge a bipolar Western conceptualization of vocal behaviour as either singing or speech.

Underpinning this worldwide use of the voice for musical performance and communication is a common anatomy and physiology (Fig. 11.1, Welch and MacCurtain, private archive) that are shaped by biological maturation, experience, cultural imperative, and tradition. Vocal *pitch* is essentially a product of patterns of vocal fold vibration, vocal *loudness* relates to changes in air pressure from the lungs, vocal *colouring* is generated by the interface between vocal fold vibration and the configuration of the elements of the vocal tract (see Welch and Sundberg 2002 for an overview).

Young children have smaller vocal folds than adults and so have higher pitched voices. Perhaps surprisingly, although boys tend to have slightly larger vocal folds than girls, they both use a similar vocal pitch for speech (Titze 1994), although girls attain a wider vocal range earlier in singing (Welch 1979*b*). Up to the age of twelve when adult-like breathing patterns emerge, children can achieve similar vocal loudness levels to that of adults by using relatively more breath (Stathopoulos 2000).



Lateral view of head and neck   Top-down view of the larynx and vocal folds

Fig. 11.1 Anatomical structure of the singing voice.

The onset of adolescence brings growth in the average size of both male and female vocal tracts, but there is a disproportionate increase in the length and circumference of the male tract and size of the larynx, resulting in the adult male having a customary vocal pitch range that is between a fifth to an octave lower than that of the adult female (see also the *gender* section below on 'inter-personal communication').

Crying is the first vocal act and it forms the substrate for all subsequent vocalization, including singing, '…prosodic elements such as variation in intensity and pitch, rhythmic patterning, and phrasing are all present in cry long before they enter into vocal play' (Vihman, *op cit*: p. 104). Greater variety of vocalization is only possible when the facial skeleton has grown downwards and forward, thus increasing the size of the oral cavity, and the proprioceptive sense receptors in the vocal tract (such as tongue tip and pharynx) are more mature (Kent and Vorperian 1995). The perceptual ambiguity of infant vocalization (as pre-speech and pre-singing) is a product of the functioning of its basic vocal anatomy as well as our adult categorical perception.

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 for a variety of cognitive and affective functions, including those related to music. Hemispheric asymmetries are often evidenced, as are relative biases towards particular neural locations, depending on the type of musical behaviour under consideration. Recent findings suggest, however, that musical perception can also involve cross-hemispheric processing (Schuppert *et al*. 2000), such that initial right-hemispheric recognition of melodic contour and metre are followed by an identification of pitch interval and rhythmic patterning via left-hemisphere systems, at least in musically experienced adults.

Musical behaviours 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 to explain neuropsychobiological musical processing (Peretz and Coltheart 2003), based on case studies of musical impairments in brain-damaged patients. Separate systems within the brain are responsible for the analyses of language, temporal organization, and pitch organization. These systems relate incoming information to existing knowledge banks (a phonological lexicon and a musical lexicon) as well as previous experience of emotional expression.

Adapting the Peretz and Coltheart model to *singing* (see Fig. 11.2), there is evidence to suggest that song lyrics are processed separately and in parallel with song melody. In performance, these are enacted by simultaneous cooperation between areas within the left and right cerebral hemispheres, respectively (Besson *et al.* 1998), with likely common cortical processing of the syntactical features of music and language (Patel 2003). Other neurological studies that compare song imagery (thinking through a song in memory) with actual song perception offer support for this adapted model. 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, based on bilateral activation of the temporal and frontal cortex and of the supplementary motor area (Marin and Perry 1999). There is also evidence that song imagery alone can activate auditory cortical regions (Marin and Perry, *op cit*).

The original 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

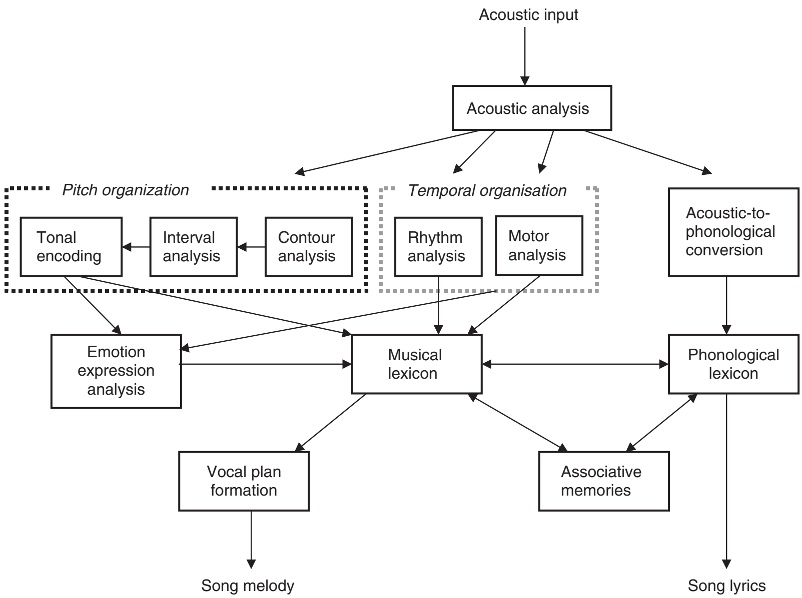


Fig. 11.2 A modular model of music processing in singing (adapted from Peretz and Coltheart 2003). Each box represents a processing component and arrows represent pathways of information flow or communication between processing components.

musical lexicon depends on the task requirements. In relation to singing, if the goal is a song, then the melody from the musical lexicon will be paired with its associated lyrics that are theorized as being stored in the 'phonological lexicon'.

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 (*cf.* Welch 1979*a*, 2000; Davidson 1994). Analysis of longitudinal empirical data on young children's singing development (*cf.* Welch *et al.* 1996, 1997, 1998) 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. A similar bias is reported in adult singers' biased ability to make fewer errors in memorizing the words of new songs compared to the musical elements (Ginsborg 2002). In relation to the model, children's singing research data indicates that the average English-speaking five-year-old's 'phonological lexicon' is often more developmentally advanced than their 'musical lexicon'.

The original 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). This developmental model and its associated literature suggest that an important phase in the child's journey towards accurate vocal pitch matching is the ability to match a song's melodic contour (Welch 1986; Hargreaves 1996). The child data support 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. Furthermore, a recent pedagogical study of the conscious development and manipulation of vocal pitch contour in six-year-olds (including the use of computer-assisted learning and visual feedback) produced significant improvements in vocal pitch matching and in an extended vocal pitch range (Western 2002).

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, facilitating an emotional response to the musical sounds. With regard to the emotional evaluation of vocal sounds, various distinct cortical and sub-cortical structures, primarily (but not solely) in the right hemisphere, have been identified as significant (Peretz 2001). As part of our basic communication, six primary emotions – fear, anger, joy, sadness, surprise, and disgust – are all commonly expressed vocally (Titze 1994) and are differentiated by strong vocal acoustic variation (Scherer 1995). 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 its 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 Thurman and Grambsch 2000 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

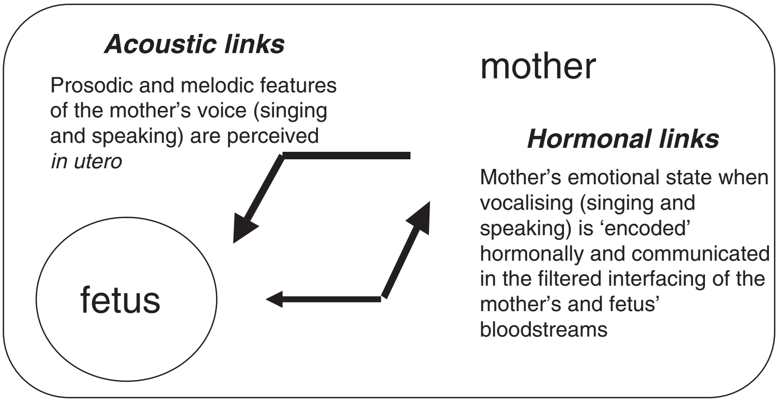


Fig. 11.3 The shaping of an integrated fetal emotional response to sound through concurrent experience of the mother's prosody, sung melody, and affective state.

(*pace* Peretz and Coltheart, *op cit*) is likely to produce a related neuro-endocrine reaction in her developing child (*cf.* Thurman and Grambsch, *op cit* Keverne *et al.* 1997). The filtered interfacing of the maternal and fetal blood-streams allows the fetus to experience the mother's endocrine-related emotional state concurrently with her vocal pitch contours (see Fig. 11.3). 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 1994) 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.

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 (DeCasper and Fifer 1980). The perceptual salience of maternal pitch contour 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), as well as an ability to imitate basic vowels at the same age after only fifteen minutes 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 2001).

Singing as emotional capital

Thus the child enters the world with an emotional 'bias' towards certain sounds, linked to their earliest acoustic and affective experiences of maternal vocal pitch contour. Arguably, this biasing 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 earlier, 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 the 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 tripolar 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, 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 2001). Analyses of recorded performances indicate that virtually every performance variable is affected in ways specific to each emotion (Gabrielsson 2003). 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, *op cit*). 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 post-natal depression will have a different vocal quality (quieter, lower pitched, longer pauses) than her non-depressed peers (Robb 1999). 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 (Eimas *et al*. 1971) is soon shaped towards a biased detection of the particular distinguishing features of salient local sounds. This, in turn, affects related behaviours. So by the age of one year, for example, infants from different cultures are sufficiently cued into the maternal language to babble differently: French infants babble with French speech units, Russian infants with Russian, and Japanese with Japanese (Meltzoff 2002). 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. 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 (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-schooler's spontaneous 'pot-pourri' songs (Moog 1976) and '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 and Villa 2002), or adult-initiated song improvisations and compositions (Barrett 2002). As the human develops social awareness and communicative vocal skills, there is shift from communication that is biased towards 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, kinaesthetic, or vestibular (Welch 1985; Gabrielsson 2003) 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 behaviour (*cf.* 'vocal plan formation' – Peretz and Coltheart 2003). In the first months of infancy, this system is being developed in the vocal behaviours 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 behaviour (termed 'voice programme' 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 behaviour feedback system also provides the basis for self-reflective psychological judgements as to the 'appropriateness' of any given example of singing behaviour, 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 judgement 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, *op cit*), 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.* 1996, 1997, 1998). In some cases, there will be a realization of a mismatch between the intended and actual singing behaviour and a subsequent correction can take place.

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 behaviour, even though they may realize that something is 'incorrect' or 'inappropriate'. It can also persist because there is no awareness that their singing behaviour 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 behaviour 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 due to the efferent stimulation of the adrenal gland (Rossi 1993; Sapolsky 2003). In addition, there are other context effects. Performance behaviours 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). 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. Some may have experienced extreme disapproval about their singing, usually from a significant person in their life (such as parent, teacher, peer) (Welch 2001). 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 behaviours, at least in public (Knight 1999), 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). Such labelling 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 2002, 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 behaviours, improve their self-image, and generally feel better. For example, fourteen weeks of individual, twice-weekly singing and speaking lessons that were aimed at generating a wider range of vocal dynamics and colour, 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.* 2002). 'Voice training became a metaphor of self-discovery' (Wiens *et al. op cit*: 231).

Singing as interpersonal, 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 being rooted in sound, movement, and heterogeneity of meaning. In singing, 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 (*op cit*) 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. 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 three hundred and twenty untrained child singers aged three to twelve years found a highly regular and linear relationship in listener judgements between the estimated age and the true chronological age (Sergeant *et al.* unpublished ms). Where listeners made erroneous judgements, 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 judgements towards some notional mean age. The ability to recognize that a singer is a child is closely related to the nature of the acoustic output. 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) to produce 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 (Hazlett and Ball 1996). '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.

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': 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), and senescence (60–80+) years. 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. 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. 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 *et al.*, *op cit*) found that listeners made greater sex identification errors for boys aged below 7 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 (*cf.* 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.

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 colour 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 configuration of the male vocal structure 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 (*cf.* Koizumi 2001). 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 (*cf.* Welch and Sundberg 2002).

There is an extensive literature on different musical genres and singing 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. Examples are found in the use of specially composed company songs to reinforce a senior management's definition of company culture (Corbett 2003) and in many diverse choral settings, such as bringing disadvantaged individuals together to create a 'Homeless Males Choir' (Bailey and Davidson 2002), as well as in the traditional choral communities of Iceland and Newfoundland.
- 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.* 2001) 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 (Welch 2003). Here the messages are about musical innovation, modernity, challenge, and/or social justice, the latter being demonstrated by the emergence of rap (Toop 2000).
- 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 recent 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 on the 'outside'.

Conclusions

It is impossible to imagine singing without some form of communication that is multi-faceted and concurrent, with different messages being produced and perceived at the same time. The singer communicates intrapersonally by the moment-by-moment acoustic stream providing 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 interpersonal 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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