CHAPTER 16

SINGING AND VOCAL DEVELOPMENT

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Introduction

Despite the warmth in the room as they shook the snow off their winter coats and gathered around the kitchen table, there was a collective sense of nervousness and, in some cases, unease that was barely touched by the hostess' cheerful manner and greeting. Outside, the dark of a Newfoundland evening had already descended and the hostess wondered if some of the wind's icy chill was reflected in the body language. This gathering was to be the first of several sessions for the group when things usually unspoken, sometimes hidden for many decades, would be allowed to surface.

> You went to school, the first thing that happened, everybody had to be singing in little concerts and things. You go to class; the nuns would say, 'anybody can sing.' You'd go and you were embarrassed to tears because you knew you couldn't sing and there was no help... I was told... you really can't sing, you can go back to your classroom.
>
> Knight, S. interview with C., aged 50 (private communication)

> 'I remember playing skipping and singing on the street. I can't remember the tunes now. My sister—I remember singing a little bit to her, but I don't think I ever really thought I couldn't sing until Grade Seven [age 12] and the teacher and all my friends and I was in glee club and that was a major time. She stopped and said, 'Somebody is tone-deaf here.' She said, 'It's you, Julie, you're tone-deaf.' She said, ' You don't have any notes. You just can't sing along with the music at all.' I said, 'I really want to stay in glee club because my friends are there.' She said, 'You can stay in glee club but you're not allowed to sing. You just got to mouth the words. You can't sing.' From then on, I assumed that I was tone deaf. I never sang in any other choirs at all after that. I go to church most of the time and I mouth the words. If we are out with a bunch of friends at a party, I try to mouth the words. Maybe, if I had a drink or two, I might sing. And even when I heard myself, I felt that I couldn't sing. My voice is deep anyway... I know a lot of people have deep voices and are beautiful singers, but I just assumed that because my voice is deep that I couldn't sing... that's 35 years ago... I was sitting second row back and there were kids behind me. You can imagine how embarrassed I felt.'
>
> Knight, S. interview with V., aged 47 (private communication)

> We always sang. We'd sit on the fence in the evening, friends and stuff like this, and we'd sing different songs that would be on the go and, of course, you would be playing and there would be songs with that. But it was always something that we did. Then in Grade Six

> [age eleven], we had a two-room school and we had Grade 1 to 3 in one room and Grade 4 to 6 in the other room, and the same teacher, of course, taught the three Grades. Her daughter was in school with us and there was some kind of play or something for Christmas, and so singing—these songs were sung. I practised at home for ages and I stood up to sing it and she [the teacher] told me to sit down, that I couldn't sing. Well, I was devastated. And I thought I had done such a good job with it . . . I'm sure I wanted to cry. Of course, you came home; it was no good of telling your parents at the time that something like this had happened to you.
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> Knight, S. interview with L., aged 42 (private communication)

Over the next few weeks and months, these adults shared many similar detailed memories. Despite the passing of time, these episodes of childhood were vividly recalled. A sense of embarrassment, shame, deep emotional upset, and humiliation, usually accompanied by reports of a lifelong sense of musical inadequacy were commonly expressed elements. For these particular Canadians, as for many other adults around the world in different cultural contexts, the associations between singing and childhood were not positive. Within the local Newfoundland culture, singing competency either as an individual or within a group has always had high status. Consequently, any perceived singing 'failure' in childhood has often led to continued self-identify as a 'non-singer' (Knight, 1999) and has reinforced a cultural stereotype of a community that is divided in two: those who 'can sing' and those who 'cannot'.

Similar findings have been reported from other studies of adults in North America, the UK, and Scandinavia. Yet, despite such experiences, there are some adults who never give up hope of improvement and there have been several successful examples of specialist choirs being started for adult 'non-singers' (Mack, 1979; Richards & Durrant, 2003). These include a new community choir in St. John's, Newfoundland, four 'beginners' choirs in one London college that have a 20-year history, various 'Singing from Scratch' choirs in the Midlands and south-east of England and similar initiatives in Sweden, the USA, Canada, Australia, and New Zealand.

The existence of such choirs for adult 'non-singers' is one of a number of significant challenges to a bipolar 'can/cannot' categorization of singing behaviours. They are part of the evidence base for singing to be considered as a normal developmental behaviour that can be enhanced or hindered, particularly by the events and experiences of childhood. The prime source of such singing 'failure' for an individual is a particular moment in childhood and/or adolescence when there is a mismatch between developing singing competences and a set singing task (Welch, 1979, 1985, 2000a,b, 2005; Cooksey & Welch, 1998). Erroneous adult expectation often creates the problem. This mismatch may then become further 'objectified' by continuing inappropriate comment from adults or peers, which suggests that the singing problem is evidence of an underlying disability in music. Arguably, the number of singing 'failures' that are socially generated in our communities would be reduced radically if there was a greater awareness of: (1) how singing mastery develops; (2) how children of the same age can be in different phases of development (as is considered normal with other forms of culturally-biased behaviour, such as reading); and (3) how best to provide suitable 'developmentally sensitive' singing activities. The narrative that follows reviews the nature of singing development from early childhood through to (and including) adolescence.

Particular features are highlighted of how normal development may be fostered, shaped, and sometimes hindered.

Singing as a developmental behaviour

Pre-birth and infancy

The foundations of singing development originate in the auditory and affective experiences of the developing fetus during the final months of gestation, particularly in relation to the earliest perception of melodic variations in the mother's voice. The amniotic fluid that surrounds the fetus is an effective transducer of the pitch contours of maternal voicing. As the mother speaks or sings, the prosodic features of her voice (melody and rhythm) are conveyed to the developing fetus by the sound waves that transfer through her body tissue and that also are reflected from surfaces in her immediate environment. At the same time, the mother's affective state as she speaks or sings is encoded hormonally in her bloodstream through neuroendocrine activity. This emotional state is believed to be experienced by the fetus relatively concomitantly with the sound of the mother's voice because of an interfacing of the fetal and maternal bloodstreams (see Welch, 2005, for a more detailed review). The outcome is an interweaving of acoustic (prosodic/melodic) and emotional experiences pre-birth that are likely to underpin the developing infant's subsequent interactions post-birth with the sounds of the maternal culture. For example, our ability to determine particularly strong emotions in vocal behaviours in speech and singing (Johnstone & Scherer, 2000; Sundberg, 2000; Nawrot, 2003) is likely to originate in these earliest dual-channel (acoustic-affect) experiences and, arguably, to create a certain bias towards the association of particular vocal timbres with positive and negative feelings (termed 'emotional capital'—Welch, 2005). Six-month-olds, for example, exhibit endocrine (cortisol) changes after listening to their mothers singing (Trehub, 2001), becoming calmed when upset and more alert when sleepy.

The first year of life is characterized by a shaping of the infant's vocal production through an interaction with the acoustic characteristics of the maternal culture. Parents, for example, typically incorporate rich musical properties when interacting with infants: they speak and sing at higher pitch levels, use a wider pitch range, longer pauses, often at a slower rate, and use smooth, simple, but highly modulated intonation contours (for reviews, see Thurman & Welch, 2000; Welch, in press; Chapter 2, this volume). At birth, neonates continue to be particularly sensitive to the sound of the human voice, while demonstrating a certain initial perceptual plasticity towards any language (Eimas, 1985). Two-day-old neonates, for example, listen longer to women singing in a maternal style (Masataka, 1999). Adult singing (both male and female) appears to be especially significant, as demonstrated in its beneficial effects on premature infants' physiological functioning through changes in heart rate and oxygen saturation, alongside a reduction in stressful behaviours (Coleman *et al.*, 1997).

The earliest vocal behaviour is crying. It contains all of the ingredients of subsequent vocalization, including singing, with variations in intensity and pitch, as well as rhythmic patterning and phrasing (Vihman, 1996). At the age of 2 months, cooing and vowel-like sounds are already evidenced and being shaped by the maternal culture (Ruzza *et al.*, 2003). Aspects of 'musical babbling' that contain definite musical features, such as pitch and rhythmic patterns, are also evidenced from 2 months onwards (Tafuri & Villa, 2002). Their incidence and quality appear to be related positively to the amount of time devoted to daily singing behaviours by the mother; the greater the amount of maternal singing, the increased likelihood of earlier musical babbling. By the age of 3–4 months, the infant is able to imitate their mother's exaggerated prosodic contours that characterize infant-mother interaction (Masataka, 1992). Vocal play emerges around the ages of 4–6 months (Papoušek, 1996). By the age of 1 year, infants are sufficiently cued into the language of the maternal culture for elements to be reflected in their own vocalizations. As examples, French infants babble using French speech units, Russian infants babble using Russian and Japanese infants using Japanese (Meltzoff, 2002).

In general, the first year of life is characterized by increasingly diverse vocal activity. The first vocalizations of infancy, with their communication of affective state (discomfort and distress, then also comfort and eustress), are expanded to include quasi-melodic features (2–4 months), developing vocal control (4–7 months), with vocal pitch behaviours that are directly linked to the prosodic features of the mother tongue.

Early childhood and pre-school

Singing development pre-school is characterized by an increasing interaction with the sounds of the experienced maternal culture. This interaction is reflected in a mosaic of different singing behaviours that are evidenced between the ages of 1 and 5 years. They relate to the young child's acquisitive, playful, creative and spontaneous nature as they engage with and make sense of their 'local' musical world. The variety of vocalization includes: 2 year olds' repetition of brief phrases with identifiable rhythmic and melodic contour patterns (Dowling, 1999), 3 year olds' vocal interplay between spontaneous improvization and selected elements from the dominant song culture, termed 'pot-pourri' songs (Moog, 1976), and 'outline songs' (Hargreaves, 1996) in which the nature of the figurative shape of the sung melodic contour (its 'schematic' contour) is thought to reflect the current level of the young child's understanding of tonal relationships (Davidson, 1994).

There is evidence of increasing sophistication and complexity in relation to the learning of songs from the dominant culture by young children (and see later for developmental models by Rutkowski, 1997; Welch, 2002). However, the path of development is not necessarily linear for any particular individual. In a US study of the spontaneous singing of 2 year olds' first songs, for example, there is evidence that 'phrases are the initial musical units' (Davidson, 1994, p. 117). Such phrases are characterized by limited pitch range, a certain disjunction of key/tonality and a descending contour. In contrast, recent Italian data of 2–3-year-old children indicate that some young children appear to be much better at imitating a complete melody modelled by their mother (and also by a specialist course tutor) than in matching individual phrases of the same song (Tafuri & Welch, unpublished data, see Figure 16.1). These Italian children had been exposed to regular sessions of their mothers' singing since the final trimester of pregnancy, both at home and in a special infant-parent singing course organized in the local conservatoire. Yet for other children in the same Italian group, with apparently the same levels of exposure to maternal singing, the opposite is the case. Their

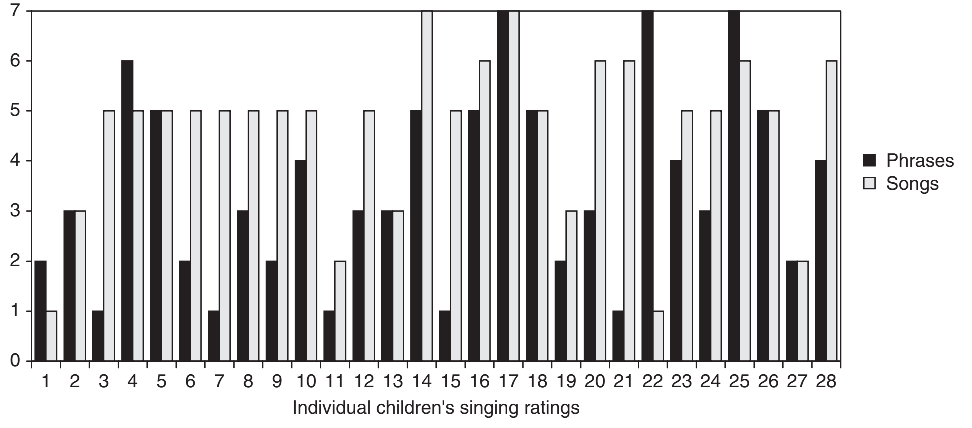

Figure 16.1 Accuracy ratings of Italian children ($n = 28$) aged 2.6–3.3 years in imitating song phrases and complete songs modelled by their mothers (Tafuri & Welch, unpublished data). Ratings are based on a seven-point scale of perceived accuracy.

sung phrase accuracy is rated as better than their whole song accuracy (Figure 16.1), in line with data from the earlier US (Davidson, 1994) study.

For the youngest children, the boundaries between singing and speaking may be blurred, or at least ambiguous to the adult listener, and are related to the dominance of a particular contour schema (Davidson, 1994) as well as to the influence of the mother tongue. For example, a longitudinal study in Canada of young girls aged 18–38 months from monolingual and bilingual backgrounds reported that 'intermediate vocalizations' (a type of vocal behaviour at the boundary between speech and song) were more prevalent in Mandarin and Cantonese-speaking children than in English-speaking children (Mang, 2000/2001). A follow-up study in Hong Kong with mono- and bilingual 3- and 4 year olds confirmed these findings and revealed that, regardless of age, the manipulation of vocal pitch was used to distinguish between singing and speaking (Mang, 2002). The mean fundamental frequencies (F_0) for songs were reported to be consistently higher than speech, but 'own choice' songs were performed at a slightly lower pitch than a criterion song. In addition, the older English monolingual children demonstrated a wider mean F_0 differentiation between their singing and speaking behaviours compared with their Cantonese mono- and bilingual peers. Taken together, such examples from these diverse cultural settings remind us that singing behaviour is subject to developmental processes, while also being sensitive to socio-cultural context (including task). In the above examples, context also includes the presence or absence of a pitch-based language as the mother tongue in which meaning is explicitly conveyed by the shaping of melodic contour.

As might be expected from the interaction of enculturation with generative skill development in music (cf. British Educational Research Association Music Education Review Group, 2004; Welch, in press), longitudinal data on singing development in early childhood confirm the importance of the prosodic features of the mother tongue. Spontaneous singing is characterized principally by the control of melodic-rhythmic contour patterns

(Sundin, 1997; Dowling, 1999). Between the ages of 1 and 2 years, for example, a typically spontaneous infant song consists of repetitions of one brief melodic phrase at different pitch centres. By the age of 3 years, three different phrases are characteristically evidenced and one phrase singing is rare (Dowling, 1988, 1999). Furthermore, recent case study research with 2–3 year olds in a free-play day-care setting (Young, 2002) celebrates a wide diversity in young children's spontaneous singing that is linked to context and activity, while being mediated by age. This diversity includes 'free-flow vocalizing' (a wordless vocal creation often associated with solitary play with no defined overall musical shape), 'chanting' (often short, repeated phrases), 'reworking of known songs' (the utilization of enculturated song fragments), 'movement vocalizing' (either of self or objects), singing for 'animation' (associated with dramatic play), and the imitation of actual sounds (defined as 'comic-strip types noises', usually associated with object play). As children grow older (3–4 years) and more sociable, more speaking than singing may be evidenced.

Age is also a factor in young children's perception and expression of emotion in singing. Four- and 5 year olds are able to express happiness and sadness in their invented songs. In one Canadian study, children used conventional musical devices, such as a major modality and dotted or syncopated rhythms for 'happy' songs, contrasted by a reduced pitch range and suppression of melodic contours in 'sad' songs (Adachi & Trehub, 2000). Their song texts were also contraposed emotionally; with 'happy' songs focused on 'friends', 'family', and 'sweets', but 'sad' songs focused more on a negative version of these (e.g., 'no family'). In contrast, older children's 'sad' songs were dominated by themes related to death (Adachi & Trehub, 1999). Data from Sweden (Gabrielsson & Örnkloo, 2002) confirm the growth of children's expertise with age in the recognition and expression of intended sung emotion, particularly between the ages of 4 and 7 years.

The first years of schooling

It is common for a diverse range of singing abilities to be exhibited by children on entry to compulsory schooling. Within this diversity, it is necessary to distinguish between (1) children's (developing) skill in the performance of a taught song (Rutkowski, 1990, 1997; Welch, 1986, 1998, 2000b, 2002; Welch *et al.*, 1996, 1997, 1998), and (2) children's ability to invent songs (Davies, 1986, 1992, 1994). As with pre-school singing behaviours, context and culture are also factors (Rutkowski & Chen-Haftek, 2000; Mang, 2003).

With regard to the first of these categories concerning the skilled performance of a taught song, two major US and UK studies have drawn on developmental theories to propose phased models of singing development (Rutkowski, 1997; Welch, 1998—see footnote[1]).

[1] Rutkowski (1997) *Singing Voice Development Measure (SVDM)*

1 'Pre-singer' does not sing but chants the song text.

1.5 'Inconsistent Speaking Range Singer' sometimes chants, sometimes sustains tones and exhibits some sensitivity to pitch, but remains in the speaking voice range (usually a3 to c4 [note: the pitch labels have been altered to bring them in line with modern conventions in which middle C = c4, 256 Hz]).

2 'Speaking Range Singer' sustains tones and exhibits some sensitivity to pitch but remains in the speaking voice range (usually a3 to c4).

2.5 'Inconsistent Limited Range singer' waivers between speaking and singing voices and uses a limited range when in singing voice (usually up to f4).

The US data (Rutkowski, *op. cit.*) was generated through systematic evaluation of children's singing behaviours across a period of over 15 years. The emergent nine-phase model (which went through several versions[2]) suggests that children progress from speech-like chanting of the song text, to singing within a limited range ('speaking range singer') to the demonstration of an expanded vocal pitch range that is allied to skilled competency in vocal pitch matching. This model has an affinity with that of another US-based longitudinal study (Davidson, 1994) that suggests that children's singing development is linked to a schematic processing of melodic contour. Data from Harvard University's 6-year *Project Zero* study of children aged between the ages of 1 and 6 years indicated five specific levels of pitch development in young children's singing, expanding from an initial melodic contour scheme with a pitch interval of a third to one that embraced a complete octave.

Within the research literature, children are sometimes reported as being more skilled when copying a sung model if they used a neutral syllable rather than attempting the song with its text (e.g., Levinowitz, 1989). This finding has resonances with data from a 3-year longitudinal study of 184 children in their first 3 years of formal education in 10 UK Primary schools (Welch *et al.*, 1996, 1997, 1998). The research provided detailed evidence of how singing behaviours are age-, sex-, and task-sensitive. Over the 3 years, the participants as a collective appeared to demonstrate little overall improvement when required to match the sung pitches of the criterion songs (two songs were specially taught and assessed each year) (see Figure 16.2). However, this singing behaviour was in marked contrast to their ability to learn the words of the songs, which was extremely good, even in their first term

3	'Limited Range Singer' exhibits consistent use of initial singing range (usually d4 to a4).
3.5	'Inconsistent Initial Range Singer' sometimes only exhibits use of limited singing range, but other times exhibits use of initial singing range (usually d4 to a4).
4	'Initial Range Singer' exhibits consistent use of initial singing range (usually d4 to a4).
4.5	'Inconsistent Singer' sometimes only exhibits use of initial singing range, but other times exhibits use of extended singing range (sings beyond the register lift: b^b4 and above).
5	'Singer' exhibits use of extended singing range (sings beyond the register lift: b^b4 and above). Welch (1998) *A revised model of vocal pitch-matching development (VPMD)*
Phase 1	The words of the song appear to be the initial centre of interest rather than the melody, singing is often described as 'chant-like', employing a restricted pitch range and melodic phrases. In infant vocal pitch exploration, descending patterns predominate.
Phase 2	There is a growing awareness that vocal pitch can be a conscious process and that changes in vocal pitch are controllable. Sung melodic outline begins to follow the general (macro) contours of the target melody or key constituent phrases. Tonality is essentially phrase based. Self-invented and 'schematic' songs 'borrow' elements from the child's musical culture. Vocal pitch range used in 'song' singing expands.
Phrase 3	Melodic shape and intervals are mostly accurate, but some changes in tonality may occur, perhaps linked to inappropriate register usage. Overall, however, the number of different reference pitches is much reduced.
Phase 4	No significant melodic or pitch errors in relation to relatively simple songs from the singer's musical culture.

[2] The conceptualization of development as occurring in 'phases' is a common outcome of research that is undertaken over a long period with time for researcher reflection and the evaluation of new data. For example, the current author has developed and reviewed a particular model of vocal pitch matching over the past two decades (1986, 2002), which reconceptualizes the evidence and reduces the number of developmental 'phases' (rather than the originally labelled 'stages') from five to four.

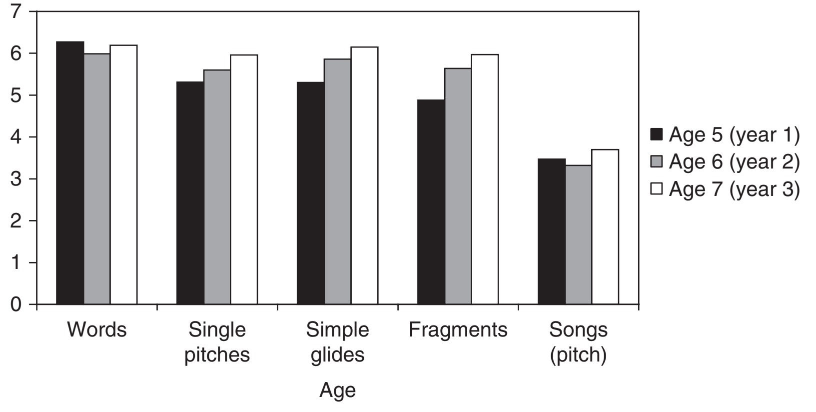

Figure 16.2 Longitudinal data on 5–7-year-old children's ($n = 184$) rated singing abilities (maximum accuracy rating = 7) for (a) words of target songs (two songs were assessed each year); (b) sung pitches of same complete songs; (c) deconstructed pitch elements of the same songs (single pitches, simple melodic contours (glides) and simple melodic fragments) (Welch *et al.*, 1996, 1997, 1998).

of compulsory schooling at age 5 (Figure 16.2: Year 1 data). Furthermore, when the pitch elements of the target songs were deconstructed into simpler musical tasks in which the children were required to match individual pitches, echo melodic contours, or copy small melodic fragments, the children were significantly more pitch accurate, as demonstrated by year-on-year improvements. There were no sex differences in their singing of these three types of deconstructed tasks. Boys and girls were equally successful and demonstrated similar improvements over time. In contrast, when the *same* boys were faced with the challenge of singing a complete song, their vocal pitch became less accurate and, as a group, they demonstrated little or no improvement in song singing across the 3 years. Overall, singing competency appeared to be closely related to the nature of the task, with many boys negatively affected in the task of singing a 'school' song. In line with these longitudinal findings, two recent studies suggest that gender stereotyping may be a factor in the lack of singing development in some young boys (Hall, 2005; Joyce, 2005). Australian research into 5-year-old boys' singing (Hall, 2005) indicates that singing may be perceived as a 'female' activity. UK research of 9- and 10 year olds (Joyce, 2005) across three primary schools found that only one-third of boys enjoyed singing (compared with two-thirds of girls) and that boys believed that girls were better singers.

In addition to age, sex/gender, and task, there are also contextual factors that can affect children's singing behaviours. For example, the UK longitudinal study data demonstrated a clear 'school effect' (Welch, 2000a). When comparing individual school data, *all* the children in one inner-city school improved their singing skills over the 3 years, notwithstanding their poor socio-economic environment and generally low academic attainment in other areas of the curriculum, whereas relatively few children made progress in another school, despite them having much higher socio-economic status and attainment levels. A major factor in these differences appears to have been teacher expectation. Progress was most marked where the class teacher expected and worked consistently for singing improvement with all their pupils over a sustained period. Similar findings concerning school effects on singing motivation, perceived self-identity as a singer and overall enjoyment of singing as a school activity are also reported by Joyce (2005).

Socio-cultural differences have been exampled also in the more advanced singing skills demonstrated by a large class of first-grade Chinese (Hong Kong) children compared with their US peers (Rutkowski & Chen-Haftek, 2000). Similarly, an assessment of the singing behaviours of 120 Hong Kong children aged 7–9 years from various language groups (Mang, 2003), using both the Rutkowski and Welch developmental profiles, reported statistically significant effects for sex (favouring girls) as well as mother-tongue. Chinese monolingual children performed consistently better than English bilingual children, even though the criterion song was in English. This was seen as a further indication (following Rutkowski & Chen-Haftek, 2000; Mang, 2000/2001) that Cantonese-speaking children achieve singing mastery earlier than their English counterparts, perhaps because the pitch centres for speech and singing of the former are more closely aligned.

Both the US- and UK-based developmental models agree that different 'phases' of singing competency are likely to be exampled within any group of children entering their first school class. Some children already will be extremely competent performers of complete songs from the experienced maternal culture (both words and music), while others will be less advanced and will be in one of the 'earlier phases' of singing development. This does not mean that the latter group of 'developing' singers will not gain singing mastery, particularly if they are provided with an appropriately nurturing environment in which singing tasks are designed to match, then to extend, current vocal behaviours. For such children, it is likely that their pre-school interactions have provided fewer opportunities to fulfil their singing potential (as outlined in the *Early childhood and pre-school* section earlier).

The effects of singing alone or with a group are equivocal in the research literature. Some research evidence suggests that children may become more accurate in reproducing the musical features of a criterion song when singing in a group compared with singing alone (e.g., Buckton, 1982; Greene, 1993). Other research (e.g., Goetze, 1985; Smale, 1988) reports the opposite in favour of increased reproductive accuracy if the young child is assessed when singing alone. It may be possible to reconcile these two positions by assuming that individual singing behaviour is likely to be framed by an interaction between current singing competency, the nature of the singing task, the competency of other singers in the group and an individual's current ability to make sense of the available feedback. There is an internal psychological feedback monitoring system that is essentially outside conscious awareness, which is used for a moment-by-moment self-monitoring of the singing behaviour. This system draws on information from internal sense receptors, as well as internal and external auditory information concerning the relative matching of vocal behaviour with an external model (see Welch, 1985, 2005). Where the individual is able to make sense of and use these different feedback channels in combination, then singing as a member of a skilled group may promote more competent behaviour. Where the individual is less able to make sense of and use this feedback, such as when surrounded by a less skilled group of singers and/or when it is difficult to 'hear' their own voice, then performing in a group context may be more disadvantageous. Data from studies of choral acoustics, for example, indicates that auditory feedback for one's own vocal output is reduced when (1) other singers are in close proximity (self-to-other ratio), and (2) when nearby singers are singing, or attempting to sing, the same pitches (Ternström, 1994; Daugherty, 2000).

Nevertheless, it is likely that singing competency will be nurtured through exposure to frequent opportunities for vocal play within an environment that encourages vocal exploration and accurate imitation (Young, 2002; Mang, 2003; Welch, 2005).

The data from various studies on early singing development were collated into a theoretical protocol 'baseline assessment of singing' for use with children on entry to school (Welch & Elsley, 1999). This was evaluated subsequently with a small class of children ($n = 19$) aged from 3 years 8 months to 5 years 10 months (King, 2000). In general, the data supported key features of the model, namely that singing competence is likely to vary at an individual level with musical task, such as in the sung reproduction of melodic contour, pitch intervals, and song text. Any assessment of singing abilities in young children, therefore, should provide a mixture of tasks (such as pitch glides and pitch patterns as well as song melodies) as a basis for diagnosis and curriculum planning. Furthermore, recent neuropsychobiological data on pitch processing modules in the brain (Peretz & Coltheart, 2003) supports a hierarchical model in which melodic contour (*pace* Davidson, 1994; Rutkowski, 1997; Welch, 1998) is analysed before the processing of intervals and tonality (see Welch, 2005 for a review).

With regard to children's ability to invent songs, a series of studies (Davies, 1986, 1992, 1994) indicate that 5–7 year olds have a range of song-making strategies. These include narrative songs (chant-like in nature, often with repeated figures), as well as songs that have more conventional features, such as an opening idea and a clear sense of closure, four-phrase structures, repetition, phrases that both 'borrow' from the immediate musical culture, and also may be transformed (sequenced, inverted, augmented) in some way. Overall, children in the first years of schooling demonstrate a clear sense of musical form and of emotional expression in their invented songs.

Older childhood

The latter years of childhood are characterized by a general singing competency for the majority. Relatively few children are reported as singing 'out-of-tune' at the age of 11 years (Welch, 1979, 2000b; Howard *et al.*, 1994). For example, evidence from a wide range of studies indicates that approximately 30% of pupils aged 7 years are reported as being relatively 'inaccurate' when vocally matching a melody within a Western cultural tradition. However, this proportion drops to about 4% of the same pupil population by the age of 11. Within each of these and the intervening age groups, 'out-of-tune' boys outnumber girls by a ratio of 2 or 3:1 (Welch, 1979). Culture, however, continues to be significant. Anthropological and ethnomusicological studies, for example, have suggested that young children from the Anang in Nigeria can sing 'hundreds of songs, both individually and in choral groups' by the age of 5 (Messinger, 1958, p. 20), Venda children in South Africa were reported as both learning special children's songs and composing new songs for themselves (Blacking, 1967), whereas Herati children in Afghanistan tended to focus on the imitation of adult models, with the children (particularly boys) of professional musicians' families (*sazendeh*) being immersed in the local music culture and often expected to perform professionally by the age of 12 (Doubleday & Baily, 1995).

The use of 'imitation' as part of an enculturated induction into the skilled practices of expert singers is evidenced in many different musical cultures, as exampled in the cathedrals where European sacred music is practised, as well as in the choral communities of sub-Saharan Africa and Scandinavia. Cathedrals in the UK, for example, typically induct their choristers at the age of 8 so that by the age of 13 they will have had 5 years immersion into a weekly (usually daily) ritual of rehearsals, performances, choral singing, and solos, embracing a wide range of compositional styles and musical genres that span over 500 years of Western classical music. Within the cathedral choir, performance skill level is signalled by singer nomenclature (such as 'head chorister', 'senior corner boy', 'probationer') and variations in the dress code, as well as by the degree of performance involvement in particular repertoire. Novices are deliberately placed in between more skilled, older choristers and normally are required to sing only certain items during the cathedral services while they deepen and develop their performance skills through listening and observing their more accomplished peers.

Although the tradition of highly skilled boy singers in the UK may be traced back to the first foundations of English cathedrals in Canterbury (AD 597), Rochester (AD 604), and St Paul's, London (AD 604), the 'all-male' hegemony of cathedral music experienced a major challenge in 1991 with the admittance of girls to Salisbury Cathedral in the west of England. Since then, by 2004, the potential for equally skilled performance by girl choristers has been recognized through the creation of separate girls' choirs in 22 cathedrals and minsters (Welch, 2004)[3]. Girl choristers are usually admitted using the same audition criteria as their male counterparts and are expected to perform the same repertoire to the same professional standard.

Evidence of the power of the musical culture in cathedrals in fostering specialist singing skills may be found both in the quality of choral outputs (such as national and international broadcasts by the BBC, commercial recordings, international tours and concerts) and also in the regular media-fuelled controversies over whether it is possible or not to perceive differences between the singing of older female and male children (Welch & Howard, 2002; Sergeant *et al.*, 2005). With regard to perceived singer gender, a summary of recent research data (Figure 16.3) indicates that, while it is possible for an untrained solo singer's sex to be identified relatively accurately from about the age of 8 onwards, it is also equally possible for trained female choristers from the age of 8 to be systematically mistaken as male, depending on the particular piece of music being performed. However, once the female chorister moves into her mid-teens, the voice quality becomes more characteristically identifiable as 'female' ('womanly')[4]. In general, children's voices tend to be higher in pitch and have a less complex acoustic make-up than those of adults. Nevertheless, children are able to achieve similar loudness levels as adults by using relatively more breath until the age of 12, when adult-like breathing patterns are observed (Stathopoulos, 2000).

[3] The data for 2004 on the numbers of cathedrals with female choristers in UK cathedrals has been collated by Claire Stewart as part of her ongoing doctoral studies at the Institute of Education into their impact on the all-male choral tradition.

[4] For a detailed review of the literature on gender and chorister voice, including similarities and differences in the underlying anatomy and physiology for singing, see Welch & Howard (2002). For data on the perceived gender of untrained children's voices, see Sergeant *et al.* (2005).

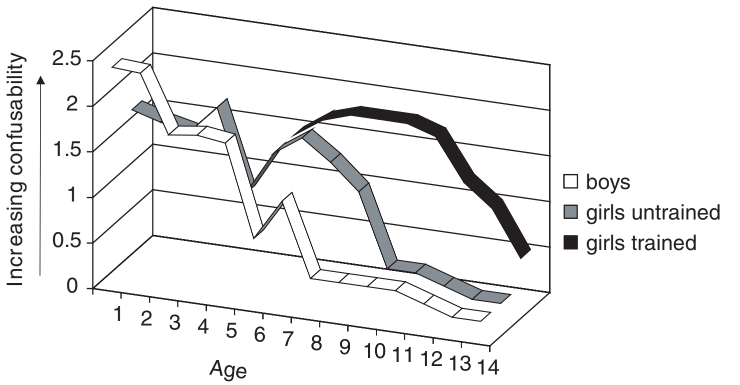

Figure 16.3 Confusability by age and gender of children and adolescents aged 4–16 years. The figure is extrapolated from measured data of perceived confusability for untrained singers (Sergeant *et al.*, 2005) and measure data of perceived confusability for trained singers (Welch & Howard, 2002). Initially, untrained young boys are confused as girls. Then, the sexes become more readily distinguishable from the age 8/9 years. However, singing training can enable girls from 8/9 years to 14 years to sound 'boy-like' in certain pieces from the repertoire. From 14 years onwards, singer sex becomes more readily identifiable.

Puberty and adolescence

The onset of puberty heralds fundamental changes to the nature and quality of the singing voice for both females and males. Whereas the actual dimensions and growth of the vocal instrument are similar across sexes during childhood (Titze, 1994), during puberty the male vocal tract becomes significantly longer and develops a greater circumference. In contrast, the growth of the female vocal tract is less marked, being about 15–20% shorter than in the male and with a different internal ratio of resonating spaces, mainly because the neck (pharynx) is relatively shorter compared with that of the male (Story *et al.*, 1997). Growth typically lasts from 10 to 18 years in females (and can begin at age 7—Herman-Giddens *et al.*, 1997), compared with 12–20 years in males (Thurman & Klitzke, 2000). The highpoint of pubertal voice change tends to be about 12–14 years of age in both females and males (Gackle, 2000; Cooksey, 2000).

There are relatively few major studies of singing voice transformation during adolescence reported in the literature, particularly with regard to the female changing voice. Those that are available draw primarily on data from populations in the USA (Williams *et al.*, 1996; Cooksey, 2000; Gackle, 2000), the UK (Geddye, personal communication; Harries *et al.*, 1996; Cooksey & Welch, 1998), Japan (Norioka, 1994), and Germany (Heidelbach, 1996). The data are consistent about the presence and characteristics of adolescent voice change.

Gackle (2000) reports the outcome of her doctoral studies in Florida (during 1987), allied to 15 years professional observation, to suggest that there are four distinct 'stages' in female adolescent voice change (see **XX** in Figure 16.4a). In the first stage (termed 'pre-pubertal') the voice has a 'light, flute-like quality' with no apparent register changes. The comfortable singing range is between D_4 and D_5, within a wider singing range of Bb_3 to F_5 (and up to A_5).

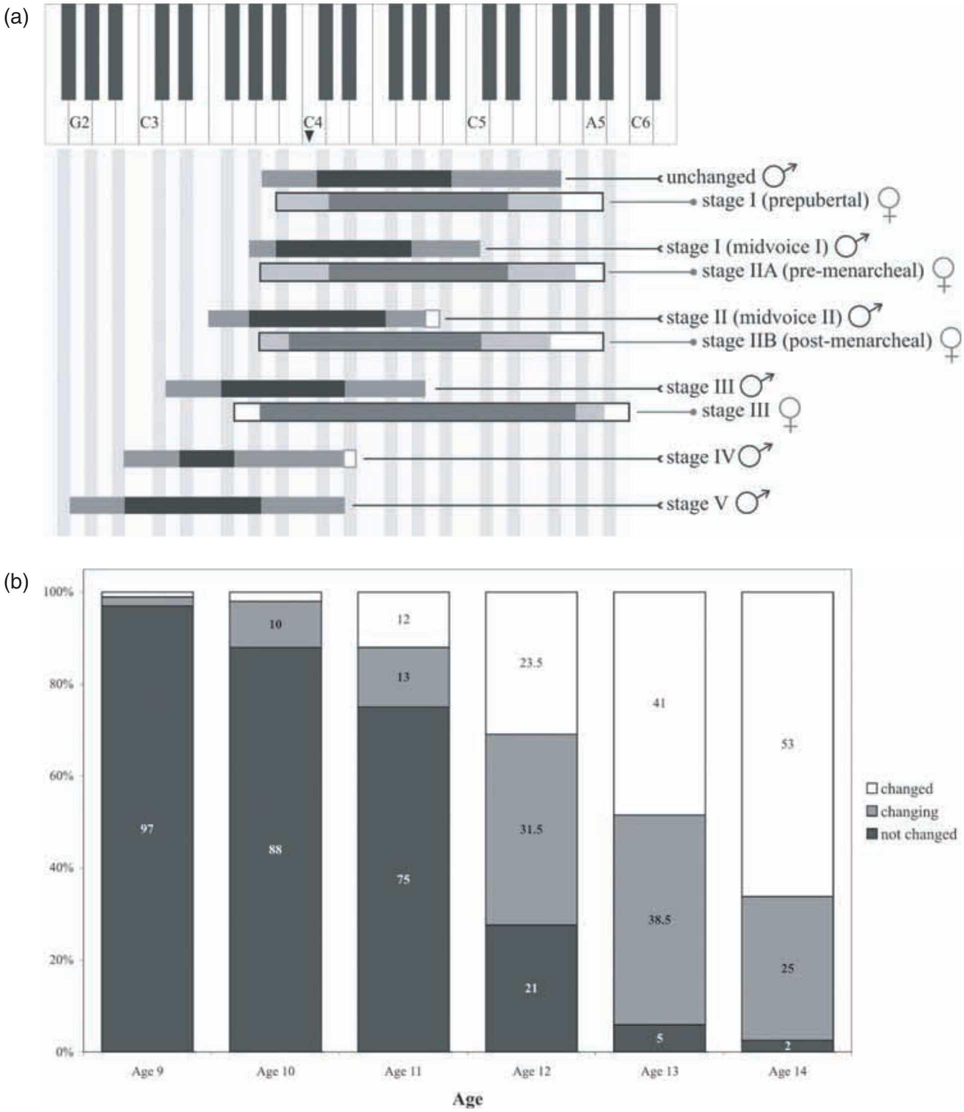

Figure 16.4 (a) Stages of singing voice change for females (based on Gackle, 2000) and males (based on Cooksey, 2000). (b) Extrapolated model of adolescent male voice change by age, based on UK (Geddye, personal communication) and Japanese data (Norioka, 1994), total $n = 3,188$.

The next stage ('pre-menarchial'—Stage IIA) is characteristic of the beginnings of female voice mutation around the ages of 11–12. The comfortable range is approximately the same as previously (D_4 to D_5), within a slightly expanded overall range (A_3 to G_5). However, there is often breathiness in the tone due to inadequate closure of the vocal folds as a result of growth occurring in the laryngeal area. A singing register transition typically appears between G_4 and B_4 and some girls may have difficulties in singing lower pitches. Singing often becomes uncomfortable and effortful and a breathy voice quality is characteristic across the range. The next stage is the peak of female voice mutation ('post-menarchial'—Stage IIb). Singing is characterized by a limited comfortable range (B_3 to C_5), discomfort (particularly at upper pitches), distinct voice qualities for each sung register and with the lower part of the voice often taking on a more 'alto' and often husky quality. The final stage ('young adult female'—Stage III) has a much-expanded comfortable singing range (A_3 to G_5), less breathiness, greater consistency in tone quality and greater singing agility. Vibrato often appears at this stage and the voice has a more adult, womanly quality. Ongoing research (Welch & Howard, 2002; Welch, 2004) indicates that adolescent voice change is the same for relatively untrained female singers as for those who have been involved in sustained vocal performance, such as through membership of a female cathedral choir. However, as with adult female singers (Lã & Davidson, 2005), there is always some individual variation in the impact of puberty on the singer's voice related to slight differences in the underlying endocrinological metabolism and physiological functioning.

Male adolescent voice change has a more extensive literature, both in Europe and the USA. One major longitudinal study was conducted by Cooksey (2000), initially based on fieldwork in California in the late 1970s, then drawing on further studies in the USA during the following decade, as well as a London-based cross-cultural study in the 1990s (Cooksey & Welch, 1998). Overall, he reports six 'stages' of adolescent male singing voice change (see **XX** in Figure 16.4a) that are characterized by an overall lowering of the sung pitch range. While the rate of voice change is unpredictable for any given individual, it is reliably sequential for all.

In the first male adolescent stage ('unchanged'), the mean sung vocal pitch range is A_3 to F_5, with the tessitura pitch boundaries $C\#_4$ to $A\#_4$. The voice quality is perceived as 'clear', with relatively little evidence of breathiness in the tone. The beginnings of voice change (termed by Cooksey as Stage I, 'Midvoice I') are marked by a reduced vocal range (Ab_3 to C_5) and instability of sung pitch, particularly for the upper frequencies, which tend to be produced with increased effort, as well as tone quality that is perceived as more effortful, strained and breathy. The sung range then descends approximately in thirds across the next three stages (see Figure 16.4a), with each stage being characterized by a reduced mean range and relative continuing instability in the production of upper pitches, but contrasted by relative stability for the lower pitches. The pitch ranges are: Stage II ('Midvoice II'), F_3 to A_4; Stage III ('Midvoice IIa'), D_3 to $F\#_4$; followed by Stage IV ('New Baritone', also termed 'New Voice'), B_2 to $D\#_4$. Within these, Stage II may be regarded as the mid-point of voice change and this is when a falsetto register (C_5 to B_5) first appears and (for some) a whistle register (C_6 to C_7). Stage III ('Midvoice IIa') is characterized by the greatest vocal instability and the least clear vocal quality. It is only in the final stage of voice change (Stage V, 'Settling Baritone', also termed 'Emerging Adult Voice' G_2 to D_4) that the mean sung pitch range opens out again and the voice timbre begins to adopt a clearer, less breathy quality. However, the number and intensity of harmonics do not yet approximate normal adult characteristics. Nevertheless, for each stage of voice change the adolescent male has a (limited) number of pitches that can be produced comfortably and musically (see the darker shaded elements in the ranges for male voices in Figure 16.4a) and it has been possible in recent years to find a greater awareness by publishers to produce repertoire that is specially written as being suitable for these changing voices.

In general, age is a poor predictor for establishing voice change stages, with any given age group likely to encompass several stages. It is possible for an individual to pass through all stages of adolescent voice change in 12 months, but is it also possible for this process to be much slower and to last several years. Nevertheless, a summation of selected UK and Japanese data for over 3000 males, aged 9–14 years, provides some indication of the possible proportions of different categories of voice change by age group (Figure 16.4b). As can be seen, the ages of 12–14 have significant proportions of males whose voices are perceived to have already 'changed', or in the process of 'changing', while embracing a reducing number that are still 'unchanged'. Ideally, choral groups of adolescent male singers in this age range are best suited, therefore, to music that has been arranged specifically for them in three parts, using the Cooksey classification guidelines (Unchanged and Stage I on a top line, Stages II and III on a middle line, and Stages IV and V on the bottom line), rather than to attempt traditional four-part music in which the tessiturae often are likely to be mismatched with current singing abilities.

Factors influencing singing development and the realization of potential

As can be seen from the previous text, singing in one form or another is an essential feature of our musical development and behaviour. In each age phase (infancy, early childhood, older childhood, adolescence), the human voice has a distinctive underlying anatomy and physiology that is capable of producing a diversity of 'singing' behaviours. These increasingly explore and approximate to the particular sonic features of models that are available in the soundworlds of the experienced maternal and global cultures. In the first months of life, these 'sung' products are driven by basic human needs, before becoming more exploratory and melodic in nature as vocal skills develop in the acquisition and mastery of musical elements. Throughout childhood and adolescence, singing development is a product of neuropsychobiological activity, potential, and change, interfaced with, and shaped by, particular socio-cultural environments in which certain patterns of sound characterize the dominant musical genres. At any age, development can be supported or hindered by a number of factors, such as the appropriateness of a given singing task set by an adult in relation to current singing capabilities, the expectations of peers and/or the value placed on singing (and certain types of singing behaviour) within the immediate culture. Opportunities to engage in vocal play and exploration, to share in singing games with peers and 'experts', as well as to improvise and compose their own songs are essential features of musical cultures that foster singing development. Children who exceed the 'norms' reported in the research literature are likely to have been provided with a nurturing environment that is designed to match, celebrate, enable, and extend individual singing expertise. Others, whose singing is perceived to be 'lacking' in some way, will not have had such appropriate opportunities. For some, entry to adolescence can confirm their identity as a 'non-singer', as someone for whom music is seen as an area of 'failure'. Yet, everyone has the potential to learn to sing. We need, therefore, to continue to seek optimal ways to allow children and adolescents to explore and extend their singing (and musical) birthright. In this, we will reduce the need for 'remedial' action in adulthood, such as the establishment of adult choirs for 'non-singers'. The stories of a lifelong sense of singing 'disability' should be confined to history.

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