Chapter 13: Through singing to music across the lifecourse

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Abstract

Although most children sing, many adults do not. Without adult singers, children lack role models at home or in the classroom. The present chapter discusses singing as a natural behavior that can both be taught and used to teach. Singing is presented as a more accessible, democratic path to music engagement than is playing a musical instrument. After a brief historical account and acknowledgement of the complex sensorimotor system underlying singing, the development and significance of singing across the lifecourse (infancy, early childhood, adolescence, early, middle, and older adulthood) is presented, noting that large individual differences result from many factors and that highly variable trajectories are not inevitable. Theoretical perspectives that have focused on interactions within systems (Gaunt & Hallam, 2016) and on possible selves (Freer, 2010) are presented as consistent with a further theoretical step that accommodates dramatic shifts in singing behaviours, for example, the switch from singer to non-singer status, and the rapid bonding among strangers associated with singing together. Given the benefits of singing in choirs for persons in good health as well for those who experience certain mental or physical health challenges, and given the value of vocal training for experiencing and learning about music, the need for greater prioritization of singing over musical instrument training in schools is proposed. The Sing-Up and The Ark Music programs in the UK offer useful prototypes toward achieving a singing society that can offer children vocal training and its viable and deserved path to music and the associated joy, understanding, and ways of meeting psychosocial challenges across the life-course.

Keywords: Singing, vocal training, choirs, lifespan stages, non-linearities, vocal vs instrumental music training, possible selves, dynamic systems, accessibility to music

Singing is one of the most accessible forms of music making at every stage of the lifespan. It is also one of the few activities in which large numbers of people can engage simultaneously. Its accessibility allows it to play a role in strengthening community, with implications for society at large. Although singing is a natural behaviour, it can be taught. Such teaching, based on pedagogies handed down over centuries, can guide an individual in performance of musical styles, cultures and difficulty levels that might otherwise be out of reach. Singers not only learn repertoire but may add to it through their own compositional creativity. Singing can also be used to teach. Its application here is almost unlimited and often depends on the ingenuity of a teacher to apply singing engagement to the goal of a lesson, be it learning a foreign language,

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poetry, dramatic skills, mathematics, geography, understanding people from a culture different from one's own, or playing a musical instrument. Typically, adults educate children, rather than the reverse. All children can sing, but by adulthood, in Western society, many adults are uncomfortable singing, and consequently cannot teach children or build community through singing. This situation is not a necessary one. History shows that engagement in singing is subject to many forces.

Evolutionary and historical considerations

From an evolutionary perspective, singing and speech developed from the same capacity for vocalization and self-expression (Bannan, 2020; Belyk & Brown, 2017; Mithen, 2005). Reference to singing appears in ancient Greek and biblical texts (Norton, 2016). Singing has served in war, encouraging soldiers to battle, enhancing nationalistic spirit, be it for good or evil. From solo voice to mass choir, singing is powerful in its emotional reach. Societies worldwide have held the beautiful voice in awe. Late twentieth and current twenty-first century western societies, place on a pedestal the vocal superstar, from Renée Fleming and Plácido Domingo in the classical world to Beyoncé and Freddie Mercury in the pop world (Krueger, 2019). Before mid-twentieth century, families and friends commonly made music at home, often involving singing hymns or popular music around a piano (Parakilas et al., 1999). From the 1920s to 1940s, singing was part of the program in movie theatres, which most people in America attended on a weekly basis (Morgan-Ellis, 2018). Such participatory singing has given way to listening to recorded music and large amplified concert performances. Although measurement of singing as compared to speech has been relatively neglected, recent reviews of the mechanics of the singing voice (Wolfe et al., 2020) and the underlying neuroscience (Cohen, Levitin, & Kleber, 2020; Kleber & Zarate, 2014) emphasize how remarkable it is that the majority of humans, beginning with very young children, are able to control the pitch of their voices as well as they do. Yet, surprisingly, only in recent years has the social and psychological significance of singing become a subject of interdisciplinary scholarly investigation (Cohen, 2020a; Cohen & Trehub, 2011; Gudmundsdottir et al., 2020; Heydon et al., 2020; Russo et al., 2020; Welch et al., 2019). As will be argued in this chapter, as knowledge emerges, so do opportunities for enabling individuals and society to benefit from the human ability to sing.

Complex processes underlying singing

The singer is constantly determining whether the sound produced is the one expected. If the sound differs from the one imagined, the present or future match is improved through rapid changes by the muscles controlling the physical properties of the vocal folds (e.g., tension and length). An intricate tri-part system involves the lungs, vocal folds and vocal tract (Sundberg, 1987). Vocal training and practice can assist in learning to develop the underlying neural network that manages this complex motor system, integrating it with the network representing

the melodic structure. Although singing is more than producing the right pitch at the right time, relatively accurate singing is fundamental in highly developed musics of the world in which melody plays a key role (e.g., Western European, Chinese, East Indian).

A minority of individuals have great difficulties in matching pitch. They have been referred to colloquially as "tone deaf" (Cuddy et al., 2005) or as poor-pitch singers (Welch, 1979), and may suffer from Vocal Pitch Imitation Deficit (VPID) as described by Pfordresher and Nolan (2019). The deficit may affect either or both the auditory image and the motor image or co-ordinating the two. Music perception tasks would seem to tap into auditory imagery system, although recent embodiment theories argue for the engagement of the motor system even here (Overy & Molnar-Szakacs, 2009).

Investigating the relationship between vocal production and vocal perception, Pfordresher and Nolan (2019) concluded that singing and music perception rely on the same abstract representation of musical structure, and that deficits in music perception may predict deficits in singing accuracy, concurring with the Linked-Dual Representation Model (Hutchins & Moreno, 2013) and the Vocal Sensorimotor Loop model (Berkowska & Dalla Bella, 2009). A study by Tsang and Trainor (2020) with 117 children (range 5.0 to 9.9 years), also tested perceptual discrimination and pitch production on individual pitches, pitch intervals, and 4-note melodies and did not show the same relation between melodic perception and production found by Pfordresher and Nolan. The preliminary results available to date for 21 children (age range 7 to 9 years) have shown that all three of these vocal production tasks were significantly intercorrelated (range .73 to .92), but only pitch accuracy and melody discrimination were significantly correlated (.47), when it might have been expected that melodic production would correlate with melodic discrimination, as found by Pfordresher and Nolan (2019) with adults. These preliminary results of the study of the relation between perception and production in children might point to challenges for children in developing separate competencies in representing and vocalizing melodic information and the subsequent integration. How competence in singing develops across the lifespan is further discussed in the next section.

Development of singing across the lifespan

Infancy and preschool years

It is sometimes said that the child learns to sing at the same time as she learns to speak. Elements of singing indeed are evidenced in infancy. Stadler Elmer (2020) has noted that the infants' repetition of a syllable, referred to as *reduplicative babbling*, offers training for both singing and speaking, as the syllable plays a role in both domains. Singing is slower than speaking and offers the infant time to focus on the attributes of a syllable. Singing also contains repetition, further offering training trials.

Several researchers have focused on the reciprocal behaviour of the mother-infant dyad when engaged in vocal communication (Addessi, 2020; Trehub & Russo, 2020 for review). Recursively, the mother repeats the sounds made by the infant, who imitates the sounds made

by the mother. The infant and caregiver are rarely in perfect synchrony. The typical asynchrony requires continual active negotiation of synchronous activity that entails engagement (Jurgens & Kirchhoff, 2019). In other words, the imperfect co-ordination keeps the attention of the participants in the communication interaction. This imperfect entrainment is characteristic of the interactions between components of complex systems. Some research suggests that the infant matches the pitches of the mother's voice by hitting either the same chroma (if the mother sang the note C or *do*, the infant would similarly sing C or *do*) or a harmonic of the C (e.g., E or G, *mi* and *sol* respectively, which are the fifth and third harmonics of C respectively) (Van Puyvelde et al., 2015). Yet most research suggests that the ability of infants to match pitch is less systematic.

By early childhood, greater mastery is developed over vocal production. The child can both speak and sing, but as Stadler Elmer (2011, 2020) describes, there is wide variability in singing accuracy. Some toddlers show the ability to sing simple melodies recognizable to adults. Gudmundsdottir and Trehub (2018) asked adults to recognize songs found on YouTube that were performed by toddlers. The toddlers had much greater vocal range than some tests of singing ability would suggest (Rutkowski, 1990; Welch, 1998).

As part of the natural behaviour of singing in early childhood, the child engages in making up songs, and moving from verbalizing to singing and back while self-absorbed in an activity, as noted by Michael Forrester (2010) in a case study of his young daughter. Barrett (2006) has noted, however, that by about the age of 8, there is a decline in making up songs. The influence of the school system may be the cause, typically doing little to encourage singing and vocal creativity. General teachers are not trained to engage children in singing. If teachers are not comfortable singing, encouragement of their students cannot be expected.

Adolescence

Adolescence is a special time in the vocal development of boys. The larynx descends, and the vocal folds enlarge, lowering the vocal register by approximately an octave from the original pitch range, which earlier overlapped that of the female voice range. The changes in the female voice during this time, though not insignificant, are negligible by comparison. The transition from child to adult male voice may provoke anxiety and frustration and sadness, due to lack of control over one's vocal pitch and loss of the quality of the child voice (Freer, 2010). Welch (2009) reported that young males may avoid singing in groups but may engage in singing pop music by themselves. In three studies of singer-songwriters (N = 18, 45, and 219 respectively), Cohen, Robison et al. (2020) obtained self-assessments of current singing performance level, their level starting out and their future level. Both males and females showed increasing self-assessed level of performance over the past, present, and future time, but males rated their singing as significantly lower than that of females in all three studies.

Popular music is important in adolescent identity formation. When young people meet for the first time, the topic of favourite music is one of the most common to be discussed.

Popular music typically relies on melody and the vocalist for its success. Popularity, almost by definition, is established by being memorable, and what makes popular music memorable is often its singability. Though adolescents may be reluctant to join a community choir, they seem to have no hesitation in bursting into song at rock concerts. Singing together entails performing in synchrony, hitting the beat together. Such an act of entrainment may offer a sense of belonging and large-scale social bonding (Launay et al., 2016).

Emerging and later adulthood

For emerging adults, songs may provide a way toward intimacy. New parents use music (lullabies and playsongs) to engage emotionally with their infants as well as to control their infants' behaviour (Trehub & Russo, 2020). Parents and their adolescent children may find common ground by enjoying popular music together, either recorded or live concerts. Krumhansl and Zupnick (2013) showed that university students know and like currently popular music most, but also they know and enjoy the music that was popular in their parent's adolescence and young adulthood. This familiarity with the parent's music may have arisen when the parents played such music in the hearing range of their infants and small children. The situation may reverse when parents come to know the songs of their children. Thus, songs played in the household or family vehicle, can bring parents and children together. Because of declining neural plasticity with age, there may be an asymmetry in the relative ease with which older and younger generations pick up each other's musical style. A speculation is that adolescence is a time when brains are just over the hurdle of learning language and could be primed for acquiring the music of the current culture.

In later adulthood, the opportunity to join a choir may add the positive experience of sharing an activity with other adults and of making new friends (Lamont et al., 2018). A phenomenon by which singing in a choir quickly leads to a sense of bonding between strangers has been referred to as the *icebreaker effect* (Pearce et al., 2015). This feeling extends to members of a large choral gathering (Weinstein et al., 2016).

Singing regularly is linked to moderating the effect of vocal aging (Lortie et al., 2017). Although for females, reduced oestrogen can negatively affect the voice and making it difficult for some singers to sing well, Rodney and Sataloff (2020) suggest that vocal training and healthy practices can help to preserve the voice into senior years. Longitudinal studies of voice change (or stability) in later years would be illuminating. One case study was carried out with a gentleman, who, over a three-year period (between the ages of 84 to 87) took singing lessons and completed a test battery of singing skills on 7 occasions. This collection of singing tests entailed singing *Brother John* (*Frère Jacques*) several times. Although he had not had formal music training, other than the current singing lessons, his choice of music key for the song paralleled that of young persons in a university music program as compared to students who lacked musical training (Cohen, Pan et al., 2020).

Summary of this section

The complexities of the development of singing at the various stages of the lifespan are revealed by the research in this area. The complexities are to some extent mastered at a young age. Unlike language which proceeds more systematically, greater variability appears in the degree of mastery and comfort level attained from middle childhood onward. Many factors such as exposure to other singers, family, and gender may play a role. Singing together influences behaviours and wellbeing at every age, and to this we now turn.

Singing together

Much attention has been given to the benefits of group singing in general and in managing specific diseases. Community choral groups represent one of the most popular leisure activities across the Western world. Participation rates of 15% in the US, 17% in Canada (Choral Canada, 2017), and 4.5% in Europe have been reported (Bartel, 2015). Community choral groups and church choirs attract an older demographic (reviewed by Cohen, 2020b). Bailey and Davidson (2005) conducted pioneering work showing the value of singing for not only middle class persons in several countries but also marginalized individuals. Clift et al. (2010) conducted a cross-national survey in Britain showing the impact of choral singing on well-being. The value of group singing for persons with physical and mental challenges has been shown anecdotally (e.g., McCarty, 2014) and through empirical studies of singing groups for persons with cancer (Fancourt & Warran, 2020; Fancourt et al., 2016), Parkinson's Disease (Tanner, 2020), aphasia (Tarrant et al., 2016), lung disease (Cave et al., 2020), and dementia (Särkämö et al., 2016), persons who have been incarcerated (Kerchner, 2020) or have learning disabilities (Hassan, 2017), or belong to the LGBTQI community (Bird, 2017). Studies have been conducted with vulnerable older people to determine if cognitive decline can be slowed by singing (Johnson et al., 2018; Tan et al., 2018). The significance of choral singing is well exemplified by choral groups who sing regardless of being able to hear (Yennari et al. 2020), or who have had their voice box surgically removed through laryngectomy (e.g., Shout at Cancer choir), or members of the Braille Tones of Edmonton, Alberta who are unable to see the conductor or the notes on the page because of blindness.[i] The research shows the benefits of these special singing groups, however more research is required to determine how choral directors might better include singers with special needs into school and community choirs (Salvador, 2013).

Methodological issues

Field research such as the study of choral groups already formed has many challenges of controlling for such variables as socioeconomic status, age, and frequency of attendance. Ideally, to measure the benefits of choral singing, participants should be randomly assigned to the choral singing group and one or more active control groups in which participants are engaged in another activity for an equal amount of time. Studies running for months or years

are costly. However, given that participation in a choral group could offer older adults resistance to neurodegenerative disease and maintain or increase well-being and quality of life, a recent two-year longitudinal study in Singapore has completed a first phase of testing[ii]. In this study approximately 100 older adults of mean age 70 years (SD < 1) were randomly assigned to one of two groups. The choral group met weekly for a two-hour singing class, and the control group met weekly to discuss healthy life styles. A pre-test revealed that the two groups were matched for age, education, gender, living alone, and scores on a variety of mental tests including the mini-mental state exam, a depression scale, and a music knowledge index. Preliminary results from the first phase of the research will soon be available. Dingle et al., (2019) reviewed research on choral singing in five countries and offered several guidelines to aid in the rigor of future studies and promoted the importance of interdisciplinarity in setting an agenda for best practice in research on group signing.

Singing vs playing a musical instrument: Does singing match up?

Studies of the benefits of music training often focus only on persons with training on musical instruments (e.g., Schneider et al., 2018; Strong & Mast, 2018; Strong & Midden, 2018), in part because degree of singing experience may be difficult to track. But without including singers in such studies, the results may be suspect when generalizing effects of musical experience. For example, in a neuroscientific study aimed to determine whether music training protected against the aging of the brain, Rogenmoser et al. (2018) obtained anatomical magnetic resonance images from participants with an average age of 25 years, differing in three levels in life-time music-making. *Brain-AGE* was measured in terms of the difference (in years) between chronological age and the "age of the brain", the latter computed by an algorithm based on prior knowledge of anatomical correlates of brain-aging. The participant groups reflected either no experience playing a musical instrument, playing an instrument non-professionally, or playing an instrument professionally. Prior to testing, the three groups differed significantly in regard to: age at which music training began, years of training, total hours of music training over the lifetime, average daily hours of music training over the lifetime, and daily hours of lifetime music practice. The results showed that brain-AGE was significantly lower for both musician groups combined, however, the professional musician group showed less decrease in brain-AGING than the amateur group, and did not differ significantly from the non-musician group in terms of brain-AGE. In addition to this conclusion that engaging in music making may reduce the speed of aging-related structural changes of the brain, the authors also suggested on the basis of the results that "making music has a stronger age-decelerating effect when it is not performed as a main profession, but as a leisure or extracurricular activity, possibly enriching a person's life with multisensory, motor, and socio-affective experiences in addition to other main activities than an amateur musician would engage in" (p. 302). But do these results pertain to making music with the human voice? Do professional vocalists have a brain-AGE no different than that of persons who have no musical experience? Unlike performers on

musical instruments, who in this study reported playing their instrument 3.95 hours per day within the last year of the test, professional vocalists typically practice less, by necessity, because the voice must be protected.[iii] Vocalists must learn to balance periods of vocal activity with vocal rest, as even speaking takes its toll (Gaskill & Hetzel, 2017, p. 263). Science has yet to provide information regarding the best balance between warm-up, exercises, and practice of repertoire. Does the fact that professional vocalists spend less time practicing than do professional instrumentalists bear any relation to brain aging? Can the benefits to brain aging be achieved as easily through amateur singing as through amateur performance on a musical instrument? Do professional vocalists engage in different kinds of practice strategies like mental rehearsal more than do instrumentalists?

The few studies that have included both instrumentalists and singers have typically found similar effects of the music training dimension. In one study, as described by Rauscher (2009), pre-school at-risk children were assigned to one of five different training groups for two years: piano, singing, rhythm, computer, or no instruction. Following instruction, the three music groups scored significantly higher on a mental imagery task, however, rhythmic instruction was associated with significantly higher performance on tasks requiring mathematical ability or temporal cognition. Notably, there was no difference between piano and vocal instruction groups.[iv] This absence of difference between vocalists and instrumentalists appears in studies of children (Schellenberg, 2004) and adults (Bialystock & DePape, 2009; Schirmer-Mowka, et al., 2015; for further detail see Cohen, 2019f). Comparisons of percussionist, vocalists and persons without music training have shown higher cognitive scores of both music groups than for the control group (Slater et al., 2017; Slater & Kraus, 2016), with percussionists having an edge on tasks requiring timing and vocalists showing superiority on melodic tasks.

Even if learning to play an instrument versus learning to sing were to show a small instrumentalist advantage in learning outcomes (e.g., Mansens et al., 2017), such differences could be regarded as negligible from the standpoint of the greater good, given the far greater number of students who, for practical reasons can be taught to sing as compared to play a musical instrument. Knowledge acquired from learning to sing (i.e., learning music through singing) provides a foundation for learning any other instrument, and offers a segue to music-instrument instruction for those who are so motivated or have shown musical aptitude. It is a question for research as to whether a massive program based on inexpensive instruments (e.g., recorders, ukuleles) could compete with the musical training and learning outcomes achieved through a first-class vocal music program.

The need to maintain singing skills into adulthood

Participating in group musical activities and performance offers children important social experiences and training in the lifelong “soft” skills of collaboration (Putnam, 2015). There is no

research to date, to the best of the author's knowledge, to suggest that time spent singing, be it for pleasure, learning to sing, or practising singing, is any less worthwhile than time spent playing a musical instrument. Yet, although engaging every school child musically through singing is less costly than through band or orchestra programs, decision makers tend to opt for instrumental music for an elite minority rather than singing for the majority. It is hard not to conclude that this must stop if all children are to receive fair access to music education and music making.

A further argument in favour of singing is evidence that singing songs of cultures for which there is systemic discrimination can help to reduce this discrimination provided that the songs are taught in their appropriate cultural context. An example is provided by the work of Félix Neto et al. (2015) which introduced a program of learning music of the people of Cape Verde, a black minority community in the mainland of Portugal. Prior to the program, children in both a control group and experimental group showed poor attitudes toward children from Cape Verde. After a 3-month intervention during which the children learned the Cape Verde culture, its music and songs, negative opinions significantly declined, and moreover, were retained throughout a two-year period. No such decline in negative attitude was seen in the control group that did not learn about the music and songs of Cape Verde. Lai et al. (2016), in a review article, described the enormous difficulty of changing implicit racial preferences and cited the Neto cross-cultural music study as a rare example of an effective intervention.

Theoretical Framework that accommodates the discontinuities in singing behaviour.

Persons who sing, whether or not they take voice lessons are often motivated to improve their singing ability for a variety of reasons, such as personal pleasure of experiencing music, being able to sing well enough to pass an audition for a choir, or being able to sing before an audience. But as has previously been discussed, beyond early childhood, many people become disinterested in singing. The contrasting aspects of singing, on the one hand being a natural, accessible way of engaging in music making, and on the other, being a potentially embarrassing uncomfortable activity, particularly for males, begs for a theoretical framework that encompasses these various forces, showing whether the decision not to sing is inevitable, and if not, providing a foundation for positive change.

One useful theoretical perspective is that of Possible Selves, first proposed by Markus and Nurius (1986) in the context of conceptions of self-knowledge (see also Chapter 23). Their concept of a self that extends both backward and forward has also found expression in the earlier writings of influential psychologists such as William James, Sigmund Freud, and Carl Rogers, and symbolic interactionists such as George Herbert Mead, influential in sociological thought. Conceptualizations of possible selves—what individuals think they might become, would like to become, or fear becoming—link cognitions to motivation, influencing the course of future behaviour. It has been argued that possible selves are expressed as engagement in

behaviours that are congruent with one's constructed identity or alternatively as disengagement from behaviours that are not congruent (Oyserman & Destin, 2010): "positive possible selves can be exceedingly liberating … negative possible selves can be powerfully imprisoning" (p. 963). It follows that if one's feared self includes embarrassment associated with poor singing, one may avoid singing altogether.

A recent survey of the research literature on choral pedagogy (Noble, 2020) revealed a high number of publications directed to the problem of the low number of male choral singers, referred to as the "problem of the missing males" (Freer, 2010). The lack of male singers challenges the integrity of the mixed-voice and male choir traditions (leaving only female vocal ensembles), and also means that males lose out on all the benefits of choir participation. The concept of possible selves may explain why males choose not to participate in choral groups. Freer (2015) systematically studied this period of transition in males through interviews of a total of 85 participants in England, Ireland, Greece and Spain who either currently sang in a choir, had withdrawn from singing, or who had never sung in choirs. The analysis revealed 17 topics of discussion across all countries, interpreted within a framework of six stages of Possible Self development. Three stages respectively referred to *discovering*, *thinking*, and *imagining* the future self (conceptualization), and three stages referred to *reflecting, growing*, and *performing* that potential self (realization) (Freer, p. 92). A stunning finding was the absence of male role models (typically family members or older students) for every boy who had withdrawn from singing and the presence of such a model for 86% of the boys who were continuing choristers. In all countries but Spain, some singers were bullied because singing was regarded as unmasculine, feminine, or homosexual, and 77% of those who had withdrawn from choir gave this as one of their reasons. Other reasons were dislike of (the sound of) their singing and the repertoire (73%), lack of male peers (68%), lack of focus on individuality (64%), and traumatic loss of child voice (46%). Participants from all countries expressed a sense of loss due to the voice change. Freer concluded that three factors influenced boys' attitudes to choral singing and continued participation: (a) teacher personality and interest in adolescent males (b) high level of musicianship of the teacher, and quality of the music, and (c) the social environment, specifically peer support and positive influence of older male role models. Participation and attitudes were thus independent of culture or nationality, but more vulnerable to specific situations. An understanding teacher who was also a fine musician with high choral standards and the presence of male role models would be sufficient to maintain good choral attitudes and associated participation in singing by adolescent males. However, if males stop singing in high school or earlier, then there will be exponentially fewer role models for younger males.

Consistent with the theory of Possible Selves, Gaunt and Hallam (2009; 2016) proposed an interactionist approach to musical learning and development, drawing upon Bronfenbrenner's ecological model of human behaviour (1979; see Chapter 9) and a biosocial

model of interactions (Hettema & Kenrick, 1992). These three theoretical perspectives of possible selves, the ecological model, and the biosocial model are similar in their consideration of complex interactions among systems, be they factors influencing the concept of self, the influences of various hierarchical environmental affordances on an individual's behaviour, and the reciprocal interactions between an individual and environments. Going one step further is a theoretical focus on changes that occur suddenly as a result of small changes in subsystems that individually would have a negligible effect. Abrupt discontinuities (having positive or negative implications) from one state to another characterize many aspects of singing.

One example of discontinuity in singing is that of the young male who belongs to a choir but withdraws immediately when his voice changes and does not return. Another example of the young female child in a school choir who is told by the choir director to mouth the words for the performance. That child may never sing again (Knight, 2019; Numminen et al., 2015). A more positive example, known as *the icebreaker effect*, is the feeling of closeness that persons who sing together have for each other after only a short time, as compared to the same amount of time spent together in other activities such as crafts or writing (Pearce et al., 2015). Further, voice students and teachers know that breakthroughs are a part of vocal learning (McCoy, 2016). Descriptions of breakthroughs have been found to include "renewed passion, more fun, new confidence, greater presence, longer endurance, and increased capability in range, tone, projection, flexibility, breath control, sostenuto technique, or a vibrato that isn't forced, yielding a degree of physical and artistic freedom that inspired joy in the singers who experienced them" (Jensen 2015, p. 220). A final example of discontinuity in singing is the transformative experience associated with choral singing that offers incomparable meaning to the lives of older adults (Balsnes, 2016) or offers psychological if not physiological healing to those who have health problems (see examples of singing for health, for intercultural understanding, and in intergenerational choirs in Heydon et al., 2020).

To accommodate the many discontinuities in the experience of singing across the lifespan, Cohen (2019, pp. 724-726) and Cohen & Ilari (2020) drew on a dynamical systems theory (DST) approach. DST has its roots in observations of early physiologists Nikolai Bernstein and Erich von Holst who acknowledged the need to understand motor coordination "as a function of temporary assemblages of multiple underlying subsystems" (Amazeen et al., 1998, p. 238). These subsystems both cooperate and compete until an equilibrium activity is obtained. The DST perspective enables modelling of change over time by focusing on a smaller number of variables that capture the essence (Krpan, 2017). An important concept in DST is that of attractor—"a stable state toward which a system evolves over time" (Krpan, 2017). Imagine two stable states of feeling comfortable (Attractor 1) and uncomfortable (Attractor 2) while an unstable state, referred to as Repeller, corresponds to a behaviour falling between these two states—a state of disequilibrium. Attractor 2, the tendency to consider oneself a non-singer in childhood might be rare, and external influences may have little effect on this

status, while the singer status, Attractor 1, is more common in childhood but subject to external influences (e.g., a teacher saying "mouth the words") that might change the behaviour to the unstable Repeller status and ultimately lead to the stable non-singer status of Attractor 2. A further concept is that of the *self-organization* that characterizes the tendency of complex systems to achieve a stable state. The concept of *emergence* refers to the whole new behaviour that goes beyond the sum of its parts, as when a non-singing deaf child, provided with appropriate scaffolding and encouragement by a teacher and electronic visual or vibrotactile feedback, experiences a sudden new joy of singing (example from Yennari et al., 2020).

Both Thelen and Smith (1994) and Van Geert (2009) noted that infant motor behaviour and child language developed more heterogeneously than the literature suggested. Milestones were arrived at in a wide variety of ways. Similarly, individual trajectories of singing development are heterogeneous as even simple singing tests reveal. One behaviour that has been described from the DST perspective is that of learning to reach. The infant's control of the vocal cords that enables metaphorically reaching of a note can be compared to the infant's control over arm muscles that enable reaching for an object. Movement is not so obvious as in reaching of the arm, but intricate sensorimotor coordination takes place invisible to an onlooker. Every time an infant produces a sound that changes pitch, a complex coordination of muscle activity must occur.

In summary, theories that consider development of the self-concept (Freer, 2015), the influence of environmental layers, and reciprocal interactions between individual and environment (Gaunt & Hallam, 2016), indicate that motivation to sing and improve one's singing depend on many factors. A dynamic systems theory (DST) approach emphasizes and accommodates the potentially discontinuous nature of singing behaviours which can arise from very small changes and complementary conditions in two or more subsystems simultaneously.

Conclusion: From theory to the practice of singing for all

If singing provides one of the most accessible means to music making and enjoyment of music as well as to additional social and health benefits, then we may ask what small changes can be made in the systems that govern our lives in order to foster singing for all. A suggested first step is to find a way of sustaining the interest of boys in singing. The research of Freer (2015) offers guidelines focused around role models and teacher development. Two other large-scale programs carried out in the UK also provide prototypes, elements of which might apply to the massive issues at hand. The *Sing-Up* program brought singing twice a week to every public school in Britain (Welch et al., 2011), and the *Ark Music Program* (reviewed by Hallam, 2017) taught generalist teachers to sing and also provided a singing program to young children. The future of singing in families, schools, communities and societies would seem to depend on the provision of male role models, development of appropriate teaching materials and curriculum, and the inclusion of singing as part of teacher education programs. As implied in this chapter,

there is little reason to suspect that learning to sing is any less beneficial than learning to play a musical instrument. To fully maximise access to quality music learning through singing requires the slow but steady transformation of the systems and subsystems that influence lives, embracing a relatively easy and low-cost process. Decision makers in music education or community music would do well to consider the benefit of directing music, arts, educational, community, and social program funding to singing and the encouragement of all students to engage in singing through to their adult years. If such programs were successful, emerging adults should be hooked on singing and be able to both serve as role models for their children and pupils and participate in community or specialized choirs which are effective for strengthening society and enhancing the well-being of individuals.

Reflective questions related to education and music in the community

1. As the principal of a school, you must authorize a budget dedicated to music education. Given that funds are not adequate for providing access to musical instruments for all students, what proportions should go to training on a musical instrument vs a choral program and learning to sing?
2. To what extent is it possible to improve one's ability to sing in middle age, or more senior years as compared to beginning such training in adolescence or early adulthood?
3. Should governments support community choirs?
4. Can one learn as much about music, other disciplines, and life through training of the voice as compared to training on a musical instrument?

Suggestions for further reading

Cohen, A. J. (Series Ed). (2020). *Routledge companion to interdisciplinary studies in singing. Volume I Development. Volume II Education. Volume III Well-being*. Routledge.

Freer, P. K. (2015). Perspectives of European boys about their voice change and school choral singing: Developing the possible selves of adolescent male singers. *British Journal of Music Education*, *32*(1), 87-106.

Gaunt, H., & Hallam, S. (2016). Individuality in learning of musical skills. In S. Hallam, I. Cross, & G. Thaut (Eds.), *Handbook of music psychology* (2nd ed., pp. 463-477). Oxford University Press.

Welch, G. F., Howard, D. M., & Nix, J. (Eds.). (2019). *Oxford handbook of singing*. Oxford University Press.

References

Addessi, A. R. (2020). The role of reflexivity during vocal interactions with caregivers in diaper change daily routine. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds.), The Routledge companion to interdisciplinary studies in singing: Volume I: Development (pp. 262-275). Routledge.

Bailey, B. A., & Davidson, J. W. (2005). Effects of group singing and performance for marginalised and middle-class singers. *Psychology of Music*, *33*(3)*,* 269-303.

Balsnes, A. H. (2016). Hospitality in multicultural choral singing*. International Journal of Community Music*, *9*(2), 171-189.

Bannan, N. (2020). An evolutionary perspective on the human capacity for singing. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds.), *The Routledge companion to interdisciplinary studies in singing* (Vol. 1, pp. 39-51). Routledge.

Barrett, M. S. (2006). Inventing songs, inventing worlds: the 'genesis" of creative thought and activity in young children's lives. International Journal of Early Years Education, *14*(3), 201-220, DOI: 10.1080/09669760600879920

Bartel, R. (2015). Singing Europe. Bonn, Germany: European Choral Association Europa Cantat. file:///E:/B-05-26/2-Main%20Files_06/0%20Mscrpts/mscript%20progr/22.%20Book%20on%20Music%20and%20Aging/Europe%202015%20europe_report.pdf

Belyk, M., & Brown, S. (2017). The origins of the vocal brain in humans. *Neuroscience and Biobehavioural Reviews, 77*, 177-193.

Berkowska, M., & Dalla Bella, S. (2009). Uncovering phenotypes of poor-pitch singing: The sung performance battery (SPB). *Frontiers in Psychology*, *4*, 714.

Bialystok, E., & DePape, A. M. (2009). Musical expertise, bilingualism, and executive functioning. *Journal of Experimental Psychology: Human Perception and Performance*, *35*(2), 565-574.

Bird, F. (2017). Singing out: The function and benefits of an LGBTQI community choir in New Zealand in the 2010s. *International Journal of Community Music, 10*(2), 193-206.

Boersma, P., & Weenink, D. (2019). Praat: Doing phonetics by computer. https://www.praat.org

Cave, P., Lewis, A., & Fancourt, D. (2020). Singing for lung health. In R. Heydon, D. Fancourt, & A. J. Cohen (Eds.), *Routledge companion to interdisciplinary studies in singing* (Vol. 3, pp. 86-97). Routledge.

Choral Canada (2017). Detailed national findings from Choral Canada's Survey of Choirs, Choruses, and Singing Groups in Canada. Hill Strategies Research Inc. https://www.saskchoral.ca/images/file/Choral%20Canada/Census%202016-17/2017%20Report%20-%20Complete.pdf

Clift, S., Hancox, G., Morrison, I., Hess, B., Kreutz, G., & Stewart, D. (2010). Choral singing and psychological wellbeing: Quantitative and qualitative findings from English choirs in a cross-national survey. *Journal of Applied Arts and Health*, *1*(1), 19-34.

Cohen, A. J. (2019). Singing. In P. J. Rentfrow & D. J. Levitin (Eds*.), Foundations in music psychology: Theory & research* (pp. 685-750). MIT Press.

Cohen, A. J. (2020a) (Series Ed). *The Routledge companion to interdisciplinary studies in singing. Volume I: Development; Volume II: Education; Volume III: Wellbeing*. Routledge.

Cohen, A. J. (2020b). Singing and choirs. In L. L. Cuddy, S. Belleville, A. Moussard (Eds.), *Music and the aging brain* (pp. 245-303). Academic Press.

Cohen, A. J., & Ilari, B. (2020). Conclusion—Singing development: The importance of research on the development of singing. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds.), *The Routledge companion to interdisciplinary studies in singing* (Vol. 1, pp. 435-451). Routledge.

Cohen, A. J., Levitin, D. J., & Kleber, B. A. (2020). Brain mechanisms underlying singing. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds.), *The Routledge companion to interdisciplinary studies in singing* (Vol. 1, pp. 79-96). Routledge.

Cohen, A. J., Pan, B.-Y., da Silva, E., & Dutton, K. (2020). Performance of Canadians on the Automated AIRS Test Battery of Singing Skills: Music training and age. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds.), *The Routledge companion to interdisciplinary studies in singing Vol. I Development* (pp. 357-371). Routledge.

Cohen, A. J., Sun, J., Mang, J., Pan, B.-Y., Lim, L. F. (2020). Tone language and musical experience: Pitch accuracy and key choice in the AIRS Test Battery of Singing Skills (ATBSS). In F. A. Russo, B. Ilari, & A. J. Cohen (Eds*.), The Routledge companion to interdisciplinary studies in singing* (Vol. 1, pp. 408-423). Routledge.

Cohen, A. J. & Trehub, S. E. (Eds.). (2011). Singing and psychomusicology. *Psychomusicology: Music, Mind & Brain, 21* (1 and 2), 1-267.

Cuddy, L. L., Balkwill, L.-L., Peretz, I., & Holden, R. R. (2005). Musical difficulties are rare: A study of "tone deafness" among university students. Annals of the New York Academy of Sciences, 1060, 311-324.

Dalla Bella, S., Giguère, J., & Peretz, I. (2007). Singing proficiency in the general population *Journal of the Acoustical Society of America*, *121*(2), 1182-1189.

Fancourt, D., & Warran, K. (2020). In R. Heydon, D. Fancourt, & A. J. Cohen (Eds.), Routledge companion to interdisciplinary studies in singing (pp. 74-85). Routledge.

Fancourt, D., Williamon, A., Carvalho, L. A., Steptoe, A., Dow, R., & Lewis, I. (2016). Singing modulates mood, stress, cortisol, cytokine and neuropeptide activity in cancer patients and carers. *ecancer*, *10*, 631. https://doi.org/10.3332/ecancer.2016.631

Forrester, M. A. (2010). Emerging musicality during the pre-school years: A case study of one child. *Psychology of Music*, *38*(2), 131-158.

Freer, P. K. (2010). Two decades of research on possible selves and the "missing males" problem in choral music. *International Journal of Music Education*, *28*(1), pp. 17-30.

Freer, P. K. (2015). Perspectives of European boys about their voice change and school choral singing: Developing the possible selves of adolescent male singers. *British Journal of Music Education*, *32*(1), 87-106.

Gaskill, C. S., Cowgill, J. G., & Many, S. (2013). Comparing the vocal dose of university students from vocal performance, music education, and music theater. Journal of Singing, *70*(1), 11-19.

Gaunt, H., & Hallam, S. (2016). Individuality in learning of musical skills. In S. Hallam, I. Cross, & G. Thaut (Eds.), *Handbook of music psychology* (2nd ed., pp. 463-477). Oxford University Press.

Gudmundsdottir, H., & Trehub, S. (2018). Adults recognize toddlers' song renditions. *Psychology of Music*, *46*(2), 281-291.

Gudmundsdottir, H., Beynon, C. & Ludke, K. (2020). Introduction: Singing and education—Learning to sing and singing to learn. In H. R. Gudmundsdottir, C. Beyon, K. M. Kudke, & A. J. Cohen, A (Eds.). *Routledge companion to interdisciplinary studies in singing* (pp. 1-11). Routledge.

Hallam, S. (2017). Report on the Out of the Ark Music Singing School Project. https://www.outoftheark.co.uk/ext/pdfs/Report_on_the_Research_About_the_Out_of_the_Ark_Music_Singing_School_Project_by_Prof_Susan_Hallam_MBE.pdf

Halwani, G. F., Loui, P., Rüber, T., & Schlaug, G. (2011). Effects of practice and experience on the arcuate fasciculus: Comparing singers, instrumentalists, and non-musicians. *Frontiers of Psychology*, *2*, 1-9.

Hassan, N. (2017). Re-voicing: Community choir participation as a medium for identity formation amongst people with learning disabilities. *International Journal of Community Music*, *10*(2), 207-225.

Heydon, R., Fancourt, D., & Cohen, A. J. (Eds.) (2020). *The Routledge companion to interdisciplinary studies in singing – Vol. III Well-being.* Taylor & Francis/Routledge

Hutchins, S., & Moreno, S. (2013). The linked dual representation model of vocal perception and production. *Frontiers in Psychology*, 4, 825. https://doi.org/10.3389/fpsyg.2013.00825

Jensen, K. (2015). The significance and pedagogic applications of the vocal breakthrough. Part one: Conditions and stages. *Journal of Singing*, *71*(2), 219-224.

Jensen, K. (2016). The significance and pedagogic applications of the vocal breakthrough. Part two: The role of attention. *Journal of Singing*, *71*(3), 355-361.

Johnson, J. K., Louhivuori, J., & Siljander, E. (2016). Comparison of well-being of older adult choir singers and the general population of Finland: A case-control study. *Musicae Scientiae*, *21*(2), 178-194.

Johnson, J. K., Stewart, A. L., Acree, M., Nápoles, A. M., Flatt, J. D., Max, W. B., & Gregorich, S. E. (2018). A community choir intervention to promote well-being among diverse older adults: Results from the Community of Voices Trial. *Journals of Gerontology: Psychological Sciences*, *11*, 1-11. https://doi.org/10.1093/geronb/gby132

Jurgens, A., & Kirchhoff, M. D. (2019). Enactive social cognition: Diachronic constitution and coupled anticipation. *Consciousness and Cognition, 70*, 1–10.

Kerchner, J. L. (2020). Group singing in prison: Discovering and developing best possible self. . In R. Heydon, E. Fancourt, & A. J. Cohen (Eds.) *The Routledge companion to interdisciplinary studies in singing – Vol. III Well-being* (pp. 158-169). Routledge

Kleber, B. A., & Zarate, J. M. (2014). The neuroscience of singing. In G. F. Welch, D. M. Howard, & J. Nix (Eds.), *The Oxford handbook of singing*. Oxford University Press. http://doi.org/10.1093/oxfordhb/9780199660773.013.015

Knight, S. (2019). Addressing the needs of the adult "non-singer" (NS). In G. F. Welch, D. M. Howard, & J. Nix (Eds.), *The Oxford handbook of singing* (pp. 621-650). Oxford University Press.

Krueger, A. B. (2019). *Rockonomics*. Currency/Penguin Random House.

Krumhansl, C. E., & Zupnick, J. A. (2013). Cascading reminiscence bumps in popular music. *Psychological Science*, *24*(10), 2057-2068. https://doi.org/10.1177/0956797613486486

Lai, C. K., Skinner, A. L., Cooley, E., Sohad, M., Brauer, M., Devos, T. … Nosek, B. A. (2016). Reducing implicit racial preferences: II. Intervention effectiveness across time. *Journal of Experimental Psychology: General*, *145*(8), 1001-1016.

Lamont, A., Murray, M., Hale, R., & Wright-Bevans, K. (2018). Singing in later life: The anatomy of a community choir. *Psychology of Music*, *46*(3), 424-439.

Launay, J., Tarr, B., & Dunbar, R. I. (2016). Synchrony as an adaptive mechanism for large-scale human social bonding. *Ethology*, *122*(10), 779-789.

Lortie, C. L., Rivard, J., Thibeault, M., & Tremblay, P. (2017). The moderating effect of frequent singing on voice aging. *Journal of Voice*, 31(1), 112.e1-112.e12. https://doi.org/10.1016/j.jvoice.2016.02.015

Mansens, D., Deeg, D. J. H., & Comijs, H. C. (2017). The association between singing and/or playing a musical instrument and cognitive functions in older adults. *Aging & Mental Health*. https://doi.org/10.1080/136078 63.2017.1328481.

Markus, H., & Nurius, P. (1986). Possible selves. *American Psychologist*, *41*(9), 954-969.

McCarty, M. (2014). United in song, Part 2: The Braille Tones of Edmonton, Alberta. *Anacrusis, x,* xx-xx.

McCoy, S. (2016). Imagine. *Journal of Singing*, *72*(5), 573-575.

Mithen, S. J. (2005). *The singing Neanderthals: The origins of music, language, mind and body*. Weidenfield & Nicholson.

Morgan-Ellis, E. (2018). *Everybody sing!: Community singing in the American picture palace*. University of Georgia Press.

Neto, F., Pinto, M., & Mullet, E. (2015). Can music reduce anti-dark-skin prejudice? A test of a cross-cultural musical education programme. *Psychology of Music*, *44*, 388-398.

Noble, J. (2020). Choral practice and research at the beginning of the 21st century. In H. Gudmundsdottir, C. Beynon, K. Ludke, & A. J. Cohen (Eds.), *Routledge companion to interdisciplinary studies in singing* (Vol. 2, pp. 295-312). Routledge.

Norton, K. (2016). *Singing and Wellbeing: Ancient wisdom, modern proof*. Routledge.

Numminen, A., Lonka, K., Rainio, A. P., & Ruismäki, H. (2015). "Singing is no longer forbidden to me—It's like part of my human dignity has been restored." Adult non-singers learning to sing: An exploratory intervention study. *European Journal of Social and Behavioural Sciences*, *12*(1), 1660-1674.

Overy, K., & Molnar-Szakacs, I. (2009). Being together in time: Musical experience and the mirror neuron system. *Music Perception: An Interdisciplinary Journal*, *26*(5), 489-504.

Parakilas, J. (1999). *Piano roles: Three hundred years of life with the piano*. Yale University Press.

Pearce, E., Launay, J., & Dunbar, R. I. (2015). The ice-breaker effect: Singing mediates fast social bonding. *Open Science*, *2*(10), 1-9. https://doi.org/10.1098/rsos.150221.

Pfordresher, P. Q., & Larrouy-Maestri, P. (2015). On drawing a line through the spectrogram: How do we understand deficits of vocal pitch imitation? *Frontiers in Human Neuroscience*, *9*, 271.

Pfordresher, P. Q., & Nolan, P. (2019). Testing convergence between singing and music perception accuracy using two standardized measures. *Auditory Perception and Cognition*, *2*(1-2), 67-81.

Putnam, R. (2015). *Our kids: The American dream in crisis*. Simon & Schuster.

Rauscher, F. H. (2009). The impact of music instruction on other skills. In S. Hallam, I. Cross, & M. Thaut (Eds.), *The Oxford handbook of music psychology* (pp. 244-252). Oxford University Press.

Rodney, J., & Sataloff, R. T. (2020). The effects of hormones and age on the voice. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds*.), The Routledge companion to interdisciplinary studies in singing* (Vol. 1, pp. 121-135). Routledge.

Russo, F. A., Ilari, B., & Cohen, A. J. (Eds.), (2020). *The Routledge companion to interdisciplinary studies in singing – Vol. I Development*. Taylor & Francis/Routledge.

Rutkowski, J. (1990). The measurement and evaluation of children's singing voice development. *The Quarterly: Center for Research in Music Learning and Teaching*, 1(1-2), 81-95.

Salvador, K. (2013). Inclusion of people with special needs in choral settings: A review of applicable research and professional literature. *National Association of Music Education*, 3(2) 37-44.

Särkämö, T. (2020). Singing for rehabilitation: Efficacy of singing-based interventions in major ageing-related neurological disorders. In R. Heydon, E. Fancourt, & A. J. Cohen (Eds.) *The Routledge companion to interdisciplinary studies in singing – Vol. III Well-being* (pp. 98-108). Routledge.

Schellenberg, E. G. (2004). Music lessons enhance IQ. *Psychological Science, 15*, 511–514.

Schloneger, M. J., & Hunter, E. J. (2018). Assessments of voice use and voice quality among college/university singing students ages 18-24 through ambulatory monitoring with a full accelerometer signal. *Journal of Voice*, *31*(1), 124.e21-123.e30. https://doi.org/10.1016/j.jvoice.2015.12.018

Schneider, C. E., Hunger, E. G., & Bardach, S. H. (2018). Potential cognitive benefits from playing music among cognitively intact older adults: A scoping review. *Journal of Applied Gerontology*, *38*(12), 1763-1783. https://doi.org/10.1177/0733464817751198

Schirmer-Mowka, K. L., Fard, P. R., Zamorano, A. M., Finkel, S., Birbaumer, N., & Kleber, B. A. (2015). Evidence for enhanced interoceptive accuracy in professional musicians. *Frontiers in Behavioural Neuroscience*, *9*, 1-13. doi:10.3389/fnbeh.2015.00349.

Slater, J., Azem, A., Nicol, T., Swedenborg, B., & Kraus, N. (2017). Variations on the theme of musical expertise: Cognitive and sensory processing in percussionists, vocalists and non-musicians. *European Journal of Neuroscience*, *45*(7), 952-963.

Slater, J., & Kraus, N. (2016). The role of rhythm in perceiving speech in noise: A comparison of percussionists, vocalists and non-musicians. *Cognitive Processing*, *17*(1), 79-87.

Stadler Elmer, S. (2011). Human singing: Towards a developmental theory. *Psychomusicology: Music, Mind & Brain*, *21*, 13-30.

Stadler Elmer (2020). From canonical babbling to early singing and its relation to the beginnings of speech. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds.), *The Routledge companion to interdisciplinary studies in singing* (Vol. 1, pp. 25-38). Routledge.

Strong, J. V., & Mast, B. T. (2018). The cognitive functioning of older adult instrumental musicians and non-musicians. *Aging, Neuropsychology, and Cognition*, 26(3), 367-386. https://doi.org/10.1080/13825585.2018.1448356

Strong, J. V., & Midden, A. (2018). Cognitive differences between older adult instrumental musicians: Benefits of continuing to play. *Psychology of Music*. https://doi.org/10.1177/0305735618785020

Sundberg, J. (1987). *The science of the singing voice*. Northern Illinois University Press.

Tan, J., Maurine Tsakok, F. H., Ow, E. K., Lanskey, B., Siong, K., Lim, D., Gan Goh, L., Tan, C.-H., Cheah, I. K., Larbi, A., Foo, R., Loh, M., Wong, C. K. Y., Suckling, J., Li, J., Mahendran, R., Kua, E.-H., & Feng, L. (2018). Study protocol for a randomized controlled trial of choral singing intervention to prevent cognitive decline in at-risk older adults living in the community. *Frontiers in Aging Neuroscience*, *10*, 195. https://doi.org/10.3389/fnagi.2018.00195

Tanner, M. (2020). Singing and Parkinson's disease. In R. Heydon, D. Fancourt, & A. J. Cohen (Eds). *The Routledge companion to interdisciplinary studies in singing Vol. III Wellbeing* (pp. 124-135). Routledge.

Tarrant, M., Warmoth, K., Code, C., Dean, S., Goodwin, V. A., Stein, K., & Sugavanam, T. (2016). Creating psychological connections between intervention recipients: Development and focus group evaluation of a group singing session for people with aphasia. *British Medical Journal Open*, *6*(2), Article e009652.

Titze, I. R., & Verdolini Abbott, K. (2012*). Vocology: The science and practice of voice habilitation*. National Center for Voice and Speech.

Trehub, S. E., & Gudmundsdottir, H. R. (2015). Mothers as singing mentors for infants. In G. Welch, D. Howard, & J. Nix (Eds.), *The Oxford handbook of singing*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199660773.013.25

Trehub, S. E., & Russo, F. A. (2020). Infant-directed singing from a dynamic multimodal perspective: Evolutionary origins, cross-cultural variation, and relation to infant-directed speech. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds.), *The Routledge companion to interdisciplinary studies in singing: Volume I: Development* (pp. 249-261). Routledge.

Tsang, C. D., & Trainor, L. J. (2020). An exploration of the relationship between perception, production, cognition and environment in the development of singing in children. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds.), *The Routledge companion to interdisciplinary studies in singing* (Vol. 1, pp. 201-213). Routledge.

Van Puyvelde, M., Loots, G., Gillisjans, L., Pattyn, N., & Quintana, C. (2015). A cross-cultural comparison of tonal synchrony and pitch imitation in the vocal dialogs of Belgian Flemish-speaking and Mexican Spanish-speaking mother-infant dyads. *Infant Behavior and Development*, *40*, 41-53.

Weinstein, D., Launay, J., Pearce, E., Dunbar, R. I., & Stewart, L. (2016). Singing and social bonding: Changes in connectivity and pain threshold as a function of group size. *Evolution and Human Behaviour*, *37*(2), 152-158.

Welch, G. F. (1979). Vocal range and poor pitch singing. *Psychology of Music, 7*(2), 13-31.

Welch, G. F. (1998). Early childhood musical development. *Research Studies in Music Education*, *11,* 27-41.

Welch, G. F., Himonides, E., Saunders, J., Papageorgi, I., Rinta, T., Preti, C., Stewart, C., Lani, J., & Hill, J. (2011). Researching the first year of the National Singing Programme Sing Up in

England: An initial impact evaluation. *Psychomusicology: Music, Mind, & Brain*, *21*(1-2), 83-97.

Wolfe, J., Garnier, M., Henrich Bernardoni, N., & Smith, J. (2020). The mechanics and acoustics of the singing voice: Registers, resonances and the source-filter interaction. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds.), *The Routledge companion to interdisciplinary studies in singing* (Vol. 1, pp. 64-78). Routledge.

Yennari, M., Schraer-Joiner, L. E., & Toole, G. (2020). Singing and the child who is deaf: Focusing on the individual. In F. A. Russo, B. Ilari, & A. J. Cohen (Eds.), *The Routledge companion to interdisciplinary studies in singing* (Vol. 1, pp. 227-239). Routledge.

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[i] On the choir of persons with laryngectomy see https://www.youtube.com/watch?v=vjGRUd0OUow and https://www.bbc.com/news/av/uk-england-berkshire-48147525/laryngectomy-patients-learn-to-sing-without-a-voice-box https://www.youtube.com/watch?v=-hbmz0fC7kU

[ii] Unfortunately, the second phase could not be completed due to COVID-19 which prevented testing of the participants after almost 2 years of training.

[iii] Occupational health standards exist for the upper limit of tissue vibration of parts of the body (e.g., when operating machinery). "… the vocal folds routinely exceed the reported safety limit for tissue vibration" (Gaskill, Cowgill, & Many, 2013, p. 11).

[iv] Rauscher and Hinton (2011) offer further details including that the singing group was taught to reproduce pitches sung by the instructor: "Unlike piano training, the visual representation of pitches is absent" (p. 217). It should be pointed out, however, that a music notation component can be readily added to voice lessons.