

Research on the Aging Voice: Strategies and Techniques for Healthy Choral Singing

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Great changes and achievements for the elderly marked the twentieth century. The proportion of the population that will reach an advanced age is growing rapidly. According to recent data from the Federal Interagency Forum on Age-related Statistics (2000), there are currently 35 million people age 65 or older, accounting for almost 13 percent of the U.S. population. Furthermore, the number of people aged sixty-five and older is expected to double by the year 2030. The challenges facing our society as we learn to cope with an aging population are many. Perhaps one of the more critical issues centers on the question of quality of life. Of what value is a gain in life expectancy if the added years do not contribute to a sense of well-being and happiness? Music certainly can play a central role in a healthy and active life style for the elderly. Yet, aging does present unique problems for continued musical activity. This is particularly true for singers.

The purpose of this paper is twofold. First, an overview of research related to the aging voice is presented. Second, information on ways to help and encourage older singers to continue to enjoy music is described. Specifically, information on the physical changes associated with aging followed by pedagogical techniques designed to limit the negative impact of these effects on singing is presented. Singing can and should be a lifelong activity. Equipped with proper knowledge and technique the mature singer can remain an active participant in the choral music experience.

Physical Changes Associated with Aging

Aging is a natural result of the human condition. Unfortunately, some aspects of the physical changes associated with aging may have an adverse effect on singing. Loss of accuracy, speed, endurance, stability, strength, and coordination occurs over time. Muscles, ligaments, and neural tissues exhibit varying degrees of atrophy often resulting in a general sense of "slowing down" (Chodzko-Zajko & Ringel, 1987). How these natural processes affect an individual's ability to engage in meaningful singing activities will of course vary for each individual. However, common changes do occur. Knowledge of these changes may help aging singers or choral conductors understand the challenges facing older singers.

Vocal Apparatus

Beginning with birth and extending into early adulthood our bones, muscles, ligaments, cartilage, and tendons are in a constant state of growth. However, after we move beyond middle age, our bodies slowly begin to deteriorate (Hollien, 1987). This pattern of growth and deterioration can also be seen within the vocal mechanism. For example, young healthy cartilage has a firm, gristly consistency and is capable of considerable elasticity (Doscher, 1988). Yet, as we age, this cartilage slowly begins to ossify or turn to bone. By age 65, ossification of the laryngeal skeleton including the hyoid, thyroid, cricoid, and arytenoid cartilages is complete. (Kahane, 1987; Morrison & Gore-Hickman, 1986; Sataloff, 2000; Sinard, 1998; Sindo & Hanson, 1990). As the skeletal structure of the larynx ossifies, it becomes less flexible and resilient, thus inhibiting the ability of the vocal mechanism to respond quickly and accurately.

In addition, age-related changes to the vocal folds themselves can affect singing. The vocal folds consist of two wedge-shaped bundles of muscles, the edges of which are made up of ligaments covered by a mucous membrane. According to Hirano (1974), the vocal folds have three outer mucosal layers. The first layer is a mass of soft mucous while the middle and deepest layers make up the vocal ligament. All three layers protect the vocalis muscles. As we age, the outer layers deteriorate, creating less protection for the vocal muscles underneath. Thus, the vocal fold edges become ragged resulting in a "roughness" to the voice quality (Biever & Bless, 1989; Orlikoff, 1990; Ryan & Capadano, 1978; Tanaka, Hirano, & Chijiwa, 1994; Woo, Casper, Colton, & Brewer, 1992).

Also, like other muscles and ligaments within the body, those which make up the vocal folds begin to atrophy over the course of time. As they thin and deteriorate, they lose their elastic and collagenous fibers. This, in turn, makes them stiffer and thinner. They may exhibit a gap in the middle third of the vocal folds due to muscle atrophy, a condition known as "bowing." Accordingly, these factors may result in changes affecting tone quality such as breathiness, slightly decreased volume, "thinning" of the voice, and loss of vocal efficiency (Paulsen & Tillman, 1998; Sataloff, Rosen, Hawkshaw & Spiegel, 1997; Sinard, 1998).

Over time changes in speaking fundamental frequency have been documented. The first noticeable change occurs during puberty. For all adolescents, growth and descent of the larynx corresponds with a sudden drop in fundamental frequency to approximately 225 Hz for females (Duffy, 1970) and 130 Hz for males (Hollien & Malcik, 1967). After this change the voice continues to drop in pitch, although at a much more gradual pace. Testing in late adulthood, age 80 to 90, reveals that female voices continue to descend settling at a fundamental frequency level of 195 Hz (McGlone & Hollien, 1963). For the male voice, however, the fundamental frequency continues to drop throughout middle adulthood then gradually rises during late adulthood settling at around 145-150 Hz (Boone & McFarlane, 2000; Hollien & Shipp, 1972; Sataloff, 2000).

While the vocal apparatus does change as we grow older, researchers have found that voice training may help maintain the voice as we age. Peppard (1990) studied eighty women (20 young singers, 20 older singers, 20 young non-singers, and 20 older non-singers) in an investigation of age related changes in vocal function. Participants were assessed using a variety of vocal performance and speaking tasks. Statistical analysis revealed significant differences among the vocal production of these four groups. The findings in this study support

the belief that training and use of the voice for singing can minimize the consequences of vocal aging. Boone (1997) also reported that mature vocal performers experienced less vocal changes as a result of aging than did their non-performing peers while Sataloff (2000) advocates the effectiveness of traditional voice therapy with specialized singing exercises to counter vocal problems. Apparently, continued voice training can make a difference.

Respiratory and Cardiovascular Systems

Age-related changes affecting the respiratory and cardiovascular systems may have a direct impact on the ability of older singers to perform at optimum levels. Since singing is a physical activity predicated on sufficient air supply and management of the breath, it is important to understand how aging may interfere with these processes. A decline in respiratory function over time has been noted (Arking, 1991; Hollien, 1987; Sataloff, et. al, 1997; Spirduso, 1995; Whitbourne, 1985). Specifically, a decrease in lung volume, vital capacity, and air flow rates coupled with degeneration of muscles and tissue occurs with aging (Hollien, 1987). A reduction in vital capacity (the volume of air moved in and out when performing under stress) coupled with an increase in residual volume (air remaining in the airways and air sacs at the end of expiration) results in less efficient breath. This process begins around age 40 leading to a 40% loss of vital capacity between the ages of 20 and 80 (Boone, 1997; Spirduso, 1995; Whitbourne, 1985).

A number of factors may account for this phenomenon including: curvature of the spine affecting the shape of the thorax; stiffening of the skeletal part of the thorax accompanied by a weakening of the connecting muscles; lowered position of the lungs and bronchi, due to gravitational pull; and loss of elasticity in the lungs (Hollien, 1987; Spirduso, 1995). Further problems are often encountered due to the cumulative effect of allergies, infections, and smoking over a lifetime (Boone, 1997). The end result is that as individuals age, more energy is needed simply to breathe.

Age effects on the cardiovascular system have been extensively studied (Spirduso, 1995; Whitbourne, 1985). Common findings indicate that a decrease in maximum oxygen consumption and a reduction in heart rate during maximum levels of exertion occur with age. Essentially, the heart gradually loses its efficiency as a pumping device (Whitbourne, 1985). As is the case with pulmonary functioning, the decline is paid for by an increase in energy needed to complete what used to be less demanding physical tasks. For the aging singer, less efficient respiratory and cardiovascular systems mean they have to work harder to sing. If the muscles involved with breathing are not strong enough to support healthy singing, it is likely that tension in the larynx will occur. This may account for problems with tone quality and pitch.

Research has found that aerobic exercise has beneficial effects on the cardiovascular system (Spirduso, 1995; Whitbourne, 1985). Daily exercise, for example, decreases the resting and exercise heart rate thus lessening the energy demands on the heart. Stationary cycling, weight training, and walking have been associated with improvements in heart rate, hamstring flexibility, and abdominal strength in chronically ill elderly subjects (Spirduso, 1995). On the other hand, it is unclear whether exercise can counteract the effects of a decrease in pulmonary function. Whitbourne (1985) explained this may be because fewer studies have been conducted that focus exclusively on the relationship between aerobic exercise and pulmonary function. Spirduso (1995) cited two longitudinal studies supporting the hypothesis

that long term exercise training may prevent a decrease in vital capacity. It appears that more research is needed to determine the effects of aerobic exercise on the pulmonary system; however, the benefits of exercise on the cardiovascular system are well documented.

Medical Conditions and Medications

In addition to the normal aging process, medical conditions often interfere with vocal health and singing. Sataloff (2000) lists numerous conditions which may interfere with healthy singing: swallowing dysfunction, gastrointestinal disorders, coronary artery disease, hypertension, hypothyroidism, diabetes, obesity, malnutrition, arthritis, and mood disorders. Some of these conditions directly affect the larynx. For example, swallowing dysfunction or gastrointestinal disorders can cause stomach acid to reflux into the throat and may result in hoarseness, chronic sore throats, consistent cough, and/or a dry throat. Other conditions, such as obesity or heart disease, do not directly affect the larynx but can hamper the efficiency of the respiratory system thus impacting the singer's ability to support the tone.

Prescription medications intended to counter a host of problems ranging from cardiovascular, pulmonary, gastroenteric, and even psychological conditions may indirectly contribute to singing difficulties. Furthermore, problems resulting from medications may occur more frequently with age. Since older people often take more medications as a result of conditions associated with aging, they are more likely to experience complications or interaction effects resulting from use of multiple medications (Boone, 1997).

Sataloff, Rosen, and Hawkshaw (1995) identified specific types of medicines, such as antibiotics, antihistamines, hormones, diuretics, Vitamin C, and even aspirin, that can negatively impact singing. Excessive drying of the upper respiratory tract is the vocal complication most often associated with these medications. For example, diuretics, Vitamin C taken in large quantities, antihistamines and decongestants can produce a drying effect that impacts singing. These medications affect the salivary glands and mucous-secreting membranes of the respiratory tract, reducing and thickening mucosal secretions, resulting in minimal lubrication of that area. The resulting dry cough may eventually damage the vocal folds. In addition, these drugs may have a sedative effect that can adversely affect vocal production by dulling the senses and slowing response time.

Aspirin and other analgesics, often prescribed for sore throats, headaches, and other common maladies, can result in serious vocal problems. Aspirin predisposes the singer to hemorrhage of the vocal folds; this is particularly true when vocal folds have been traumatized by excessive or improper use. Older singers who are untrained or out of shape may be at risk if they are taking aspirin regularly. Aspirin may also mask the pain of a sore throat. Since pain often serves as a warning sign of physical problems within the vocal apparatus, ignoring these signs may result in serious vocal injury (Sataloff, et al., 1995).

Effects of Menopause

Female singers face additional challenges with the onset of menopause that have a direct effect on the vocal mechanism. Estrogen deprivation causes substantial changes in the mucous membranes that line the vocal tract. As estrogen levels decrease, laryngeal tissues begin to absorb water causing the vocal folds to swell, blood vessels to become enlarged, and vocal fold

mass to increase (Emerich, Hoover, & Sataloff, 1996). Changes in hormone levels have been associated with decreased fundamental frequency, hoarseness, decreased vocal range, and difficulty with complex motor tasks (Boone, 1997; Doscher, 1988; Emerich, et al., 1996). For example, Baker (1999) studied four women who complained of significant voice alterations following hormone treatments. These women reported hoarseness, lowering of pitch, loss of intensity, and loss of control when singing. Apparently these conditions resulted from the use of medication containing virilizing agents and/or testosterone. While some of the symptoms decreased with voice therapy and after withdrawal from medication, some permanent changes to the voice did occur.

Estrogen therapy has been helpful in forestalling the typical voice changes that follow menopause. Female singers may want to obtain a baseline estrogen level while in their thirties or early forties to aid in achieving optimal therapeutic levels during and following menopause. While the effects of menopause on the voice may be severe, estrogen replacement therapy has been found to be an excellent solution for female singers (Boone, 1997; Emerich, et al., 1996).

Changes in Hearing and Vision

Changes in one's ability to hear often accompany the aging process. Approximately one third of all non-institutionalized persons aged seventy or older reported some form of hearing impairment (Desai, Pratt, Lentzner, & Robinson, 2001). Presbycusis, the term used to describe hearing loss most often associated with aging, refers to hearing loss in both ears due to degenerative changes to the inner ear (Lubinski & Higginbotham, 1997). The condition is usually irreversible and worsens with age. Individuals with presbycusis generally have difficulty hearing sounds emitted at high frequency levels and often have trouble understanding speech. When a singer's hearing is impaired, their ability to accomplish these tasks is compromised. Specifically, problems with distortion of sound quality, loudness (loudness recruitment), and pitch discrimination (diplacusis) may result from sensory deficits in the cochlea (Henoch & Chesky 1999; Sataloff & Sataloff, 1991). For the hearing impaired individual, the ability to fine tune intonation and discriminate certain timbres may prove exceptionally challenging.

There are a variety of visual changes that also accompany old age. Changes in the lens, cornea, and retina are responsible for a decrease in visual acuity (the ability to see details on objects at varying distances), sensitivity to light, depth perception, and colour discrimination. These changes are the result of either neural (often permanent) or optical (often correctable) factors (Lubinski & Higginbotham, 1997). Changes in visual acuity typically surface between ages 40-50. They are generally tied to a decrease in pupil size and the amount of light entering the eye. Difficulties focusing on objects that are close and/or less effective night vision are common problems for the elderly. Reading glasses and additional lighting can help compensate for deteriorating eyesight.

Implications for the Choral Profession

In summary, it appears that numerous physiological changes occur as a natural part of the aging process and that these changes can have a negative effect on singing. Breathiness, loss of range, change in tone quality, development of tremolo, vocal fatigue, and pitch inaccuracies

are not uncommon correlates of the aging voice. While it is true that older adult bodies do not function at the same level as individuals in their 20s, it is not true that older adults cannot maintain and/or regain a healthy lifestyle. Engaging in regular physical exercise is one way older adults can counter the effects of aging. Exercise may improve muscle tone and function, as well as coordination, and contribute to greater efficiency of the vascular, nervous, and respiratory systems (Sataloff et al., 1997; Spirduso, 1995; Whitbourne, 1985). Since healthful singing is predicated on the interaction of these systems and structures, it follows that physical exercise can be tremendously beneficial for the older adult singer.

In addition to physical exercise, older singers may benefit from regular vocal instruction. As mentioned earlier, there is evidence that vocal training may be able to help some individuals maintain or even improve their singing (Boone, 1997; Peppard, 1990). Choral conductors can encourage the development of proper vocal habits by incorporating voice-building techniques into every rehearsal. By paying careful attention to the needs and abilities of older singers, it is possible to craft a series of warm-up exercises that will help them strengthen the muscles and coordination necessary for optimal vocal production. Smith and Sataloff (1999) recommend using a warm-up sequence that focuses on the following four elements: relaxation, posture, breathing, and resonance.

To facilitate singing, begin by stretching the muscles connected directly or indirectly to the vocal mechanism. These include the groups of muscles in the face, neck, shoulders, arms, upper chest, abdomen, sides of the torso, and upper/lower back. Because all muscles atrophy with age, it is important to methodically stretch all the muscle groups involved in the phonation process. Furthermore, because of the age group, it is important to set a slower pace to the stretching sequence and be mindful of selecting exercises that do not cause undue strain. Once the body is duly relaxed, singers should be guided in finding their optimal posture for singing. Make sure they know the best positions for singing both while standing and sitting. Because older people may be affected by curvature of the spine, arthritis or other problems impacting the skeletal structure, it may take longer to improve their posture. They may also benefit from more frequent rehearsal breaks that incorporate physical stretches.

Exercises that focus specifically on inhalation and exhalation will also be beneficial to older adult singers. While respiratory functions naturally decrease with age, appropriate breathing exercises may increase the vital capacity of the lungs. Exercises that encourage good posture and strengthen the muscles involved in breathing should be incorporated into every rehearsal. Laughing patterns, staccato singing, and panting exercises can be used to engage the abdominals, diaphragm, costals, and muscles of the back. Exercises based on blowing, puffing, hissing and chanting are useful in developing exhalation (Ehmann & Haasemann, 1981; Smith & Sataloff, 1999). After focusing on breathing exercises, the next step is to help singers make the connection between breathing and phonation.

Choral conductors can ease the transition into vocal warm-ups by choosing exercises that continue to strengthen the breathing muscles while gently initiating sung pitches. Lip trills, vibrating the lips while phonating musical pitches, are an excellent example. A singer cannot maintain a continuous lip trill without a great deal of air flowing through the voice; furthermore, the lips, throat, and tongue must remain flexible and relaxed. Lip trills can be sung on a single pitch or gradually expanded to incorporate a wide variety of melodic patterns. Perhaps most importantly, lip trills allow older singers to experience phonation without undue strain, an important step in developing healthy singing. In addition to lip trills, other exercises

may prove useful in helping older singers develop the connection between breath, phonation and resonance. Smith and Sataloff (1999) suggest using melodic patterns sung on "ng" or "n", descending sliding patterns, and phrases sung on French nasals.

Many of the pitch problems older singers experience, such as singing below the pitch, excessive vibrato (wobble), and a strident or "tinny" tone quality, are caused by a disconnection between the breath flow and the vocal mechanism. Therefore, exercises designed to increase vital capacity and develop breath management may help eliminate or diminish some of these problems. By choosing appropriate exercises, practicing them regularly, and continually monitoring progress, choral conductors may take a proactive role in helping older singers continue to experience the joy of singing. Exercise, both physical and vocal, can and should be a part of every rehearsal.

Choosing suitable literature for this population may also require special consideration. Barrier (1993) investigated criteria for evaluation of choral literature appropriate for older singers. She found that music with a lower tessitura and limited vocal range was more effective. In addition, music with long phrases, rapid melismatic passages, and wide unprepared leaps was found to be troublesome for older singers. Rhythmic, homophonic works were recommended for older singers. Furthermore, her findings indicated that intonation was found to be better when some type of instrumental accompaniment supported the vocal line. With careful planning, it is possible to develop a musical program that will challenge and excite older singers, yet one that meets the needs of this population. By doing so, the conductor is able to ensure continued musical growth and satisfaction.

Finally, modifications to the environment in which rehearsing and performing take place may provide immediate and rewarding results. Because vision impairment is a common problem for older adults, lighting is an important consideration. Using brighter light that is more evenly distributed and avoiding surfaces and lighting that cause glare can be especially helpful. It is also important to check the lighting in hallways, stairways, and parking lots. Making access to the rehearsal hall as safe and comfortable as possible will encourage singers to continue to participate even if their eyesight is not as good as it used to be. Modifications to music scores can also aid older singers. Using scores with large print, resizing original music using notation software, or having magnifiers available can assist singers with failing eyesight. In addition, crisp and clear copies of music scores are important. Dark letters on flat white backgrounds are easiest to read when eyesight is a problem. It is best to avoid tinted paper and coloured fonts.

Changes to the environment can also help those singers who are experiencing hearing loss. Choral conductors working with older singers may want to reduce noise and reverberation in the rehearsal area. Using carpet, keeping windows shut to block out street noise, and limiting the use of fans can reduce background noise and help older singers successfully participate in music rehearsals. Choral conductors may want to consider using seating charts to help place singers with hearing and/or visual problems in optimal locations.

Consideration should also be given to planning rehearsal time in the actual concert space. This is particularly true if the performance is to be held at a new location. Older singers may need more time to adjust to the new setting. Difficulties adapting to the brightness and glare from concert lighting, getting on and off risers, and fine tuning hearing aids to the new space may be alleviated with extra rehearsal time in the actual performance space. If singers are more comfortable with the physical environs in which they will sing, they will be better able to

concentrate on the musical tasks at hand. By making singers feel as safe and comfortable as possible, choral conductors can go a long way in assuring music participation for a lifetime.

Conclusion

The research presented in this paper provides information on the physiological changes associated with aging; however, it is not conclusive. Further research addressing the question of how aging affects singing is needed. Specifically, studies that investigate the following would be beneficial: 1) the effects of exercise on the pulmonary system; 2) the effects of hearing impairment on vocal production, especially with regard to pitch and loudness factors; 3) the efficacy of short and long term voice building programs on the vocal production of older singers; and 4) the effect of accommodations to the environment on satisfaction and retention of older singers in choral ensembles. If we truly believe singing is for a lifetime, then we have a responsibility to learn about the effects of aging. With a more complete understanding of the unique needs of this population, choral conductors will be able to incorporate pedagogical techniques that encourage healthy singing into rehearsals, and create an environment that nurtures the talents of the older singer.

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