Title
The Effects of Singing in Speech in Geriatric Voice

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My research involves looking at the effects of singing on speech in geriatric voice. Over the course of 8 weeks during the summer I worked with a group of senior citizens at the South Berkeley Senior Center. I held two singing classes a week for 8 weeks and worked with approx. 18 seniors between the ages of 65 and 90; 17 females and 3 males, none of whom had had any voice training or singing experience and all reported no history of any voice or respiratory problems.

My personal interest in this particular topic is in part because I am a professional singer and have worked as a vocal coach for over 15 years. During that time I have perceived changes in the speaking voices of my students. I'm interested in how singing improves speech in every respect, but in particular how it can help improve speech in the elderly population, and even how it might be possible to repair speech function through neuro-linguistic programming, assisting with Alzheimer's and other degenerative diseases that impact speech.

Scientifically, it has been noted that the voice undergoes many changes with age, most of which occur more intensely after 65 years of age in men and after menopause in women. Changes include reduction in volume and pitch, voice breaks, increased breathiness, vocal strain and hoarseness and overall, the aging human tends to see a decline in vocal function. This theory has been tested by Mendes et al., Tay, Phyland & Oates and Barrichero et al., but has yet to be scientifically proven. Considering that the population of the United States is facing the largest volume of retirees in history: 83.7 million by 2050 compared with 43.1 million in 2012, it is my belief that singing may be pivotal for improving and maintaining language function for the elderly. Academically, I would like to build on the existing research to discover more specifically what scientific factors of speech can be improved through singing.

Most of the studies I have read thus far do not describe the methodology of the singing training in substantial detail. My methods had a strong emphasis on thoracic breathing, stretching or opening the vocal tract (explain) through sustained note exercises on different vowel sounds holding the tongue out or with the jaw moving side to side, along with articulation exercises involving tongue twister and breathing exercises. In terms of the experiment, my methods were similar to many previous studies in that I conducted a pre and post-test recording before and after the singing lessons. The participants read passages and sustained vowels in the recordings; a, i and u to an assigned pitch *(the pitches were A3 (220Hz), C4 (262Hz) & E4 (330Hz))*, and lastly I measured each subject's strength of exhalation using a Peak Flow Meter. Out of the group, a total of 13 females and 3 males were able to complete the post-test, I'll be reporting my findings so far for the female population of the study. By the end of the 8 weeks almost every participant had extended pitch range, less tension in their jaw and tongue muscles and better breath control. Some had better pitch accuracy, most but not all.

At this early stage of my data analysis, I have the following things to share based on 13 females who completed the post-test. The PFM pre-test readings were, mean = 320

L/min with a variable of 250 L/min to 350 L/min. The post-test readings were, mean = 355L/min with a variable of 290 L/min to 390 L/min. This result has a p value of $p < 0.01$. To offer an understandable comparison to this, the standard for a healthy female of 70 years old at 150cm tall is 360L/min.

The f0 of [a], [i] and [u] from the pre-test are as follows; [a] mean = 205Hz with a variable of 165Hz to 215Hz, [i] mean= 255Hz with a variable of 235Hz to 257Hz and [u] mean = 305Hz with a variable of 315Hz to 325Hz. The results from the post-test are as follows; [a] mean = 210Hz with a variable of 208Hz to 212Hz, [i] mean= 260Hz with a variable of 255Hz to 265Hz and [u] mean = 330Hz with a variable of 320Hz to 330Hz.

The duration of [a], [i] and [u] from the pre-test are as follows; [a] mean = 4.3 seconds with a variable of 2.2 seconds to 7.8 seconds, [i] mean= 4.5 seconds with a variable of 3.8 seconds to 8.8 seconds and [u] mean = 4.5 seconds with a variable of 3 seconds to 8.5 seconds. The results from the post-test are as follows; [a] mean = 7.8 seconds with a variable of 6.5 seconds to 9.8 seconds, [i] mean= 9.8 seconds with a variable of 6.5 seconds to 11.5 seconds and [u] mean = 8.5 seconds with a variable of 6.5 seconds to 11 seconds.

To speak of long term benefits in working with the retirees, I see potential for the development of speech therapies through singing. I feel quite strongly that the results thus far show positive findings for strengthened exhalation and fine grained motor control of speech. I also see a thread between my intended research and cognitive processes of aging and fine motor control in the adaptation to physical changes of one's body. Hopefully, through this research I may be able to get started on some of the fundamental details that can assist in paving the way not just for improving speech, but for repairing speech as well. I should also add, that the emotional reaction to this study was overwhelming. Subjects regularly reported feelings of happiness and elation, tears were shed by at least one person at each class, and subjects undergoing chemo reported not feeling any pain during the singing class.

From here I intend to look at the pre and post-test files more thoroughly. Do speech analysis of the readings, look at breathing regulation & speed of speech, natural f0 of the readings (because they were not to an assigned pitch), vowel quality, hoarseness, creak, other formants and shimmer, amplitude perturbation (which measures variability in intensity from pulse to pulse within a sound wave) and jitter, frequency perturbation (which measures variability in periodicity) which both basically provide a way to detect hoarseness, breathiness and consistency.

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