The Effects of Auditory Feedback on Singing

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Introduction

Children learning to speak, initially distinguish and produce speech sounds regardless of the sound environment around them; however, by 6 months they quickly begin to recognize the sounds in their home environment, and of their native language. By 9 months they are aware of the language stress, and rhythms, and by 12 months will no longer recognize speech sound outside of their native language. Furthermore, studies conducted on avian vocal learning, often analogous to human vocal learning, show that birds will learn the sounds of their environment, meaning their birdsong will mimic the sounds they hear, and not necessarily be the song of their parents. (Doupe & Kuhl, 1999, Brainard & Doupe, 2000, and Sakata & Brainard, 2006) Investigations involving deaf children show that even though they are given extensive therapy, they will not develop normal speech sounds. Even preadolescents and adults who loose their hearing later develop speech abnormalities; however, adults are more successful at continuing to speak normally. (Houde & Jordan, 2002) (Doupe & Kuhl, 1999 and Ward & Burns, 1978).

Houde and Jordan suggest that although auditory feedback plays less of a role in adults than in children, changing the feedback will result in a change in articulation. They had 8 male subjects perform a vocal task, for example speaking [ɛ], where they altered the vowel formant frequencies to provide feedback consistent with a different vowel [i]. They observed that the subject would alter their articulation of the intended vowel to [æ] , so the feedback produced the target sound of [ɛ].

All of this suggests that humans learn speech via auditory feedback, and are influenced by their sound environment, and that auditory feedback is necessary for learning and maintaining speech. Since singing can be considered a form of exaggerated speech, can the sung tone be affected by changes to auditory feedback?

Alfred Tomatis, a French ENT, believed that it could. Based on self reported anecdotes of altering feedback, Tomatis theorized that the voice cannot make a sound that the ear cannot hear. This has previously been shown to be the case. The result was that Tomatis put forth the concept of an auditory feedback loop.

The vagus nerve, he suggested, which is the major nerve that runs from the brain to the heart, lungs, and diaphragm, was the main circuit of the feedback loop. The reason being that the auditory nerve, superior laryngeal nerve, and the recurrent laryngeal nerve all branch off of the vagus nerve, in effect creating the feedback loop from the ear to the larynx to the breath. Therefore, if one can make a change to someone's auditory feedback, one should be able to change how one sings.

Discussion and Conclusion

There are definite changes to Pitch, Intensity, Formant data, and Vocal Fold Vibration with differing auditory feedback conditions. Pitch appears to be most improved under the HP and M, and most troublesome during L and SF with a tendency to be more sharp and flat, respectively, possibly indicating the importance of those frequencies areas for securing Pitch. Intensity drops overall with the Low Protocol seeing the largest rise. Formant frequencies tend to mimic each other with F1 decrease in all protocols except L. F2 increases during L, but decreases consistently during M, H, and SF, supposedly due to the high presence of that area in the protocols. F3 (area of the Singer's Formant) seems impacted most by L, perhaps due to the lack of feedback the subject were altering the formant to better hear it. In the higher protocols it shows no consistent affect, as well as F4. When examining the formants v. HP feedback, the M protocol showed the most inconsistency in F1 and F2, and therefore most affecting the vowel. F3, the Singer's formant was most accurate for all subjects (2.8 kHz) during the L protocol, again suggesting that the absence of feedback in the area of that formant caused those with low F3 to raise it. Formant Bandwidths show interesting changes. B2 widens under all protocols with SF having the widest. B1 narrows with the narrowest being with SF, B4 widens throughout, with the least during H. Overall, CQ values increased for all protocols, with the H having the greatest increase. The largest average change occurred during the M and H protocols, and H and SF brought about the most overall changed, positive or negative, suggesting that feedback in those areas disrupts phonation patterns more than the others. When comparing CQ to the base of the HP protocol, the L protocol had the most impact on phonation, where the others, M, H, and SF were very stable.

Finally, changes in auditory feedback do affect the sung tone. Acoustically, it appears that areas that are amplified tend to cause the non-amplified areas to "improve", meaning the lack of the target sound prompts the singer to more specifically produce the target sound. This would make the acquisition of the target sound is a crucial importance to singers and teachers. Future study should include an investigation of target sounds and varying feedback conditions, as well as the impact of attentional listening exercises on the sung tone.

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