How Do Laryngeal and Respiratory Functions Contribute to Differentiate Actors/Actresses and Untrained Voices?

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Summary: Purpose. The present study aimed to compare actors/actresses's voices and vocally trained subjects through aerodynamic and electroglottographic (EGG) analyses. We hypothesized that glottal and breathing functions would reflect technical and physiological differences between vocally trained and untrained subjects.

Methods. Forty participants with normal voices participated in this study (20 professional theater actors and 20 untrained participants). In each group, 10 male and 10 female subjects were assessed. All participants underwent aerodynamic and EGG assessment of voice. From the Phonatory Aerodynamic System, three protocols were used: comfortable sustained phonation with EGG, voice efficiency with EGG, and running speech. Contact quotient was calculated from EGG. All phonatory tasks were produced at three different loudness levels. Mean sound pressure level and fundamental frequency were also assessed. Univariate, multivariate, and correlation statistical analyses were performed.

Results. Main differences between vocally trained and untrained participants were found in the following variables: mean sound pressure level, phonatory airflow, subglottic pressure, inspiratory airflow duration, inspiratory airflow, and inspiratory volume. These variables were greater for trained participants. Mean pitch was found to be lower for trained voices.

Conclusions. The glottal source seemed to have a weak contribution when differentiating the training status in speaking voice. More prominent changes between vocally trained and untrained participants are demonstrated in respiratory-related variables. These findings may be related to better management of breathing function (better breath support).

Key Words: Actors–Actresses–Voice training–Glottal airflow–Subglottic pressure–Contact quotient.

INTRODUCTION

Since the 1980s, research regarding the actor's voice has intensified. Most studies on the actor's voice focused on acoustic and auditory-perceptual analysis of the voice. One of the most common acoustic tools used to study actors' voices has been the long-term average spectrum (LTAS), which is extensively used to assess the so-called actor's formant (AF). The AF is defined as a spectral peak around 3.5 kHz, which is considered a differentiating feature of good voice quality.[1] Leino[1] reported that poor voice quality is different from good voice quality by the steepest spectral slope and suggests that the spectral slope declination has perceptual relevance in the evaluation of voice quality. A gentle spectral slope and a prominent peak at 3 and 4 kHz appear to be the main features, which characterize a good speaking voice.[1–9] The AF has been found in some American and European actors to display a spectral prominence of approximately 3.5 Hz.[1,6–8] Brazilian actors have demonstrated similar results. Master et al aimed to compare actors' and non-actors' voices, the actor's voice showed a smaller difference between low and high harmonics of the spectrum (less spectral tilt), stronger energy level of the AF range, and a higher degree of perceived projection.[9]

The AF is explained physiologically as a resonance phenomenon. Nolan [10] suggested that the AF is accomplished in the same way as the singer's formant according to Sundberg.[11] When the cross-sectional area in the pharynx is at least six times wider than the laryngeal tube opening, the epilarynx acts as an independent resonator. Therefore, an extra formant is added to the vocal tract transfer function (the singer's formant). According to Sundberg,[11] the lowering of the larynx, typical in male classical singing, may explain the ratio between the cross-sectional area of the low pharynx and epilaryngeal tube opening. However, a low vertical laryngeal position is not necessarily desirable in the actor's voice technique. To this regard, earlier studies have demonstrated the presence of a spectral prominence in speaking voice samples to be around 3500 Hz without lowering the larynx. In a magnetic resonance imaging (MRI) and acoustic study, Laukkanen et al[12] found that after vocal exercises using artificial lengthening of the vocal tract in a female subject with a background in speaking voice training, the ratio of the transversal area of the lower pharynx over that of the epilarynx increased. Moreover, acoustic changes showed more energy in the speaker's formant cluster region. Additionally, the distances between the formant frequencies of F3 and F4 and between F4 and F5 decreased. Similar MRI and acoustic findings were observed in another study designed to identify acoustic changes in voice production after a warm-up of two professional voice users.[13] Furthermore, in a study designed to investigate the origin of the speaker's

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formant, authors found that after voice exercises performed by a professional male actor, the strong spectral peak at 3.5 kHz was present in all vowels and formed by the clustering of F4 and F5. The results of computer modeling from the same investigation suggested that a speaker's formant could be obtained with slight narrowing of the epilaryngeal region, widening of oral pharynx, and narrowing of the front part of it.[8] The underlying nature of the AF is still not completely understood, and it is the subject of several speculations.

Regarding auditory perception of voice, most studies carried out with actors have focused on the perception of voice projection. Actors are often required to vocalize with an increased loudness under suboptimal acoustic conditions inherent in most theaters. To accomplish an increased loudness without producing vocal damage, actors are required to learn how to maximize loudness through technical and expressive exercises. Furthermore, the term "vocal projection" does not necessarily have a specific and clear definition, and it usually creates confusion about the exact meaning.[14–20]

Although the term vocal projection seems to be subjective and inaccurate, a previous study determined acoustic and perceptual differences between comfortably projected voices and voices with maximum projection in a group of professional actors.[5] Results showed that spectral energy differences between stronger and weaker regions of specific harmonic frequency ranges (alpha ratio) decreased, and the perception of projection increased with as sound pressure level increased. The authors concluded that LTAS can be a useful tool to evaluate voice quality. Based on this finding, it is possible that the AF would be helpful in producing effective vocal projection during acting. This is essential for performers, making it possible for their voices to be heard with maximum intelligibility by listeners using minimum vocal effort. Additionally, Bele[21,22] conducted a study to develop a valid method for the evaluation of normal-to-good voice quality. This study investigated both normal and supranormal (resonant voice quality) voices in two groups of professional voice users: teachers and actors.

Electroglottgraphy (EGG) has been also used in earlier studies to differentiate vocally trained and untrained voices. Master et al[23] conducted a study aimed to investigate the contribution of the vocal folds to the projected voice, comparing actresses and nonactresses' voices in different levels of intensity. Findings showed no significant differences between groups for EGG quotients. Another study designed to evaluate vocal economy in actresses and nonactresses using an electroglottogram-based voice economy parameter (quasi-output cost ratio) were recently performed. Authors reported no significant differences between groups.[24]

Because theater actors spend several years training their voices, it would be expected that they would have other measurable differences compared with untrained subjects other than the AF. To the best of our knowledge, no previous research has used aerodynamic measures as possible markers to differentiate trained from untrained speaking voices. The present study aimed to compare actors/actresses's voices and nonactor/actresses's voices through aerodynamic and EGG used simultaneously. We hypothesized that glottal and breathing functions should reflect technical and physiological differences between vocally trained and untrained subjects.

METHODS

Participants

A total number of 40 participants were included in this study (20 theater actors and 20 nonactors). The average age of the subject set was 32 years, with a range of 27–47 years of age. In each group, 10 male and 10 female subjects were included. Inclusion criteria for actors and actresses included the following: (1) to be aged between 25 and 50 years, (2) more than 5 years of theater acting experience, (3) at least 3 years of formal vocal training, and (4) no current or past history of a voice disorder based on participant reporting. Inclusion criteria for nonactors and nonactresses included the following: (1) the same age range as trained participants, (2) no current or past history of a voice disorders, (3) no professional use of voice, and (4) no previous voice training or voice therapy. All subjects were asked to attend a single recording lasting about 1 hour. The session obtained audio recordings, aerodynamic, and EGG assessment of voice for both groups.

The present study was conducted with approval from the Institutional Review Board at University of Chile. The nature of the study was explained to each participant before they signed an informed consent.

Equipment

Data were collected in the Voice Research Laboratory at University of Chile. Acoustic, aerodynamic, and EGG signals were captured simultaneously during all phonatory tasks. Aerodynamic data were collected with a Phonatory Aerodynamic System (PAS), KayPENTAX, model 4500 (KayPENTAX, Lincoln Park, NJ). EGG data were obtained with an Electroglottograph, model 6103 (KayPENTAX). Both aerodynamic and EGG systems were connected to a Computerized Speech Lab, Model 4500, which in turn was connected to a desktop computer running a real-time aerodynamic and EGG analysis software, model 6600, version 3.4 (KayPENTAX). To obtain sound pressure level (SPL) and fundamental frequency, acoustic output was measured at a constant microphone-to-mouth distance of 20 cm using a condenser microphone AKG (AKG acoustics, Vienna, Austria) integrated into the PAS. Samples were recorded digitally at a sampling rate of 22 KHz with 16 bits per sample quantization. Acoustic signal was calibrated using a sustained vowel [a:] produced by one of the investigators. The sound level of this reference sound was measured with a sound level meter (Brüel & Kjær, model 2250; Brüel & Kjær Sound & Vibration Measurement, Nærum, Denmark); also positioned 20 cm from the mouth.

At the beginning of the examination, participants were asked to comfortably sit upright in a chair. After this, two surface electrodes were attached over the thyroid cartilage by means of a lightweight elastic band. The electrodes were attached with a Velcro strip, which was comfortably wrapped around the participant's neck as tightly as possible to prevent any movement of electrodes throughout the data collection. Readjustments of the