PARALLELS BETWEEN SINGING AND PHONETIC TERMINOLOGY

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1.0 Introduction

The interdisciplinary study of the human voice involves differing and often inconsistent terminology. Researchers from a variety of backgrounds—medicine, psychology, speech science, articulatory phonetics, theatre , music, and engineering acoustics—use a range of terms which often describe similar phonetic events, sounds and postures. The purpose of this paper is to highlight some of the terms common to the North American schools of singing and describe them using the auditory labels commonly used in the British school of phonetics.

2.0 Registers and registration

The most basic terms in singing deal with registers and registration: chest voice, head voice, falsetto, and flageolet. Ingo Titze, a voice scientist from University of Iowa, describes ***registers*** as "perceptually distinct regions of vocal quality as pitch or loudness is changed" (1994:335). In the world of singing, if a voice quality, such as chest voice, occurs for a certain pitch range, then this would be called the ***chest register***. Some singing pedagogues believe there is only one blended register, neither chest or head. Others believe in two or more. Many have elaborate charts with registration events and registers noted for each fach[1]. Pedagogues who teach registers believe that in order for singers to ascend in pitch they must change register. Most singing pedagogues describes the process of "gradual register transition" (Miller 1986) as vocal ***registration***. Titze (1994) states that there are two theories about registration. The first involves the coordination between the cricothyroid muscles and the thyroarytenoid muscles. For example, singers gradually relax the thyroarytenoid (TA) muscles as the cricothyroid muscles (CT) gradually increase activation. The thyroid cartilage tilts forward, stretching the vocal folds, thereby increasing tension, for a smooth ascent of pitch.

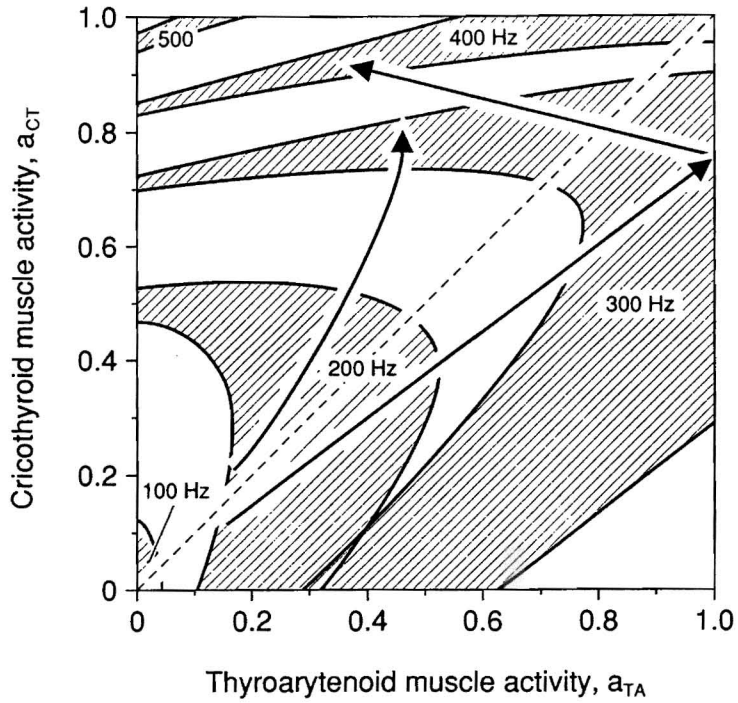


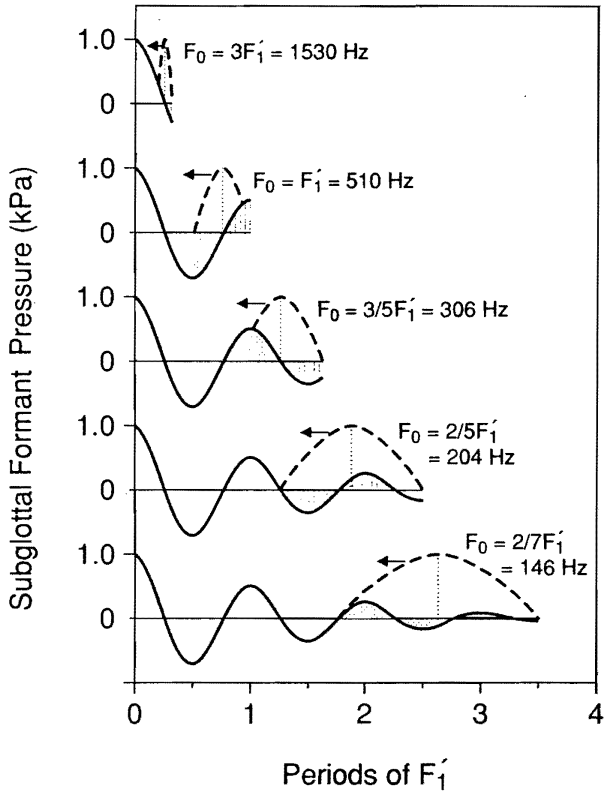
Figure 1 shows a graph that plots the activation of the cricothyroid against the thyroarytenoid muscles.

FIGURE 1.

A muscle activation plot (MAP), showing abrupt register transition in the two straight arrows and gradual transition in the curved arrow. (The hatched areas represent bands of constant F_0. From Titze 1994:270.)

[1] A standard term used to designate vocal category according to voice type, and also body and personality characteristics (Ware 1998:278).

The shaded sections of Figure 1 show a wide variety of combinations of muscular activation that can produce the same pitch. The straight arrows show that when the TA muscles reach a point where they can no longer withstand the tension applied by the CT muscles, the TA muscles release all of a sudden to produce the appropriate pitch. This would be perceived as a *registration event* or *yodel.* The yodel is not encouraged in classical singing; however, in folk and popular singing, it is often a prized technique.



The second theory involves the subglottal acoustic waves that set up an interference pattern with the glottal wave (Austin 1992; Titze 1983, 1988; Van den Berg 1960). "Acoustic pressures below the vocal folds can be phased in such a way that they contribute, constructively or destructively, to the intraglottal driving pressures of the vocal folds" (Titze 1994:263).

Such places of acoustic interference may correspond to what singers call *passagi, register breaks* or *registration events.*

FIGURE 2.

Phase relationships between the pressure waveform of the first subglottal formant (F_1', solid lines) and the glottal area waveform (dashed lines) for the periodically increasing fundamental frequency, F_0. (From Titze 1994:266.)[2]

3.0 Voice quality and phonation type

Registers are not commonly discussed in acoustic phonetics. However, the voice qualities associated with these registers are referred to extensively. The labels are different than in singing, but the qualities described are similar.

3.1 Modal voice and 'chest'

In the British school of phonetics, Laver refers to a voice quality and phonation type called ***modal voice.*** He describes modal voice as the "neutral mode of phonation having moderate adductive tension and moderate medial compression, with moderate longitudinal tension" (1980:111). He states that this phonation type "essentially corresponds to chest voice" (1980:110), but he says that it could be differentiated into two sub-types *chest voice* and *head voice.* Miller (1986) refers to a similar voice quality as chest voice (*voce di petto*). He says that in women, it "is characterized by a certain masculinity, because its execution is similar to the production of the male chest voice: heavy action from the thyroarytenoid muscles; wider amplitude of vibration; thicker and shorter folds." However, he does not quote his source. He mentions that sympathetic resonant vibrations are felt in the chest and body, especially in the trachea and bronchi and the larger bones of the rib cage. The term ***chest voice*** also refers to a phonation type in singing, which is characterized by a thick vocal fold with a vibratory pattern that involves first contact of the lower edges of the fold alternating with contact of the upper edges of the fold as seen in Figure 3.

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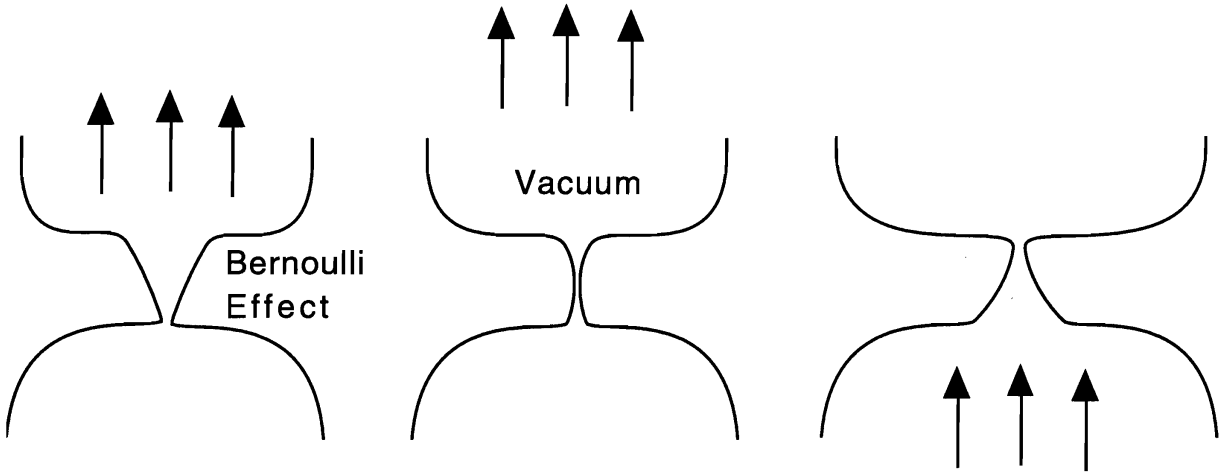
[2] Figures 1 and 2 are equivalent to Figures 10.11 and 10.9 in Titze 1994:270,266, respectfully. Dr. Titze has kindly granted the author permission to reproduce them for this paper.



Air pressure drops as air moves through the constriction of the vocal folds (Bernoulli effect). This causes vocal folds to begin to close.

Air flow is stopped at the folds but air column above the folds continues to move. This creates a suction that closes the folds the rest of the way.

Air pressure increases below the vocal folds pushing them apart. The cycle repeats.

FIGURE 3. Modal vocal fold vibratory patterns.

This vibratory pattern produces a complex glottal wave in the mucosal layer of the vocal fold. Titze (1994:261) describes this phonation type as follows: "[I]t is suspected that the bottom of the vocal fold is adducted more in modal register than in falsetto .... The thyroarytenoid (TA) muscle ... bulges the vocal fold medially below the level of the vocal processes. This creates a thicker and deeper vibrating structure. ... [T]he entire cover (including the ligament) is lax, and the TA muscle is used to regulate the effective tension of the vocal fold." Often the vocal fold adjustment is referred to as ***modal***.

Already, the term ***chest*** has been used to describe a register (chest register), a voice quality (chest voice), a phonation type (chest voice) and a vocal fold adjustment (chest); this term may relate closely to the term ***modal*** such as in Laver's voice quality (modal voice) and phonation type (modal), as well as Titze's vocal fold adjustment (modal).

3.2 Falsetto

In phonetics, there are two voice qualities that arise from the vocal fold thickness and subsequent mode of vibration: modal voice and ***falsetto*** (Laver 1980). In singing, students are encouraged to thin the vocal folds gradually over the pitch range. This may involve an infinite continuum of vocal fold thicknesses, controlled by the gradual activation of the CT muscles, along with a gradual relaxation of the TA muscles. At some given point along this continuum, the body of the vocal fold stops vibrating and only the ligament vibrates (Laver 1980, Titze 1994). However, the nature of the vocal folds' changing shape is still under investigation. Titze is currently investigating vocal fold movement using computer modelling techniques. The phonetic auditory label for the voice quality produced when only the ligament is vibrating is falsetto. Laver (1980:118) states that the vertical cross-section of the edges becomes thin and the glottis remains slightly apart. The vocalis muscle is relaxed and only the thin margins of the vocal folds participate in phonatory vibration. In singing, the term falsetto is reserved for describing the top register of a male voice. Vennard (1967) observed two possible mechanisms for producing it. The first method was similar to the phonetic definition. The second involved partially damping the vocal folds, thereby increasing the compression of the arytenoid cartilages and utilizing only the anterior part of the fold for vibration. Male singers who make a career of singing in falsetto belong to a voice type called ***countertenor***. Vennard's observations have, to date, never been substatiated by other researchers, so it is still unclear which mechanism is most commonly employed by professional countertenors. The closest female counterpart to falsetto in the singing terminology is the voice quality produced in the ***whistle*** or ***flageolet*** register which Vennard

describes as employing the same damping mechanism as for the male singer using falsetto. However, if the physiological description for the phonetic term falsetto is used for singing, then at some point the female singer may also use only the ligament for vibration. This practice may correspond to female ***head voice*** (***voce di testo***) above the ***secondo passaggio*** (register change). Would this pure head voice then be falsetto in phonetic terms? Not according to Richard Miller, who says that "the term falsetto should be reserved to designate the imitation of female vocal quality by the male voice" (Miller 1986:133).

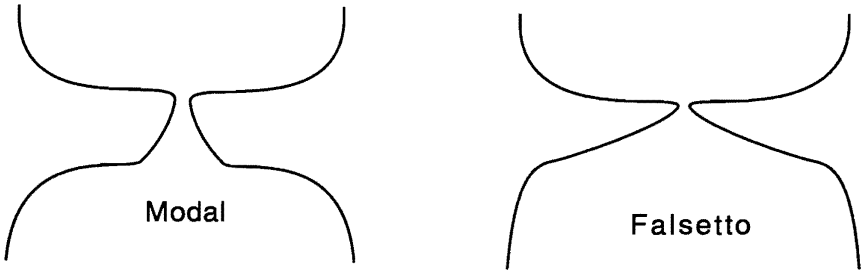


FIGURE 4. Modal voice and falsetto.

3.3 Mixed registration

Miller (1986) indicates that the range of chest voice (voce di petto) for a soprano is G_3–E*flat*$_4$ and that the range of head voice (voce di testo) is G_5–C_6, leaving over one octave without a designation. Singers negotiate this area using a ***mixed registration***. In voice science, this has been labelled ***middle*** or ***mixed voice*** (Titze 1994), or in singing, ***voce mista*** (Miller 1986). Titze indicates that this mixed voice could be called head voice, which could explain why Laver describes modal voice as chest or head—he may be including voce mista. Miller, on the other hand, represents the vocal fold variations within this register with the terms ***chest mix*** and ***head mix.*** These terms denote the relative thickness of the vocal folds and the corresponding sensations in the body. Chest mix would indicate relatively thick vocal folds and sympathetic vibrations felt in the chest. Head mix would indicate relatively thin vocal folds with sympathetic vibrations felt in the head. To complicate matters, singing teachers sometimes use qualifiers. For example, a teacher might say, "She sang that note in ***open chest.***" This usage would correspond to Laver's modal voice. The teacher might then say, "Try not to use such a ***heavy mechanism***." This instruction would direct the student to thin the vocal folds. Would this correspond to Laver's sub-type modal voice II (head voice)?

In order to correspond directly to Miller's labels, Laver's sub-types would require sub-subtypes: modal voice (open chest), modal voice IIa (chest mix), and modal voice IIb (head mix). These auditory qualities are distinguishable, and have been used as descriptive terms by voice teachers over the centuries. However, many pitches can be sung with a variety of mixes which could not be captured even by expanding Laver's labelling scheme. Vennard offers three generalizations,

> one as to pitch, one as to intensity, and a third as to quality. First, to develop the widest possible range without a break, the adjustment must be heavy in the lower part of the voice, and the balance should shift smoothly toward the lighter production as the scale is ascended. Second, on any given pitch, the softer it is, the lighter must be the production without breathiness; and the louder, the heavier. Third, to produce "rich" timbre the adjustment should be heavy; to produce "sweet" timbre, it should be light. We have seen that the differences in timbre are differences in degrees of regularity and irregularity in the pattern of each vibration. (1967:77)

Perhaps Vennard uses *heavy* to describe the chest mix and *light* to describe the head mix. In Classical singing, a lighter mechanism is usually preferred, although heavier mixes are used by mature "dramatic" singers. Such variations would account for Titze's statement that mixed voice can also be called head voice, which in turn corresponds to Miller's term, head mix. In popular singing, the Broadway Belt style setting of Ethel Merman or Barbara Streisand would use a heavier mechanism than the corresponding Classical style setting for the same pitch. However, this does not mean that the singer will 'lock' the folds at one thickness. Many pedagogues believe that Belters gradually thin the vocal folds with ascending pitch, but not to the degree seen in Classical voice. More research is needed to confirm this theory. Estill *et al.* (1996) indicate that Belt voice uses modal adjustment, but

that Opera also uses modal adjustment. This may be because the opera quality described is the mature dramatic sound, and the lyric and lieder singer quality which uses a falsetto adjustment Estill *et al.* call Sob (1996:243).

3.4 Flageolet or whistle

The top register in the female voice is called the ***flageolet register***. Miller (1986) states that the flageolet voice has a high rate of longitudinal tension in the vocal ligaments, considerable damping of the posterior portion of the vocal folds, limited vibrating mass of the vocal folds, with high subglottic pressure and airflow rate. Miller, again, does not state his source. Flageolet register is used extensively by soubrette and coloratura voices. In female voices, the vocal folds may eventually stop vibrating as pitch increases, causing the tone created by either a chink between the arytenoid cartilages or a fine (approximately 1 mm) slit between the folds. This produces a whistle-like sound and the associated register is termed ***whistle register***. The voice qualities associated with these registers are ***flageolet*** or ***whistle***. There do not appear to be corresponding phonetic terms for these voice qualities; however, if falsetto can be proven to be either of two types, ***undamped falsetto*** or ***damped falsetto***, then the phonetic terminology may be brought into line with that used for singing. It is unclear how whistle quality would relate to phonetic terminology; Vennard even questions its use in singing. "[I]n rare cases true whistle does occur through an opening between the arytenoid cartilages (the mutational chink) but this is not very loud, and is not useful for singing. We may ignore it" (Vennard 1967:67). It is unclear which type of mechanism a pop singer such as Mariah Carey uses for her extreme upper register and how it relates to the operatic coloratura in her upper register. The mechanism may be damped falsetto, undamped falsetto or true whistle. More research is needed in this area.

3.5 Creak or fry

Thus far, only two of the four descriptive phonetic auditory labels for voice quality settings have been discussed: modal and falsetto. The two other simple phonation types are ***creak*** and ***whisper***. The term creak is never found in singing terminology; most often this phonation type is referred to as *fry*. Classical singing never utilizes this phonation type, considering it a pathology to be overcome in training the voice to coordinate the onset of phonation. However, in pop voice it is widely used as a means of artistic expression, especially as an onset effect at the beginning of a phrase. As with modal and falsetto, creak can be used in reference to registration or phonation. Creak register is also known as ***pulse register***. Titze (1994) describes pulse register as the perceptual result of subharmonic or chaotic patterns in the glottal waveform if the frequency of the wave is below about 70Hz. He calls it a register with perceived temporal gaps. Other terms for creak are ***glottal fry*** and ***vocal fry***. Creak phonation may also occur with modal voice, yielding ***creaky voice*** or, with falsetto, yielding ***creaky falsetto.*** Usually in pop songs the onset will start with creak, then move through creaky voice to modal voice or whispery voice, usually accompanied by a ***scoop***, where the voice starts with a glissando up to the appropriate pitch.

3.6 Whisper

The fourth simple phonation type is ***whisper***. Titze (1994) describes whisper as the sound created by turbulent glottal airflow in the absence of vocal fold vibration. Laver (1980:121) describes the glottal configuration as "a triangular opening of the cartilaginous glottis, comprising about a third of the full length of the glottis." Whisper may be combined with modal voice or falsetto to form ***whispery voice*** or ***whispery falsetto***. Whisper is rarely used in Classical singing; however, there are occasional occurrences in twentieth century art music. In the pop idiom, it is common to mix air into the sound to add another colour to the artist's palette. Pop singers refer to this as ***air mix*** (Popeil 1998). Whether this quality corresponds to whispery voice or to another phonetic auditory label, ***breathy voice***, depends on the supralaryngeal settings that accompany the sound. For example, in Country style the high laryngeal position and pharyngeal constriction produces a sound which corresponds more closely to ***whispery voice***. However, the Rhythm and Blues style involves a low laryngeal position and an expanded pharyngeal space, which produces a sound corresponding more closely to ***breathy voice***.

3.7 Harshness

In popular singing, many of the compound laryngeal settings are used. The sounds made by the singing voice are as diverse as those produced with by the speaking voice. They would not all be taught in a voice studio, however. For example, the phonation type ***harsh voice*** is considered a pathology in all singing styles. Harsh voice is described by Laver (1980:127) as phonation with aperiodic vibration. The acoustic characteristics of harsh voice include irregularity of the glottal wave-form (jitter) and spectral noise. Titze (1994) attributes these features to a constricted glottis and insufficient air flow, resulting in "a ghastly sound" (Titze 1995). In some styles, such as Heavy Metal, a rough, rasping sound may be desirable. But generally the voice teacher's job is to improve the

quality of a voice. Most voice teachers would prefer to have singing students use signal processing to degenerate the sound quality rather than practice ways of producing harsh voice. It is, however, useful for a singing teacher to be able to identify this auditory quality and prescribe ways to help encourage periodic vibration without any excessive medial compression of the vocal folds. Perhaps for this reason, the term should be included in the singing terminology; singing pedagogues generally use the term ***pressing*** to describe excessive medial compression that results in a harsh timbre.

4.0 Conclusion

This paper has discussed some of the similarities and differences between singing and phonetic terminology, focussing on the four descriptive auditory labels of *model, falsetto, creak* and *whisper* as well as a few compound labels, such as *harsh voice, breathy voice* and *whispery voice*. Readers familiar with Laver's phonetic auditory labels will realize that there are many more labels with possible correlates in singing terminology. Perhaps a universal terminology would be helpful to those who study the human voice in its many capacities; such terminology may serve to reduce the confusion in an already challenging interdisciplinary subject area.

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