

**VOCAL MECHANICS  
AND  
THE CULTIVATION OF LISTENING SKILLS  
by  
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Throughout the greater part of the twentieth century to the immediate present, considerable attention has been directed toward the importance of laryngeal mechanics and acoustics to technical training. Nevertheless, few suggestions have been made to explain how this body of knowledge is to serve a practical pedagogic purpose. Especially notable, because of its absence, is advice directed toward the development of listening skills as these relate to basic vocal mechanics.

Before entering into a discussion of the processes essential to the development of listening skills, it must be noted that, with rare exceptions, those evaluating the singing voice listen aesthetically. For teachers of singing, however, the issue extends well beyond aesthetic judgment. For them, listening skills must include recognition of the influence of impedances, such as a psychological predisposition to prefer certain types of tonal quality to the exclusion of others, and/or preferences based on time, place, taste, fashion and culture.

Cultural attitudes, in particular, have been directly influenced by periods of history, among them the agrarian, manufacturing and the present electronic age, each directly affecting the aesthetics of the listening experience. From this, it naturally follows that from one period of history to another, singing styles change, and with them, the introduction of tonal concepts, practices and terminologies reflecting the dynamics and attitudes identifiable with a particular time and place.

With respect to the agrarian age, vocal skills were cultivated and developed within the framework of an organic logic. This connection is evident from Giambattista Mancini's comment (1774) that runs as follows:

Art consists in knowing where nature directs us, and to what we have been destined; understanding at once the gifts of nature, cultivating them easily, man can perfect himself; how sure is harvest for the attentive farmer, who has observed and understood the different seeds, which are fecund in diverse types of earth.<sup>1</sup>

Moving into the manufacturing era, the voice came to be looked upon as something to be produced. In contrast to the theories and practices in vogue during Mancini's lifetime, Manuel Garcia's definition of a register (1894) coincided with the dawn of the manufacturing age, where references to the voice as being produced gained ready acceptance. According to his understanding of vocal training and its mechanical basis, he believed a register to be:

. . . a series of consecutive homogeneous sounds produced by one mechanism, differing essentially from another series of sounds equally homogeneous produced by another mechanism. . .<sup>2</sup>

By the mid years of the twentieth century, training objectives and aesthetic goals increasingly fell under the influence of what might be termed the electronic age. Gradually, listening perceptions became conditioned, first by qualities associated with hi-firecordings, subsequently because of the influence of digital sounds produced by CDs, iPods and other sophisticated modes of transmission.

As a consequence of listening to digitally altered voices, leaning toward a preference for high levels of intensity, contemporary aesthetic taste has become increasingly conditioned to prefer excessively bright tone qualities, without regard for their negative effect on either the physical well-being of the vocal musculature or the subtleties of musical expression. To reverse this listening trend, those concerned with maintaining the integrity of natural singing must adopt theories and practices consistent with the preservation of organic health.

There is but one satisfactory solution to problems related to the acquisition of a free and natural tonal emission - the development of listening skills wherein analyses and evaluations of tonal quality directly correspond to healthy and free organic movements within the laryngeal musculature; in other words, by learning to listen functionally.

Viewed from this perspective, functional listening may be defined as a way of analyzing singing tonal qualities by associating that which is heard with the probable adjustments made in connection within the physical and acoustic conditions operative at the sound source. Unless listening skills are directed away from aesthetic judgments based on a current fashion and made to center on the physical events responsible for their appearance, vocal problems are unlikely to be attacked at their source.

An immediate benefit derived from the acquisition of listening skills is the diversion of attention from merely listening to the voice, as opposed to learning what to listen for. In the final analysis, voice training is synonymous with ear training, where aesthetics, aesthetic judgments, vocal mechanics and acoustics share common ground. The ultimate goal of these collective responsibilities is the attainment of a free vocal technique.

## **CONVENTIONAL VS. FUNCTIONAL LISTENING**

When pedagogic viewpoints, extending from the twentieth century to the immediate present, are brought under consideration, it becomes evident that a wide gap in listening objectives exists between conventional and functional listening habits. Undoubtedly, certain elements of the listening experience are shared in common. Careless intonation, tonal unsteadiness of various types and descriptions, limitations of tonal range and poor breath management, are among those faults commonly agreed upon as being undesirable.

All of the technical limitations mentioned above are directly related to muscular imbalances originating at the sound source, each being a product of poor muscular coordination guided by equally poor concepts. Clearly, it is within this area of interactive events that functional listening plays a key role. Therefore, unless a training program is so constituted as to impinge favorably on the response capability of the laryngeal musculature, the possibility of correcting vocal faults at their point of origin is remote. The roadmap to this understanding leads to the discovery of what might be termed functional listening, where the quality heard is directly associated with its physical activities.

By definition, if growth into an understanding of vocal mechanics is to be achieved, all vocal study should be based on observations made (and conclusions reached) with respect to the relationship between cause and effect. Beyond question, unless a mechanical basis can be established upon which a practical pedagogic theory can be structured, the limitations imposed on the teaching and listening experience will continue to result in confused thinking and undesirable consequences. To avoid this confusion, the advice given by Polonius, in Shakespeare's Hamlet, is a council that should be taken seriously:

And now remains that we find out the cause of this effect, or rather say, the cause of this defect, for this effect defective, comes by cause.<sup>3</sup>

By contrast to this observation, conventional listening is generally directed toward the immediate attainment of a desired aesthetic, regardless of whether or not the quality associated with that aesthetic is freely produced. Throughout all stages of vocal training, technical freedom should be the direct object of study; not an immediate aesthetic goal. A beautiful tonal quality is the outcome of correct function, a quality that has never been heard by either student or teacher as long as technical flaws remain uncorrected.

To successfully launch an inquiry into the fundamentals connected to the development of listening skills, the search for answers must be found within the context of the terminologies familiar to those interested in vocal mechanics from the earliest times to the immediate present. There are only two such terms whose appearance is common to all generations of vocal pedagogues: falsetto and chest voice.

## HISTORIOLOGY OF THE LISTENING EXPERIENCE

As early as the fourteenth century, it was observed that the singing voice divided into two widely dissimilar tonal qualities: the *vox integra* or natural voice and the *vox ficta* or false voice. Recognition of this division offers a profound insight into the inner workings of the vocal mechanism and leads to an understanding of the significance of functional listening.

This mechanical knowledge, together with the importance of the blending process involving these two disparate tonal qualities, is highlighted in the following statement by Francesco Tosi (1723): “. . . if the union [of the chest voice and the falsetto] is not perfect, the voice will be of more registers, and consequently will lose its beauty.”<sup>4</sup>

Instruction as to how these two qualities were to be developed and unified did not appear until Vincenzo Manfredini (1797) offered this advice:

. . .it is necessary to unite these and those [notes in the head voice and notes in the chest voice] in such a way, that the voice seems to be of one register . . . This is done not by forcing the high notes of the chest, but rather by reinforcing the low notes of the falsetto; or doing the opposite, if the notes of the chest

are weak and deficient and those of the falsetto are abundant and strong.<sup>5</sup>

It was not until Manuel Garcia published his *Mémoire on the Human Voice*, which he presented to the French Academy of Sciences in November 1840, that it was definitively proven that the two vocal registers could be alternatively separated and/or combined; an event that implies the presence of a mechanical basis underlying the production of all singing tone qualities. Impressed by its scientific nature, a special committee formed for that purpose invited Garcia to demonstrate his theories. Proof of the success of Garcia's demonstration is contained in the committee's report. In their opinion:

That able professor of singing has trained some students to whom he has taught the art of maneuvering their vocal organs with enough facility to separate clearly and at will the sounds which derive from the full voice and those which derive from the falsetto voice.<sup>6</sup>

During the course of his demonstration, Garcia was able to establish that "the same compass belongs to the two registers" and that it is possible to "utter all the tones in the chest voice or in the falsetto voice at will."<sup>7</sup> However, it was not until the publication of Garcia's *Observations on the Human Voice* (1854) that the qualities associated with registers, or voices, were linked to their physiological origins. This connection is made clear in the following statement:

As the entire system of vibrations arises slowly from the inferior ligaments, it is evident that the cause of the different tones called registers, must be sought for in the muscles which set these ligaments in motion; and that the other parts of the larynx must be considered only as apparatus for strengthening the sounds obtained, and for modifying their quality.<sup>8</sup>

A more direct connection between singing tonal qualities and their physical origins was supplied by Douglas Stanley (1929). He associated the registers with specific muscle systems, the cricothyroids and the arytenoids, asserting that because physiologically only two systems are participating in adjusting glottal dimensions, there can only be two registers. His definition runs as follows:

There are two groups of muscles: the arytenoid and the cricothyroid groups, which act as tensors of the vocal cords. The preponderance of effect of one group over the other determines a register. There are, consequently, two and only two, registers in the human voice.<sup>9</sup>

Subsequently, Willem van den Berg (1967) referred to the mutual antagonism between the two systems acting as stretchers of the vocal folds in the creation of longitudinal tension. It was van den Berg's further contention that due to this antagonism, neither the chest register nor the falsetto is capable of functioning independently. Otherwise, there could not be a two way stretching action available to regulate glottal dimensions. Since this relationship is indisputable, the critical problem in technical training is to 'hear' the extent to which both the falsetto and the chest voice are operative throughout the singer's entire tonal range. This mutual antagonism holds true even though one or more disruptions or 'breaks' within the tonal flow may occur at different points throughout the voice.

In agreement with Stanley, van den Berg also recognized but two registers, one referred to as the chest voice, the other as falsetto. Moreover, van den Berg warned against considering the mixed, or mid-voice, to be a separate register with this admonishment, "Right here we should stress the point, however, that the mid voice is not a really 'independent' register, but a 'mixture' of chest and falsetto register."<sup>10</sup>

Ingo Titze (1994) also appears to have recognized but two muscle systems engaged in the adjustment of glottal dimensions. Noting the natural tendency of the laryngeal musculature to function antagonistically and create difficulties concerned with a smooth bridging of the *passaggio*, or 'break,' Titze explains the processes involved in terms of vocal mechanics as follows:

. . . an effective way to eliminate register breaks is to train the thyroarytenoid muscle to deactivate gradually, in coordination with increased cricothyroid (CT) activity. In their electromyographic investigations of laryngeal control, Hirano, Vennard, and Ohala (1970) showed that this was indeed the strategy employed by a well-trained singer. As the pitch was raised, TA activity decreased in relation to CT activity, and there was no abrupt release of TA activity. This differential

control of two intrinsic laryngeal muscles is one of the most difficult tasks in all of voice training.<sup>11</sup>

In this analysis, Titze offers a physiological accounting for what Manfredini had previously explained on a practical level. To gradually deactivate the thyroarytenoid muscle, the intensity level of the chest voice (as per Manfredini's instruction) must be reduced. At the same time, for cricothyroid activity to be increased, the low notes of the falsetto must be reinforced by a stronger admixture of chest voice qualities (again as per Manfredini's instruction) to form a head voice.

Indispensable to the success of this process is a refinement of listening skills. If these relationships cannot be heard and properly assessed, there can be little expectation of success in managing the difficulties encountered in bridging the *passaggio*.

Why is the unification process the most difficult task to be accomplished successfully? Because the constantly shifting degrees of muscular tension necessary to accommodate a variety of pitch, intensity and vowel patterns are impossible to either calibrate or act upon directly. Nevertheless, inducing the laryngeal musculature to respond in a positive, predictable manner can be achieved through the selection of a beneficial environment (a vocal exercise), coupled with a hearing sensitivity tuned to recognize the relationship between that environment and the special characteristics of the tonal product.

Unquestionably, the process of associating the physical and acoustic events operative at the sound source with their tonal equivalents, is not only the most difficult task in singing, but also fundamental to everything that transpires during the development of vocal skills.

To place technical training within a satisfactory context, it is necessary to possess at least a rudimentary knowledge of the muscular activities operative at the sound source. This knowledge, in turn, must correlate with theories and practices designed to create an environment wherein the laryngeal muscular systems can be induced to interact during phonation in conformity with their natural movement potential.

## **FUNCTIONAL LISTENING: ITS PHYSIOLOGICAL BASE**

With the primary goal of technical training identified, what remains to be defined are the roles played by those elements whose activity regulates glottal dimensions.

Physiologically, vocal fold tension during the production of singing tonal qualities occurs because two mutually antagonistic laryngeal muscle systems, the arytenoid and the cricothyroid, have been adapted to serve that purpose. When so used, arytenoid tension is capable of shortening, thickening, dampening, opening and/or occluding the vocal folds. To further complicate matters, this system is antagonistic within itself, one part opening the glottis during each respiratory cycle, while the other is responsible for closing it.

Over and against these complex adjustments, cricothyroid activity is simplistic. The sole obligation of this muscle system during phonation is to lengthen and thin the vocal folds to elevate the pitch or to slacken its tension to lower it. When functioning within a coordinate relationship with the arytenoids, this system becomes an active participant in the creation of the longitudinal tension essential to the regulation of glottal dimensions. The opposition supplied by these systems can either be proportionally or disproportionably balanced with respect to the regulation of vocal fold dimensions. Unquestionably, the level of precision with which these systems interact represents the single most important physical event determining the ease or difficulty of the tonal emission.

An influence of equal importance to the regulation of vocal fold activity is the suspensory muscular system. In its natural functioning, tension on this system serves to elevate and/or depress the larynx, as well as tilting it slightly forward, downwards and/or backwards. As a consequence of these adjustments, in their varying levels of engagement, each degree of elevation or depression exerts a direct influence on the precision with which the vocal folds are brought under tension.

Given these responsibilities, the suspensory muscles must not only function in a state of equilibrium within themselves to stabilize the larynx, but also with the tensors of the vocal folds, namely, the cricothyroids and the arytenoids. Should anything disturb the equilibrium within this intricate balance of tension, it would not only inadvertently affect the elevation and

depression of the larynx, but also negatively impact the tensors of the vocal folds and, by extension, glottal dimensions.

Once a correct balance of tension has been achieved, the singer will sense an ability to 'lean' on the voice, a term referred to within the Italian vocal tradition as the *appoggio* or *appoggiare*. The importance of the *appoggio* and its relationship to energy expenditure is immeasurable. Energy cannot be used effectively without resistance. Thus, the impression of being able to 'lean' on the vocal folds indicates that the total system is functioning in a state of equilibrium. The result is a self-supportive arrangement of the vocal mechanism, leading the singer to an awareness of efficient energy use.

### **FUNCTIONAL LISTENING: ITS ACOUSTIC BASE**

An area of equal importance to an understanding of functional mechanics centers on the shaping of the vocal tract to define and resonate a variety of vowel qualities. Once activities taking place at the sound source have been converted into the production of singing tonal qualities, the vibratory patterns moving through the vocal tract form into sound waves possessing a fundamental frequency and a series of overtones. As these impulses move upward, they cluster into frequency bands or formants, whose special arrangements make it possible to create and resonate a broad spectrum of vowel qualities.

As for the aesthetics of vowel qualities, they provide aural evidence indicating what is mechanically correct or incorrect, as well as suggesting the nature and origin of faulty vocal mechanics. Beyond question, all mechanical imperfections are revealed through a distortion of the vowel. Those qualities, often described as thick, thin, veiled, shrill, etc., supply audible evidence pointing to poor laryngeal muscular coordination.

Although the properties associated with quality analysis reside with information supplied by evidence contained through vowel analysis, an equally significant body of quality characteristics is revealed through an understanding of the tonal properties associated with resonance. There are three such areas: 1) sub-glottal or tracheal, 2) tonal energy concentrated within the laryngopharynx, and 3) resonance within the oropharyngeal cavity, or soft palate.

Acoustically, when adapted to serve phonative needs, the resonance potential of these cavities is not only capable of producing a great number of vowel qualities, but also vibratory impulses essential to a highly sophisticated vocalization. It is the adjustment potential of these cavities, acting in conjunction with the tensors of the vocal folds, that admits the possibility for optimizing the resonance potential of the throat parts with skill and precision.

Another important acoustic event resulting from a well-resonated tonal quality is the ability of the vocal tract to create those conditions necessary to ensure the appearance of a standing wave. This type of sound wave occurs whenever the vocal tract is adjusted so as to return the vibratory energies created at the sound source back toward their point of origin, where they then combine with the newly injected waves set in motion by the oscillatory pattern of the vocal folds. These two waves of vibratory motion move in opposite directions, criss-crossing to form into loops, or pulsatory movements of regular periodicity, whose amplitudes of vibration rise and fall with increases and decreases of intensity.

There are several acoustic by-products resulting because of the presence of a standing wave. One in particular is an awakening of resonance experienced within the trachea. Francesco Lamperti (1888) described this sensation when he spoke of a well-formed head voice as being felt both deep in the throat, as well as high in the head. Clearly, this sensory perception must have been connected to resonance within the trachea. In more recent times, this phenomenon has been referred to by Ingo Titze (1994) as subglottal resonance.

Another by-product of tracheal resonance has been described by the French scientist Raoul Husson (1950) as a condition where eighty percent of the tonal energy is concentrated at the vibratory source, the remaining twenty percent moving into the outer atmosphere. When these acoustic conditions are in place, the performer can be said to be 'singing on his interest rather than his capital.' In the Italian tradition, this sensory perception was referred to as *inalare la voce*, or a feeling of drinking in the tone, again resulting in symptoms of sound waves traveling backwards and returning to the sound source. Vibratory impulses possessing these quality characteristics enable tones of varying intensity levels to emerge with a minimal expenditure of energy.

Acoustically, with or without the presence of those conditions essential to the propagation of a standing wave, the cavities of the throat

and mouth can be tuned to resonate a variety of vowel phonemes. When the natural frequency of the cavity coincides with that of the vibrating vocal folds, optimum resonance of the tone quality will have been achieved.

Equally important, it must be noted that sound waves moving through the vocal tract are capable of imposing their energy so as to create differences in the length, mass and tension of the vocal folds, while at the same time maintaining a constant pitch, or vibratory speed. As a result, many different gradations of tonal qualities can be produced while the vocal folds maintain the same frequency of vibration. An example of this arrangement presents itself when examining the dynamics of a well-executed *messa di voce* (the art of swelling and diminishing on a single tone) where textural changes gradually rise and fall, both as to quality and intensity, but without altering the pitch level.

With a more advanced vocal technique the acoustic influence of the cavity over tone quality can be used in subtle and aesthetically acceptable forms through what is commonly recognized as 'tone coloring.' This option is available through the use of dark and bright vowel qualities resulting from slight adjustments within the cavities of the throat and mouth, used conjunctively with varying levels of intensity, coupled with different oscillating patterns of the vibrato.

At this juncture, it must be strongly emphasized that a cavity generates no acoustic energy of its own, but is restricted to resonating those vibrational characteristics (sound) defined by the quality of the vibratory impulses (movement of the vocal folds). Within this arrangement, the laryngeal cavity is capable of absorbing and/or dissipating the vibratory impulses perceived as 'voice' in two ways: through a depletion of energy caused by conceptual flaws associated with incorrect pedagogic theories and practices and due to friction present because of a poorly coordinated laryngeal musculature.

The critical factor in basic vocal mechanics, however, is the extent to which the cricothyroid and arytenoid systems draw the vocal folds into tension and their consequent effect on glottal dimensions. To consider cavity adjustments to be the sole, or even primary, factor in determining the efficiency with which adjustments within the resonating system (oropharynx, laryngeal pharynx and trachea) define and resonate a variety of vowel qualities, attributes to them an importance they do not possess.

## THE FOCUS OF FUNCTIONAL LISTENING

Throughout this discussion, emphasis has been placed on tone production as a physio/acoustic event. However, acoustics (the study of sound and sound waves), while based on processes connected with vowel qualities, is not a separate and distinct physical entity. Of itself, sound is merely a perception of moving air, and it is impossible to train sound waves. Since singing tonal qualities are incapable of being trained, learning what to listen for must center on those events occurring within the laryngeal muscular activities operative at the sound source, as the vocal folds are drawn into tension and assume different lengths and thicknesses.

Although energy contained within the cavities of the throat and mouth exerts considerable influence over the coordinative activities taking place at the laryngeal level, its impact is minimal when measured against the improvement potential inherent in the coordinative skill of the tensors of the vocal folds, the cricothyroids and arytenoids.

The focal point of technical training should, therefore, center on an approach whereby a properly utilized mechanical principle is capable of developing and reconditioning the response of the tensor mechanisms of the vocal folds. Because this possibility exists, these tensor mechanisms can then be brought into a high state of coordinative skill and muscular tonicity.

## THE PROBLEM

Of the many problems to be overcome during the development of technical skills, none supercede those confronted when attempts are made to bring the vocal mechanism under control. When addressing this issue, measures instituted to overcome vocal difficulties must of necessity center on an understanding of the movement capability of the involuntary laryngeal muscular systems without violating their intrinsic movement potential. However, before entering into a discussion of a viable pedagogic solution, several obstacles must be taken into consideration.

First and foremost, the vocal mechanism is not of itself an organic system, but a contrivance comprised of parts borrowed from processes connected with respiration and the act of swallowing. When adapted to phonation, each system is required to function in opposition to its response norm. The systems involved in respiration and the ingestion of foods and

liquids are functionally incompatible, since it is impossible to breathe and swallow at one and the same time without extreme discomfort.

Clearly, on the basis of this incompatibility, learning how to sing becomes a problem of considerable magnitude, especially because sustained phonation requires that these two systems participate cooperatively. In addition to this obstacle, the respiratory musculature must abandon its natural function associated with the rhythmic opening and closing of the vocal folds, while, at the same time, maintaining them in a state of continued approximation.

A further difficulty to be overcome is the natural tendency of the swallowing muscles to elevate the larynx during phonation, an occurrence inevitably resulting in greater or lesser degrees of throat constriction. To add to the confusion, cricothyroid tension (the pitch regulatory control) is influenced by the activity of the suspensory muscles acting in their role as the elevators and depressors of the larynx. Consequently, should the cricothyroids fail to pull the thyroid cartilage forward and downward, it becomes almost impossible for this muscle system to adequately participate in pitch regulation.

Additionally, should the cricothyroids function improperly during the maintenance of vocal fold vibratility, the imbalances of tension they impose will inevitably inhibit the ability of their opposer (the arytenoid system) to perform efficiently. The result is a general disequilibrium within the total system, a condition that in large part explains the physical origins of most vocal faults.

There are two other obstacles to be overcome. One is due to the fact that the muscles involved in phonation are involuntary and therefore cannot be acted upon directly. The second is that the free, full functioning qualitative properties possessed by even the most talented singers are to a greater or lesser extent obscured by vocal faults; hence unknown because they lie beyond one's conceptual awareness. Considering the inherent limitations of the laryngeal musculature to respond favorably to overt control systems, the question remains as to how these involuntary muscle systems are to be stimulated so that they are able to function more efficiently.

With overt controls incapable of having a positive effect on the correction of functional deficiencies at the sound source, it is necessary to search elsewhere for practical solutions to vocal problems.

## THE SOLUTION

The one area of vocal theory and practice constantly overlooked is the science of neurology. In a lecture delivered during the *Eighth Symposium Care of the Professional Voice* presented by The Voice Foundation (June 1979), Barry Wyke, a British neurologist, prefaced his lecture on the subject of neurology as it relates to vocal technique with the following statement:

Whether utilized for the purposes of everyday conversation, declamatory speech or singing, phonation requires an extremely complex sequence of precisely timed neuromuscular events that involves at least 40 muscles, the mechanisms controlling which are basically similar in all phonatory circumstances.<sup>12</sup>

Bearing in mind the complexity of the interactions involving the forty or more muscles used during phonation, it is certain that any attempt to gain volitional control over any one part of the laryngeal musculature is bound to fail. Wyke emphasized the holistic nature of the vocal mechanism and the inherent failure of overt control systems with this observation:

Phonation should, therefore, be regarded realistically as one (albeit complex) component in the holistic behavior that is audible communication, giving expression to the speech (and singing) processes that have been acquired in the brain of each individual. Thus I would submit that when singing teachers or teachers of dramatic actors are teaching their pupils to do what they do they are not teaching them to control their respiratory muscles, they are not teaching them to control the adductor muscles of their vocal folds, they are not teaching them to adjust the position of the tongue in the mouth or the palate in the pharynx – instead, they are teaching (or rather, they should be teaching) their pupil's brain to integrate all of this kaleidoscopic array of neuromuscular control systems into an efficiently functioning form of precisely co-ordinated behaviour, out of which will emerge (hopefully) an intellectually meaningful and emotionally satisfying product.<sup>13</sup>

The key concept in this statement is Wyke's stress on the importance of teaching the pupil's brain to integrate an array of neuromuscular activities into an efficiently functioning mechanism. This process he believed to represent the fundamental properties of a neuromuscular control factor. However, energy transmitted through neurological channels contains within itself certain limitations. These exist because the singer's past vocal experience has already been automatically programmed into the brain. Therefore, the vocal musculature is pre-set *by habit* to produce, reflexively, sounds to which the singer has become accustomed – the degrees of correctness varying with the student's particular vocal status. In short, learning how to sing at an increasingly higher technical level centers on the breaking down of habitual responses associated with the vocalist's conscious or sub-conscious tonal concepts.

In view of these considerations, the question remains as to how one is to set about regulating and improving ingrained habits and habitual muscular responses. This objective can best be obtained by setting up those conditions capable of revising the student's concepts through the stimulation of natural reflexes. This process, according to Wyke, is facilitated by what he termed "prephonatory tuning," or a mental pre-setting of the vocal mechanism as a totality. Reduced to bare essentials, prephonatory tuning is defined by Wyke as follows:

This is the process of prephonatory tuning of the vocal folds . . . [where] the tension, length and mass of the vocal folds are repeatedly preset to the degree required for each forthcoming phonemic utterance.<sup>14</sup>

On these terms, the total laryngeal musculature will automatically adjust in response to a tonal concept comprised of varying combinations of pitch, intensity and vowel. By means of this process, prephonatory tuning will succeed in bypassing the student's misconceptions simply by requiring him to: 1) conceptualize the pitch, intensity and vowel pattern to be sung, 2) fully expel all the residual air in the lungs, 3) *allow* the inspired breath to enter the lungs without self conscious effort, and 4) release the breath on a strong rhythmic impetus.

Of itself, this process will inevitably result in qualitative changes lying well beyond the vocalist's normal expectation, pre-concept or habitual response, thus setting in place a system where bad habits and familiar

tonal qualities will be replaced by those recognized as being more natural and correct.

Although an essential pedagogic ploy, prephonatory tuning fails to offer a complete explanation as to *how* the vocal mechanism is to be trained so as to function with greater efficiency. Assurance of a desired result can only be obtained through the adoption of an environmental control system. However, before entering into the specifics of such a system, an important neurological point must be taken into account. The cricothyroid muscle is innervated by the external branch of the superior laryngeal nerve, as opposed to the recurrent laryngeal nerve whose function is to innervate all of the intrinsic muscles of the larynx; that is to say, the arytenoid system. An understanding of this neurological arrangement is extremely important, since it offers a plausible neuromuscular explanation to account for the separation of the falsetto from the chest voice.

How is it possible to influence a poorly coordinated laryngeal muscular complex in order to fully exploit its movement potential? The only truly efficient process whereby this goal can be fully realized is through the adoption of an environmental control system.

### **THE ENVIRONMENTAL CONTROL FACTOR**

Whenever attention is directed toward issues related to vocal mechanics and their role as a control factor, it is important to take into consideration the interactive potential involving two natures. One is the organic systems inside ourselves and the other is the environment outside ourselves presented in the form of a vocal exercise. Clearly, if real technical progress is to be made, the dynamics of these two natures must be taken into account. Of the two, it is through regulation of the nature outside ourselves that it becomes possible to alter the nature inside ourselves. Because of the availability of this interactive potential, fundamental changes in the functioning of the vocal mechanism can be made. Thus, on a practical basis, technical progress can best be achieved through procedures based on an environmental control system.

Central to the success of this approach is the need to observe the interactions between an external stimulus (a vocal exercise), its effect on the vocal mechanism and, consequently, the tonal product. However, this still leaves open the question as to how environmental pressures capable

of making changes at the tonal source can be used to make radical improvements in the tonal product. The answer is to be found by observing a series of equivalencies.

For example, each pitch demands a specific adjustment of the vocal folds. Change the pitch and the vocal folds will adjust their physical dimensions accordingly. Through regulation of the intensity level, the vocalis will correspondingly alter its tension, causing the vocal folds to thicken as intensity increases, becoming proportionally thinner as the intensity level decreases. Change the vowel, and both the configuration of the vocal tract and the conformation of the vocal folds will also change reflexively, each change having a direct bearing on both tone quality and mechanical functioning.

On the basis of these equivalencies, a specifically designed exercise construct will predictably result in a particular type of vocal fold conformation whose dimensions, in turn, will be determined by the proportional amounts of tension assumed by the cricothyroids and the arytenoids. It is within these interactive relationships that an environmental control system becomes operative.

A successful exploitation of the principles and practices associated with environmental controls unquestionably relies upon the cultivation of listening skills; that is to say, aural impressions gained when observing the developmental and integrative potential of the chest voice and the falsetto. Consequently, through a familiarity with the mechanics of registration, it becomes possible to determine the probable laryngeal adjustments associated with the tonal product.

It is evident, therefore, that by altering the environmental conditions, it becomes possible to literally transform the response capability of the involved laryngeal musculature. With the availability of this option it follows that specific patterns of pitch, intensity and vowel are capable of separating the two registers when they are poorly coordinated or, contrariwise, combining them so that they are able to interact more effectively. Manifestly, it is through environmental controls that an equilibrium of forces operative within the laryngeal musculature can be established and real technical progress assured.

## LISTENING REGISTRATIONALLY

With the two register theory a verifiable fact, procedures concerned with the development and integration of these basic qualities become issues of extraordinary pedagogic importance. Unquestionably, if a valid connection is to be made between the quality of the tonal product and the physical and acoustic activities associated with its appearance, the tonal product must be critically observed and studied at its most primitive mechanical level.

Given the natural tendency of the voice to divide into two parts, the chest voice and the falsetto, the immediate area of pedagogic interest is to link these special qualities with those muscle systems whose activity accounts for the variables in their pitch ranges and quality characteristics. At the same time, these qualities and their corresponding muscular equivalents must be associated with the special combinations of pitch, intensity and vowel, presented in the form of a vocal exercise, whose energies are responsible for their appearance.

As the foregoing relationships apply to functional listening, when the bulk of the vocal folds (vocalis) increases in the lower pitch range of the voice with minimal cricothyroid participation, a rather crude and masculine tone quality will appear, whose special properties are commonly recognized as a chest voice. The emergence of this tonal characteristic is facilitated when an 'AH' vowel is sung at a high level of intensity concentrated within a pitch range extending from E above middle C to include pitches extending downward.

On the upper side of the division, or 'break' in the voice, the complexity of falsetto mechanics can be traced to the degree to which parts of the arytenoid system oppose the pitch regulatory function of the cricothyroids. Opposition provided by the arytenoid system can occur in several ways. For example, an isolated, totally 'false' tonal quality will emerge when the vocal folds remain fully opened, in which case the optimally engaged posterior cricoarytenoids would merely brace against the active contraction of the cricothyroids. As a consequence of this arrangement, the quality characteristics of the tonal product will be an extremely breathy, short ranged and harmonically impoverished pure falsetto, located in a pitch range extending from A below middle C to an octave and a third above.

The vowel directly associated with the quality characteristics of a pure falsetto is an exceedingly breathy 'OO', having a rather toneless tone quality, sung within the above mentioned pitch range. Without exception, this type of falsetto stands aloof from all aesthetically satisfying tonal qualities, since it possesses no vibrato and is unable to function cooperatively with those elements of the arytenoid system whose tension both thickens and approximates the vocal folds and is qualitatively associated with a chest voice.

Numerous and different types of 'false' tonal qualities surface when increased arytenoid tension causes a series of gradual shifts to take place, with vocalis tension especially becoming more active as the tonal quality attains greater legitimacy. Each stage of this balancing process alters the degrees of falseness variously described as weak, dull, acute and ringing, effeminate and/or considered to be semi-legitimate.

The presence of these qualities, however, is not necessarily indicative of a legitimate, or even an aesthetically acceptable and functionally efficient tone quality. Perhaps a more satisfactory way to describe tonal legitimacy is to associate its special physiological properties with the degree to which vocalis activity thickens the vocal folds as it opposes cricothyroid tension.

In addition to this arrangement, legitimate tone qualities are those that find the vocal folds fully approximated, coupled with an appropriate length and thickness sufficient to ensure a reasonable resonance of the fundamental frequency. It is important to note, however, that a legitimate quality is merely one that is not considered to be 'false', it is not necessarily healthy, nor free of muscular imbalances and varying degrees of throat constriction.

For both physiological and acoustic reasons, 'false' tonal qualities, as they apply to females, occur within the same limited pitch range as those of their male counterparts. Another factor to be considered is that women do not undergo a voice change at puberty and, as a result, rarely experience a noticeable separation of the voice into two parts. Since singing requires the engagement of both the 'false' and the natural voices, female vocalists enjoy a distinct technical advantage over male vocalists. At a very young age, females with a talent for singing intuitively tend to combine the two registers. Consequently, their mechanical status leaves them in a condition where they are ready to sing.

For males, the integration of the falsetto with the chest voice presents a genuine difficulty. Legitimate voice categories aside, certain types of 'false' tone qualities will sometimes include a pitch range of at least two octaves (a coordination observable in the technique employed by the countertenor). Nevertheless, this type of register integration represents only a quasi-legitimate or incomplete tonal quality, due to a deficiency of vocalis tension. Consequently, this coordinative arrangement merely indicates one among many phases of the integrative potential involving the falsetto and the chest voice.

At the outer extremes of the vocal pitch range potential lie two characteristically different tonal qualities. The first is identified with the altissimo notes of the coloratura, often referred to as a flute voice or whistle tones. With notes sung in altissimo, the vocal folds become fully approximated through a dampening process. This condition seals the glottis and prevents all but a small elliptical opening, positioned in the anterior portion of the vocal folds, from vibrating.

The second quality to be considered is located at the lowest extreme of both the male and female pitch ranges and is referred to as vocal fry or a pulse register. With this sound, the arytenoid system is functioning without cricothyroid opposition, causing the vocal folds to present a short, stubby vibrating surface capable of functioning only in a state of extreme relaxation. Although this tone quality possesses no legitimacy due to an absence of both a fixed periodicity, a discernable vowel quality and vibrato, it is occasionally useful when attempts are made to correct problems associated with throat constriction.

As for the head voice, it differs in all respects from sounds produced in altissimo in that the vocal folds are not dampened, but continue to vibrate along their outer edges and throughout their full length. At the upper end of its pitch range, head voice qualities terminate at high B-Flat. This terminal point applies to both male and female vocalists, even though their natural pitch ranges are located an octave apart. Within its lower extension, head voice mechanics are more complex, being dependent on the development of the chest voice and the extent to which the cricothyroids remain active.

Simply stated, all voice qualities are formed out of some combination of the chest voice and the falsetto. Consequently, a head voice may be said to make its appearance as a result of tension distributed between the cricothyroids and the arytenoids, where cricothyroid tension (falsetto) becomes more active as the pitch ascends, while by contrast arytenoid

tension (chest voice), particularly the vocalis, becomes increasingly active as the pitch range continues its descent. At this juncture, it is important to recall van den Berg's concept relating to tonal mixtures.

## **LISTENING SKILLS AND QUALITY ANALYSIS**

From the standpoint of functional listening as it relates to quality analysis, the hearing faculty must become tuned to recognize tone qualities as they equate to the proportional amounts of tension distributed between the two tensor mechanisms of the vocal folds. In turn, these physical arrangements must inevitably find expression with respect to mixtures or blends, of diverse types of false and chest voice tonal qualities.

Keeping track of the register blending process requires a recognition of the following underlying causes responsible for their appearance: when dominant, the chest voice tends to brighten the quality of the tonal product, whereas the influence of the falsetto or head voice is responsible for bringing about a general mellowing. On the basis of these observations, a proper blending of the falsetto with the chest voice results in a quality consisting of both clarity and warmth, neither of the two factors being dominant. The achievement of this tonal blending is indicative of a proportional balance of tension distributed between the cricothyroids and the arytenoids relative to the pitch, intensity and vowel pattern being sung.

All qualities may be seen to be traceable to two factors, 1) register balance and 2) the extent to which the throat is free of constrictor tensions. The following are some specific aural clues. Genuine 'ring' in the upper pitch range when sung at high levels of intensity indicates a well-balanced registration. On the other hand, excessive brightness combined with a cutting, edgy or nasal quality, indicates the presence of throat constriction. Yet another aural clue is provided when the singer is unable to produce high notes softly, a condition caused by an excess of chest voice driven too high into the tonal range. Another manifestation of throat constriction is revealed through the inability to sing pure vowel qualities.

Generally speaking, it is reasonable to assume that if the intonation is correct, the mechanical problem is not to be found with the cricothyroid system (whose only function during phonation is to regulate pitch and whose active tension corresponds to the falsetto register) but with the arytenoid system and its association with the chest voice. For example, uneven distribution of tonal vitality, sweetness of quality accompanied by a

lack of power, respiratory problems, throat and jaw tension, are all indicative of a lack of efficient chest voice participation.

As outlined above, these quality admixtures become important guides to the development of listening skills. Audible proof of an ideal tonal mixture appears once the following criteria have been met: purity of vowel quality, unobtrusiveness of vibrato, an ability to swell and diminish smoothly and evenly (particularly in the area of the register break), impeccable intonation and, acoustically, a vocal tract tuned to resonate the fundamental frequency with optimal strength.

### **THE COMPLEXITY OF THE LISTENING EXPERIENCE**

As previously stated, the vocal mechanism is capable of qualitatively articulating a variety of tonal options, with the most elemental stage being a condition where the two registers, the falsetto and the chest voice, are completely separated. It is out of the blending potential of these two qualities that a veritable host of tonal mixtures can be made. From this perspective, the very essence of the complexity of the listening experience finds expression in the selection of subtle modifications of registrational balances peculiar to different stages of technical development.

Additionally, there are different aspects of tone color above and beyond loud and soft levels of intensity and differences in registrational balances to be considered. These tonal subtleties are attributable to the fact that it is possible, given the same pitch and intensity levels, to produce diverse nuances of color. Thus, aspects of tonal color may be perceived more as a reflection of the singer's temperament rather than registrational balances per se. Such qualities, however, must not supercede vocal mechanics related to registration and overall technical skills. They are merely different aspects of the complexity of the listening experience.

From yet another perspective, there is this possibility to be considered. In a statement appearing in *Singing: The Physical Nature of the Vocal Organ* (Husler and Rodd-Marling 1965) one idea stands out from among all others. In their opinion:

We no longer have at our disposal the acute sense of hearing once possessed by the great teachers of singing . . . Our ears have lost that strange kind of intuitive, almost somnambulistic

intelligence, together with its extraordinarily accurate discriminative faculty.<sup>15</sup>

While this comment may be partially true, the real difference as it affects hearing sensitivity boils down to an ability to listen to the voice on the basis of aesthetic judgement and evaluations made through the prism of an understanding of vocal mechanics. One must learn, as a teacher or pupil, to listen to sounds with reference to their mechanical origins; in other words to listen functionally in conformity with physiological health.

Viewed from this perspective, Mancini's statement quoted earlier that links development of vocal skills to environmental conditions, makes perfect sense. Unquestionably, a vocal exercise composed of specifically designed patterns of pitch, intensity and vowel, is equivalent to the idea, or seed which, when planted in soil whose chemical composition is conducive to organic health will, when properly nurtured, yield a bumper crop or, in vocal terms, the acquisition of a free vocal technique.

The approach advocated here is important since, to a considerable extent, it disposes of psychological factors and tonal qualities reflecting no more than personal preferences - a very shaky dependency. One of the primary advantages to be gained through the adoption of the principles formulated above is contained in a concept of vocal training based on a remark attributed to Giovanni Bontempi, a sixteenth-century authority, who contended that one learns to sing through the experience of singing itself. On these terms to quote Giambattista Lamperti, one of the master teachers of the late nineteenth century:

There is no "attack," no "mouth position," no "tongue control," no "voice placement," no "fixed chest," no relaxing this or that muscle, no stiffening any part of the body, in fact, nothing that would not spring from instinctual utterance.<sup>16</sup>

To this list should also be added that there is no "support," no "belly breathing," no "lowering of the larynx," no "covering," no "masque resonance," nor any other manipulative techniques currently in vogue.

Additional evidence supporting this view is to be found in a letter appearing in the London Musical Herald (1894) contributed by Manuel Garcia. In his opinion:

Avoid all these modern theories and stick closely to Nature. I do not believe in teaching by means of sensations of tone. The

actual things to do in producing tone is to breathe, to use the vocal cords, and to form the tone in the mouth. The singer has to do with nothing else. I began with other things; I used to direct the tone in the head, and do peculiar things with the breathing, and so on, but as the years passed by I discarded them as useless, and now speak only of actual things and not mere appearances.

I condemn that which is spoken of nowadays, viz., the directing of the voice forward, or back and up. Vibration comes from puffs of air. All control of the breath is lost the moment it is turned into vibrations, and the idea is absurd that a current of air can be thrown against the hard palate for one kind of tone, the soft palate for another, and reflected hither and thither.

With regard to the position of the larynx, higher or lower, the singer need only follow natural emotional effects, and larynx, palate and the rest will take care of themselves. As to breathing, do not complicate it with theories, but take an inspiration and notice Nature's laws.

With the exception of the statement, "to form the tone in the mouth," (clarified in an earlier writing where Garcia declared the pharynx to be the real mouth of the singer) this position is correct in all respects.

It is significant that after decades of teaching, Garcia ultimately concluded that most manipulative methods are inhibitory and that one should "notice Nature's laws". To focus on the nuances of tone qualities and the development of listening skills is difficult enough without being distracted by superficialities. Adhering to an environmental control system that works with Nature's laws is by any measure the only viable solution to vocal problems.

Surely, to build a training program founded on principles meeting in agreement with an environmental control system fits comfortably within concepts related to a 'natural' vocal pedagogy, as here presented. Unquestionably, once such a system is put into practice, it should ultimately reveal those pedagogic principles directly connected with natural functioning. Approached from this perspective, aesthetic goals must be temporarily set aside, while attention is directed toward discovering the cause of the defects. Evaluated from this point of view, vocal problems,

their source and physiological causes, must be considered a primary concern. The focal point of this process is to listen and catalogue differences of vocal quality as these are willed to respond to environmental changes.

To be successful, such a program must be founded on a tuning of the listening sensitivity capable of satisfying two different requirements. The first and more fundamental phase of this listening experience necessitates a basic understanding of register mechanics, i.e., the processes involved with the separation and integrative potential of the chest voice and the falsetto. The second type of listening has to do with aesthetics and is more directly concerned with those subtleties of qualities associated with register mechanics and vocal technique, as it becomes operative at higher levels of technical skill. Taken together, a path will open up which, when followed, will lead to a unity of functional mechanics and listening skills.

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