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On Shaky Ground Part II: Navigating Challenges in Vocal Vibrato

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Hello to the Voice Foundation Community! In this edition of the newsletter, singers who are also singing teachers, scientists, and speech-language pathologists share their insights on vocal vibrato. Vocal vibrato is a singing phenomenon that involves rhythmic modulation of voice and contributes to a pleasing tone. If the perceptual features of vibrato differ from those that are expected, however, the voice may be perceived as poorly controlled or imbalanced. Achieving the optimal features of vibrato requires vocal skill and can be altered by a number of factors including training, pathology, and environmental conditions.

John Nix discusses methods for training vibrato and for conducting research on vibrato to inform our understanding of vibrato control. Pasquale Bottalico, Joshua Glasner, and Yvonne Gonzales Redman share their research on the effects of the singing environment on control of vibrato and the implications for navigating these effects in voice training. Marci Rosenberg describes how vibrato may be affected by vocal pathology and used to guide voice therapy. Finally, Natalie Chiapetta shares her experiences learning how to control vibrato in different styles of singing. We hope that these authors' insights and experiences pique your interest in vibrato and motivate discussions and research on this fascinating vocal technique.

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In the current issue, the authors discuss vocal vibrato from research, teaching, and treatment perspectives.

ROSEMARY A. LESTER-SMITH, PH.D., CCC-SLP



EDITOR

Vibrato in Singing

Professor John Nix

Vibrato in singing has fascinated generations of voice pedagogues and scientists. It has been a key research area of mine for much of my career as a voice teacher and researcher.

Vibrato in singing occurs not only as a periodic variation of fundamental frequency, but also as a periodic fluctuation in amplitude, timbre, vocal tract resonances, subglottal pressure, glottal adduction, and transglottal airflow. Moreover, while some of these variations tend to occur at the same time, others may not, and this relationship may depend upon the vowel and pitch being sung. For example, the fundamental frequency and the resonances of the sung vowel can interact to make the frequency and amplitude vibrato completely in phase (rising and falling at the same time) or completely out of phase (one rising while the other is falling). The interaction between the vowel and pitch can also cause the amplitude vibrato to occur at twice the rate of the frequency vibrato. If the frequency and amplitude variations are completely out of phase with each other, the singer's voice might sound like it has a beat in it, while amplitude vibrato at twice the speed of the frequency vibrato might have a fluttering quality.

Typical measures of vibrato describe the rate of the fluctuation of the vibrato characteristic being examined, the extent or magnitude of change in each fluctuation cycle, and the regularity of the fluctuation over time. Regarding frequency vibrato, the rate is given in Hertz, the extent in cents (with 100 cents per half-step or semitone) or percent, and the regularity measure or jitter (the cycle-to-cycle variation in the period of the vibrato) in percent.

Voice pedagogues often use vibrato as a bellwether of the stability and freedom of a singer's voice production. This usage is quite well-founded, as poor postural balance, unsteady airflow, unbalanced intrinsic muscle function, or undesirable extrinsic muscle activity can all have an impact on the vibrato rate, extent, and jitter.

Current avenues for research include the effect of performance spaces and acoustic feedback on vibrato characteristics, how variations in vibrato characteristics occur over time in different singing styles and across different contexts within styles, the ability of trained and untrained listeners to discern differences in vibrato characteristics, and differences in preferences for vibrato between groups of listeners and between genres. Further work is being performed to examine the similarities and differences between vibrato as a volitional behavior that is cultivated and tremor as an involuntary behavior that is undesirable.

Some of the challenges in studying vibrato include measuring changes that occur outside of the steady state condition (e.g., a sustained note on a single vowel for several seconds), such as during a heavily embellished singing passage that one might find in 18th or early 19th century operas, at voice onset and offset, and during volitional changes

John Nix is Professor of Voice and Voice Pedagogy and chair of the voice area at the University of Texas at San Antonio. His mentors include Barbara Doscher (singing, pedagogy) and Ingo Titze (voice science).

Current and former students have sung with the Santa Fe, Arizona, Chautauqua, St. Louis, Nevada, Omaha, Utah Festival, and San Antonio opera companies, and two have served as NATS Intern Program Master Teachers. In addition to his active voice teaching studio, he performs research in voice pedagogy, literature, and acoustics, having produced 50 published articles and 8 book chapters; he also co-chairs the NATS Voice Science Advisory Committee, serves on The Journal of Singing's editorial board, and serves on the Rowman and Littlefield/NATS book editorial board. Mr. Nix is editor and annotator of *From Studio to Stage: Repertoire for the Voice* (Scarecrow, 2002), vocal music editor for the *Oxford Handbook of Music Education* (Oxford University Press, 2012), one of three general editors for the *Oxford Handbook of Singing* (Oxford University Press, 2019), and co-editor of the forthcoming *Oxford Handbook of Voice Pedagogy* (Oxford University Press, 2024).



(Continued from page 3)

in amplitude (e.g., crescendo and decrescendo on a single note or on a musical phrase), extracting vibrato signals ‘in the wild’ – during live performance and in ensemble situations, and examining listener perceptions of vibrato.

Voice pedagogues often use vibrato as a bellwether of the stability and freedom of a singer’s voice production.

In my own experiments exploring vibrato, I have tried to avoid some of the more challenging data collection situations mentioned above by working on steady state vowels in laboratory conditions, in part to get better mean data. For example, in a multicenter study of vibrato in U.S. college voice majors (Nix et al, 2015), the initial and final 500 ms of each sample were excluded from analysis, as the vibrato rate, extent, and jitter tend to be quite variable during onset and offset, with rate typically increasing prior to offset (Prame, 1992). I am pleased that my colleague Theodora Nesterova (Ph.D. student at McGill University) is now revisiting this large data set of collegiate singers looking specifically at the changes in vibrato characteristics during onset and offset. With regards to listener perception of vibrato, to test specific aspects of vibrato perception while controlling all other variables, using synthesized samples is a fairly standard practice. Synthesized samples can also be used in training teachers and clinicians to be able to discern and discriminate changes in frequency vibrato rate and extent regardless of pitch, vowel, and gender (Meyer, Nix, and Okerlund 2021). Work is ongoing, however, to test how well perceptions of rate, extent, and jitter/regularity in synthesized samples compare with perceptions of actual sung samples, and how well training protocols using synthesized samples prepare pedagogues and clinicians for making accurate assessments of actual singers.

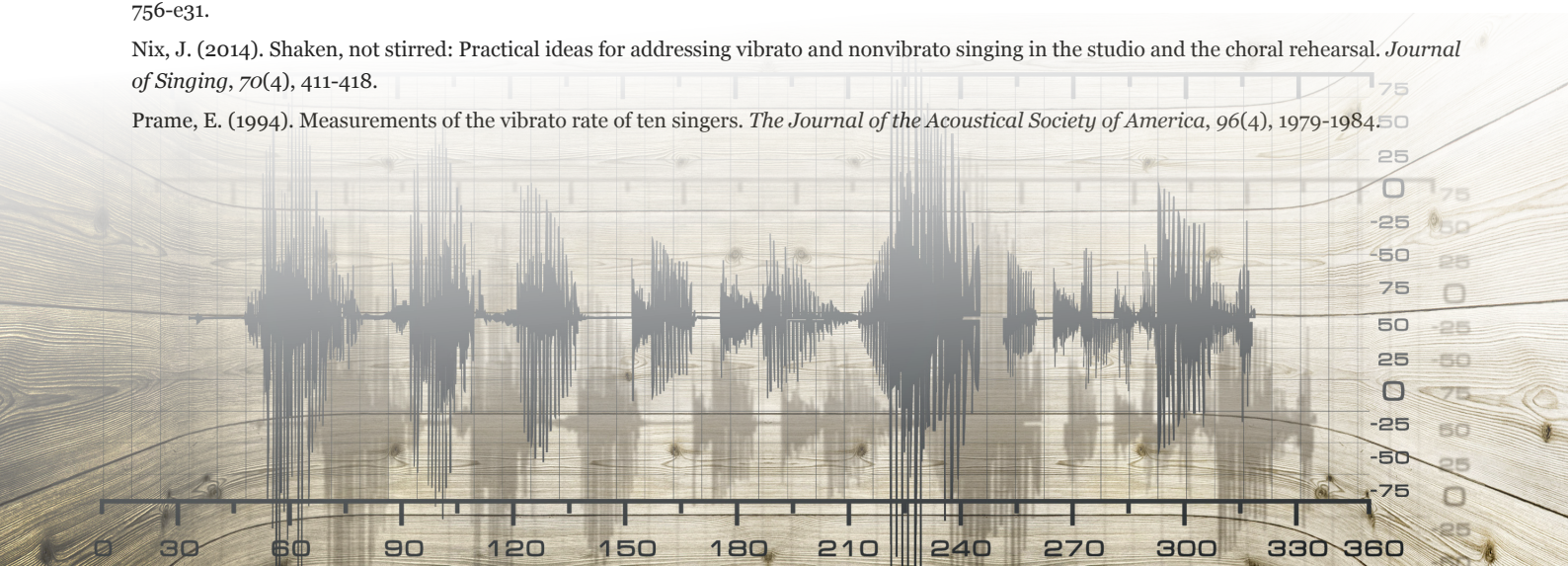
In the teaching studio, there are a number of facilitation techniques that can be used to help a student establish a consistent, style-appropriate vibrato. Alternating fast moving passages (rapid scales, arpeggios, and ornaments like trills) with sustained notes can help a singer transfer the laryngeal muscle balance and vocal tract freedom present in the more florid passages into passages that are more static. Alternating staccato or bounced patterns with legato phrases or sustained notes can also be effective in promoting optimal laryngeal posturing and respiratory coordination, both of which may allow a free vibrato to emerge. Exercises involving so-called semi-occluded vocal tract postures, like lip trills and singing through a straw, may also help a singer find greater ease of production which then aids the regularity of the vibrato. All of these types of exercises can be combined with flowing movements, tactile stimuli such as sweeping a hand smoothly and steadily along the top of the piano or along a wall, and real-time visual feedback from analysis software. Many other ideas are presented in the “Shaken, Not Stirred” article in the references below.

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THE EFFECT OF ROOM ACOUSTICS ON SINGERS' VIBRATO

Pasquale Bottalico, Ph.D., Joshua D. Glasner, M.M., Ph.D., and Yvonne Gonzales Redman, B.M.

It has been established that auditory feedback has a strong effect on the performance of singers and instrumentalists, and an integration of such feedback is important in achieving an ideal sound. In the case of instrumentalists, the source of sound is external to their own body. Conversely, for vocal performers, the voice is generated internally. Therefore, vocal performers rely not only on external auditory feedback, but also on proprioceptive feedback associated with internal sensations of their voices. These internal sensations consist primarily of pallesthetic (vibratory) and kinesthetic (muscular) sensitivities, which provide performers with landmarks for controlling their voice

In a recent study (Bottalico et al., 2022), our team investigated the influence of room acoustics on singers' vibrato, by analyzing consecutive sung performances of classically-trained students in five different performance spaces. We wanted to examine how vibrato changes due to the performance space, and how auditory feedback in these spaces contributes to the performance of the singers. The experiment was conducted in one session within four performance halls and one outdoor amphitheater. Recordings were made in five locations at the University of Illinois in Urbana-Champaign consecutively beginning in Smith Memorial Room, followed by Foellinger Great Hall, Colwell



Dr. Bottalico is an Assistant professor in the Department of Speech and Hearing Science at the University of Illinois in Urbana-Champaign. He completed his education in Italy in engineering (acoustics) and music (Voice). His research focuses on the interaction between room acoustics and voice. Bottalico is also a professional chorister, performing under such prestigious directors as Rafael Frühbeck De Burgos, Yuri Ahronovitch, Jeffrey Tate, Gianandrea Noseda, Ottavio Dantone, Wayne Marshall, Helmuth Rilling, Christopher Hogwood, Robert King, and Ivor Bolton.

production. This means of control is more reliable than external auditory feedback, for which the perceived voice is fundamentally filtered by environmental and anatomical characteristics.

Vocal vibrato is a well-recognized and prominent feature of operatic singing. Subjectively, vibrato can be described as a variable, vibrant, and gentle tone. From an objective perspective, vibrato is characterized by the pulsation of fundamental frequency (f_0), intensity, and formant frequencies; however, the physiologic underpinnings of vibrato production have yet to be fully described. Studies that have examined vibrato suggest that a negative feedback loop—with reflexes in pairs of antagonistic laryngeal muscles—works in concert with pulsations in subglottal pressure during vibrato production. Additionally, auditory feedback modulates vibrato and contributes to the timbre.

Playhouse, Krannert Amphitheatre, and concluding with Smith Recital Hall (<https://krannertcenter.com/>).

The singers tended to exhibit an increase in vibrato extent (i.e., a “wider” vibrato f_0 range) when a higher proportion of their sound resided in the early sound field than in the late sound field. In other words, vibrato extent was wider in the “dry” performance spaces, as compared to the “live” space, suggesting that the singers may have tried to compensate for the lack of feedback from the room. Similarly, when the acoustic feedback perceived by the singer was clearer and less reverberant, singers changed their vocal function in a way that produced a slower vibrato rate. This result is another example providing evidence that singers' reactions to auditory feedback noticeably influences vibrato production.

Joshua Glasner, M.M., Ph.D. is Assistant Professor of Speech-Language Pathology at Delaware Valley University where he teaches courses including research methods and speech and hearing science. He also serves on the summer faculty at Westminster Choir College's Summer Voice Pedagogy Workshop. His multidisciplinary research involves broad-ranging topics ranging from historical voice pedagogy and recording technology to the perception of the singing voice and treatment efficacy. Dr. Glasner's scholarly work has been presented at various national and international conferences, and has been published in peer-reviewed journals such as the *Journal of Voice* and the *Journal of the Acoustical Society of America*.

Dr. Glasner holds degrees in voice performance and voice pedagogy from the University of Delaware and Westminster Choir College, a certificate in vocology from the National Center for Voice and Speech, and a research doctorate from New York University.

More information can be found on his website at <http://joshuaglasner.com>.



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singers' reactions to auditory feedback noticeably influences vibrato production

This study supports what singers have reported for at least a century: the acoustics of a performance environment affect their vocal performance. With this information, voice pedagogy should encourage vocalists to vary their rehearsal locations, allowing these singers to become accustomed to different acoustical environments. Additionally, pedagogical practices and methods should prioritize training singers' kinesthetic and somatosensory awareness. This focus would limit the possible negative implications of singing in a "live" or "dry" performance space. Looking forward, emerging pedagogical methods that focus on kinesthetic and somatosensory awareness is a worthy subject of future research in order to optimize singers' abilities to have functional and reproducible artistic results on stage. We also look forward to future studies that elucidate the physiological causes of vocal vibrato and how practitioners might assist singers in achieving results that align with current performance practice.

Bottalico, P., Łastowiecka, N., Glasner, J. D., & Redman, Y. G. (2022). Singing in different performance spaces: The effect of room acoustics on vibrato and pitch inaccuracy. *The Journal of the Acoustical Society of America*, 151(6), 4131-4139.

Yvonne Gonzales Redman is an Associate Professor of Voice at the University of Illinois Urbana-Champaign. She began her musical career as a winner of the Metropolitan Opera National Council Auditions and was an apprentice in the Lindemann Young Artist Development Program, enjoying an 18-year career there as a main stage soprano including live radio and television broadcasts found on Sirius XM radio.

Her experience rehearsing, performing, and teaching in multiple acoustic spaces inspired her current research interests related to the impact of musical work environments on our voicing and hearing. This has resulted in several interdisciplinary research studies with Dr. Pasquale Bottalico. The results of these studies have been presented at multiple conferences including the 48th, 49th, 50th, 51st, Voice Foundation Annual Symposium and published in the *Journal of Voice* and the *Journal of the Acoustical Society of America*.



Clinical Application of Vibrato in a Rehabilitative Setting

Marci Rosenberg, M.S., CCC-SLP

Although the topic of vibrato is typically reserved for a rehabilitative setting, it can often yield valuable information in a rehabilitative setting. The voice clinician might be able to use vibrato in a variety of ways to help guide and optimize therapy approaches for a singer.

The biomechanics of vibrato are not completely defined and our understanding of the relationship between vocal technique and vibrato continues to evolve. Vibrato is often targeted when addressing technical challenges in the voice studio. While empirical wisdom is not considered a benchmark for scientific validity, voice trainers and pedagogues have been troubleshooting biomechanical inefficiencies related to vibrato in the studio setting for hundreds of years. Even without



Marci is a singer, speech pathologist and clinical singing voice specialist. She has worked clinically for almost 20 years at The University of Michigan, Vocal Health Center specializing in rehabilitation of injured voices. Additionally, she serves as the on-site vocal

health consultant to the Department of Musical Theatre at University of Michigan. Marci teaches workshops and lectures nationally and internationally on vocal health and wellness, managing vocal injuries in the vocal athlete, and application of kinesiology principals to voice therapy and singing voice rehabilitation. She is co-author of *The Vocal Athlete*, and *The Vocal Athlete- Application and technique for the hybrid singer*, soon going into its third edition. She has research publications and is also a featured author in several voice pedagogy books. Marci is guest faculty at The New CCM Summer Pedagogy Institute at Shenandoah and served as Vice President for the Pan-American Vocology Association. Marci continues to be very active with PAVA. She maintains a private voice studio and consulting practice. As Marci specializes in multiple vocal styles, her clients have ranged from the Broadway stage to the Metropolitan Opera and everything in between. Contact vocalathlete@gmail.com, marci-rosenberg.com.

A singer presenting with bilateral vocal fold lesions and complaints of vocal strain and fatigue may initially present with a tight and restricted tone in both speaking and singing. Vocal fold nodules sometimes present a clinical conundrum, as we do not always fully understand if the muscular tension created a scenario

wherein vocal fold nodules developed, or if maladaptive response to the presence of vocal fold nodules created the excessive muscle tension and strain. Baseline perceptual assessment of singing for this patient may also reveal restricted or aberrant vibrato. This could present in a variety of ways including

unevenness, and abnormal rate and/or excursion. If manual therapeutic probes in the neck region reduces perception of restricted vibrato in any of the above

stated areas, then an approach targeting musculature in the head and neck region may be beneficial. This technique could be included along with other more traditional approaches directly targeting voice production and vocal hygiene. In this scenario, vibrato is not used to diagnose the cause of the vocal fold nodules, rather it serves as an indicator of a positive response to a targeted intervention. This data point may provide useful information that helps inform the clinical approach.

In another clinical scenario, therapeutic interventions for a patient with vocal fold nodules and muscle tension dysphonia might target a forward, resonant placement during connected speech. As part of this process, the patient experiences more

efficient biomechanics such as increased flexibility of the tongue and jaw. In addition to more efficient speech, the patient also demonstrates carry over of these benefits into singing resulting in more stabilized vibrato. This is also a case where change in vibrato is one indicator of a carry-over response to a targeted intervention.



complete scientific understanding of the role of vibrato in singing, many pedagogical approaches have evolved and refined over the decades including shifts in how and when vibrato is used across styles. The therapeutic arena has also benefited from this. The aim of this article is to provide some theoretical scenarios highlighting

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The third scenario illustrates how vibrato can also be used as a therapeutic tool targeting biomechanical inefficiencies. A singer might present with a new complaint of vocal fatigue after choir rehearsals. Further probes into the onset and nature of the complaint reveal a new voice demand requiring a significant amount of straight tone singing for extended periods of time. In this case, specific exercises aimed at exaggerating vibrato can be used therapeutically to facilitate more freedom and range of motion across the vocal mechanism helping to minimize vocal fatigue. A warmup and cool down routine can be designed for this patient incorporating such exercises to help rebalance the vocal mechanism before and after rehearsal.

The voice clinician might be able to use vibrato in a variety of ways to help guide and optimize therapy approaches for a singer.

The examples above illustrated different uses of vibrato in a clinic setting. First, vibrato serves as a metric demonstrating a positive response to a specific intervention. The second uses vibrato as a way to assess carry-over of an intervention to a behavior that was not targeted. Finally, the third example illustrates the use of vibrato as a therapeutic tool and component of a target intervention. Vibrato is a very complex phenomenon, and studies have indicated that there is variation across singers in how vibrato is generated even within a similar voice type. Therefore, use of vibrato as either a diagnostic or therapeutic tool must always be considered within the larger context of the patient especially when dealing with difference genres.

The topic of training use of vibrato or troubleshooting technical issues related to it have been discussed in vocal pedagogy texts for hundreds of years. Artistic use of vibrato varies across genres and will continue to change, based on evolution of vocal aesthetic standards for various styles. The pedagogical disciplines have long-used effective tools targeting vibrato and application of vibrato as a clinical tool is also proving to be useful in the rehabilitative setting. As we await science to explain more clearly what we have known empirically for years, voice training approaches will continue to develop and evolve to not only serve the traditional aesthetic of vibrato but also the more contemporary demands in both habilitative and rehabilitative settings.



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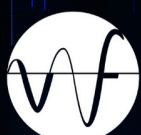
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Singing with Vibrato or Straight Tone

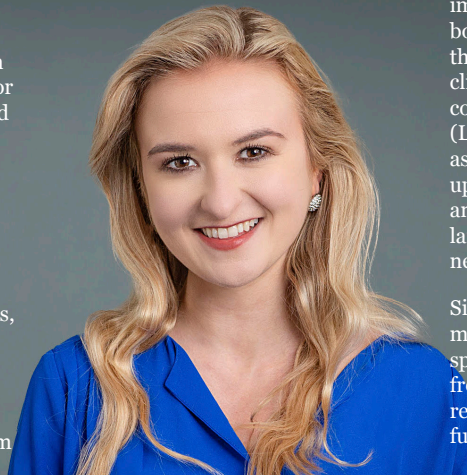
Natalie Chiapetta, M.S., CCC-SLP

In addition to being a voice therapist, I am also a trained vocalist, versed in the classical, contemporary, liturgical and musical theater style of singing. I have been fortunate to have learned various vocal skills which have broadened my perspective of the voice, enlightening me to the diverse techniques that vary from genre to genre. In my early years of training, I can recall standing in a rehearsal studio, under the tutelage of private instructors, attempting various singing techniques. One of the most prominent techniques I recall learning was vibrato.

Natalie Chiapetta, M.S., CCC-SLP,

As a speech-language pathologist and voice therapist, with a concentration in voice disorders, I specialize in both the habilitative and rehabilitative care of the voice. My passion for the voice stems from my deep-seated love for singing. As a trained operatic vocalist, I learned how the voice is a conduit that establishes identity and enables self-expression. I strive to help individuals return to meeting their vocal needs when vocal fold injuries attempt to limit them.

At the NYU Voice Center, I provide patient centered care to help individuals such as singers, public speakers, and non-professional voice users regain strength in their voices in order to restore their creative outlet, artistic identity and livelihood. I enjoy meeting the needs of performers from all backgrounds spanning from



amateur to professional vocalists.

As a vocalist myself, I understand the importance of vocal health and serve to offer both preventative care and rehabilitative therapy for the voice. Additionally, I provide clinical care targeting transgender voice communication, Lee Silverman Voice Treatment (LSVT) for patients with Parkinson's disease, as well as therapy for vocal fold paralysis and upper air way disorders such as chronic cough and vocal cord dysfunction. I collaborate with laryngologists to identify a patient's specific needs and provide patient-centered care.

Singing has brought vibrance into all facets of my life. It is rewarding using my training in both speech and vocal mechanics to help individuals from all walks of life find their unique voices, regain their vocal identities, and achieve their full potentials.

Vibrato, is an Italian word, which means "to vibrate." In a musical context, vibrato is the variation in pitch of a musical tone in which the voice alternates quickly between two pitches. This embellishment typically occurs when a singer sustains a note, and to the listener's ears, it comes across as eliciting a "vibration." This technique is opposite from singing "straight tone," in which a singer sustains a note without alternating between two pitches, creating an unwavering sound. Choosing to sing with vibrato, versus singing straight tone, may differ depending on the style of music and choice of the performer. For example, operatic singing stylistically calls for consistent use of vibrato, whereas choral singing involves singing straight tone, as to elicit the effect of vocal unison. Musical theater and contemporary singers use vibrato, though varied, as it may not occur on each sustained note for its entirety. Some notes may begin with a straight tone and end with vibrato, a choice ultimately decided by the vocalist.

Vibrato is created with adequate breath support, placement of the voice, and a relaxed and stable laryngeal posture. Though acoustically pleasing to the ear, vibrato also is thought to serve as a means of managing tension in the larynx.

Just as various parts of the body shake in response to prolonged physical exertion or holding heavy objects for extended periods of time, the muscles of the larynx rhythmically "shake" while holding a pitch with healthy tension and subglottic pressure. Straight tone occurs when the vocal folds are held in a fixed and stationary adducted position during phonation, suppressing rhythmic "shaking." This posture can be compared to that of a "plank", often used in physical workouts as an isometric and stationary exercise.

Whether choosing to sing with vibrato or straight tone, each technique poses unique challenges. When singing



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straight tone, if not relying on adequate abdominal breath support and vocal placement, a vocalist may potentially accrue excessive muscle activation of the larynx to sustain the note. This may cause the singer to feel tightness

Vibrato is created with adequate breath support, placement of the voice, and a relaxed and stable laryngeal posture.

in the voice and may also lead the tonal pitch to flatten. Singing straight tone may be difficult depending on the vowel of the note, the range in which the pitch is being sung, as well as the dynamics. For example, when a soprano sings in her upper register with a softer vocal dynamic, the vocal folds are elongated and thinned, vibrating hundreds of times per second in a fixed position. For a voice to be held in this extremely precise posture, it is no wonder that this technique may be difficult for vocalists!

In contrast, using vibrato may also cause challenges. It is crucial for singers to rely on breath support, placement of the voice and relaxed laryngeal posture to produce the vibrato. Changes in the subglottic pressure created by poor breath support may also cause the vibrato to be uneven. If vocalists do not use breath support efficiently, they may activate excess laryngeal muscles or extraneous muscle movement to achieve the desired effect, such as head or jaw shaking. This manufacturing of the vibrato, by relying on muscle rather than adequate technique, may cause maladaptive habits to be formed. If used overtime, it can cause singers to memorize this tension resulting in effortful singing and vocal instability overall.

I began my vocal journey trained in the music theater style, with varying use of straight tone and vibrato. Years later, I pursued a degree in vocal performance where I was trained in the operatic style of singing. Singing with consistent vibrato became a hallmark of my repertoire. As a lyric soprano, when vocalizing in my upper register, using vibrato often feels less effortful and easier than if I were to sing the same note with a straight tone. However, I often enjoy using straight tone singing when rehearsing to confirm that I am on pitch more precisely. Singing with the absence of vibrato can expose the accuracy of the pitch itself. Overall, using both vibrato and straight tone relies on adequate technique and should be used at the discretion of the vocalist and the genre of music.



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