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Best Practices: Using Exercise Physiology and Motor Learning Principles in the Teaching Studio and the Practice Room

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IT IS A JOY TO HEAR a free voice expressing the full range of human emotions. Regardless of the vocal genre, to accomplish this artistic ideal, singers must methodically develop a reliable, flexible technique capable of meeting the style's demands. A secure technique enables the singer to achieve greater artistry by freeing him or her from having attention diverted from expression to the physical challenges of singing. By employing knowledge drawn from voice physiology, voice acoustics, voice development, exercise physiology, and motor learning, all of which are used in combination with the most essential tool, a discerning ear, teachers can individualize training for each singer based on the strengths, weaknesses, and learning style of the student.

Like all athletes and skilled performers, singers must practice in order to maintain and improve their proficiency level. The major goals of practicing are developing the necessary physical and mental skills for artistic singing, applying acquired skills of singing performance to artistic expression, and physically and mentally preparing for varying performance situations.

Many factors determine who succeeds as a singer. Certainly genetically determined body structures and a musically enriching environment in the developmental years are very important. Mental factors also have a crucial impact on performance outcomes. All these factors being relatively equal, however, some singers excel while others do not. A principal reason is how they practice. Those singers who best know how to train through efficient practice will progress more rapidly and will meet performance goals more consistently.

EXERCISE PHYSIOLOGY AND VOICE TRAINING

Four basic principles of physical training have been identified which, when carefully manipulated, can evoke training benefits. These four are overload, specificity, individuality, and reversibility.¹

Overloading involves asking more from a muscle or group of muscles than normal. An example of overloading in singing training might be to take the three consecutive phrases at the beginning of Beethoven's "Adelaide" and doing them at a slower tempo than is needed for performance. Such practic-

Journal of Singing, November/December 2017
Volume 74, No. 2, pp. 215–220
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National Association of Teachers of Singing

ing would tax the singer's breath management system beyond what is needed to perform the song; by so doing, the singer would gain greater ease in performing the phrases at tempo and in an artistic fashion. It is important to distinguish this example from overloading that would not be constructive, such as singing a piece that is too advanced or singing overly loud or dark.

Specificity means that the training must match the task or skills to be developed. Specificity of training for a singer performing Handel's "Ombra mai fu" might include practicing a *mesa di voce* exercise on the /o/ vowel in the pitch range required at the start of the aria.

Individuality concerns adjusting the training to match the performer's age, physical development, experience, health, and skill level. Matching singers and repertoire is one example of how singing training can incorporate this principle.²

Reversibility is how training benefits are lost over time without continued training. An example of this in singing would be a song that a singer decides to discontinue practicing for a while; when work on the piece resumes, it is "rusty"; elements that had previously been mastered are once again awkward and in need of renewed attention.

Singers and teachers have additional variables that can be used in designing optimal practice sessions. These include practice frequency, the practice session duration, intensity of sessions and exercises within a session, and how quickly to advance to more difficult tasks.³ More will be said about these variables in the practice examples later in this article.

FROM THE GENERAL TO THE SPECIFIC

One further element in organizing all practice is working from the general to the specific. When first starting to learn golf, one does not go to the course and practice a back-spinning fade; rather, one receives a bucket of balls and patiently works on fundamental mechanics of the swing. Professionals continue this pattern in how they warm up before a tournament: one sees them start with general skills on the driving range. They reinforce the fundamentals of their swing before reviewing specific or more advanced skills and starting a competitive round.

The same is true for how singers should organize practice. One begins with gross motor control by using simple vocalise patterns, then gradually works toward

finer elements of technique. The *mesa di voce* on a challenging vowel in the *passaggio* is saved for late in the session. This general to specific hierarchy also applies to how teachers should ideally approach training young singers. Gross motor control of "the big picture" items, such as postural alignment and breathing efficiency must be acquired before more refined sounds can be expected. This general to specific dictum applies to vocalizing, repertoire selection, and how a teacher gives feedback to a student.

MOTOR LEARNING AND VOICE TRAINING

As the field of motor learning continues to grow, it is increasingly apparent that music teaching has been oriented toward *how information is most easily delivered* to students rather than *how teaching could be structured for optimal student learning*. By learning, from the perspective of motor learning, we mean that a permanent change in the capability for skilled movement has occurred.⁴ This is quite different from any temporary performance enhancement. Consider a master class where a singer performs better than before, thanks to the guidance of a clinician. However, the next day, the singer is frustrated when recapturing the same level proves elusive. Short term performance was enhanced, but learning did not occur. This situation, which is quite familiar to many readers, has been dubbed the "Master Class Syndrome" by Lynn Holding.⁵ Evidence of learning includes maintenance, for example, the retention of a skill after training, and generalization, the transfer of a skill to a related but untrained task.⁶ By not being able to match the level of performance displayed in the master class, the singer in question exhibited neither maintenance nor generalization.

In many cases, as is shown in Table 1, practice and feedback that promote learning frequently suppresses immediate performance, and practice and feedback that promote performance often impede learning. The information may seem counterintuitive when compared with more traditional approaches to teaching.

Given the evidence to date, how might a practice session employing the ideas presented in this article be structured? Here is an example:

- One or two simple conjunct descending exercises (perhaps starting with semi-occluded postures) in blocked constant fashion.

TABLE 1. Motor learning and singing training.*

Practice Category	Description	Singing Training Example	Comments (caveat: few studies have been done on motor learning and voice)
Blocked Practice Order	Desired behaviors practiced in separate blocks or groups.	10 5 note ascending scales on /i/; then 10 5 note scales on /a/—i.e., AAA, BBB, etc.	Learning may best be assisted by blocked, then random practice.
Serial Practice Order	Desired behaviors practiced in sequential order that is repeated.	5 note scale on /i/; 5 note scale on /a/; 5 note scale on /o/; repeat all in order; i.e., ABC, ABC, etc.	Random and serial better than blocked for learning; little difference exists between serial and random.
Random Practice Order	Several different desired behaviors practiced intermixed in a nonsequential fashion.	5 note scale on /i/; 5 note scale on /a/; 5 note scale on /u/; 5 note scale on /ae/; i.e., ABA, BCA, CAB, BBC, CAA.	Change of target versus unpredictability of next task seems to be the reason serial and random are better than blocked for learning.
Type of Behaviors Practiced: Constant	Exact same behavior or movement is practiced in the same context.	Diction drills on /z/ between two /a/ vowels, i.e., /caza/, /raza/, /daza/, /baza/.	Suppresses learning with large amounts of practice; best when used in early stages of training. Learning may best be assisted by constant, then variable practice.
Type of Behaviors Practiced: Variable	More than one variant of a given behavior or movement are practiced; behaviors practiced are different from each other and occur in different contexts.	Scale on /i/ vowel; then an arpeggio on /i/, then staccato on /i/, then <i>messa di voce</i> on /i/.	Enhances learning with large amounts of practice; most effective when coupled with random or serial order; more similar to “real world” situations; may help children more than adults (children have less motor learning experience); most beneficial in later stages of training.
Massed Practice Schedule	Same amount of practice time or repetitions used as in distributed practice (below), but practiced in a relatively short time period.	One 60 minute practice session per day.	No clear evidence available. Some massed practice is essential for developing endurance for extended performances.
Distributed Practice Schedule	Same amount of practice time or repetitions used as in blocked practice (above), but divided into several sessions spaced over a longer period of time.	Six 10 minute practice sessions per day, each separated by 1 hour of other activities.	No clear evidence available. Distributed practice is less fatiguing to all muscle groups and the lamina propria than massed practice.
Timing of Feedback: Concurrent (with guidance/cues during practice) versus Non-concurrent	Real-time outcome information is either presented—i.e., immediate knowledge of results (KR) or knowledge of performance (KP)—or given after a delay.	Concurrent: teacher places hand on the singer’s abdominal wall to cue breathing movements. Nonconcurrent: teacher allows the student to perform an entire song without comments or cues.	Concurrent feedback greatly benefits performance while practicing, but suppresses learning, except when the feedback provides an external focus of attention. Nonconcurrent is essentially the same as delayed feedback.

(Continued next page)

TABLE 1. Motor learning and singing training.* (continued)

Practice Category	Description	Singing Training Example	Comments (caveat: few studies have been done on motor learning and voice)
Timing of Feedback: Delayed	Feedback (KR or KP) presented after a pause of seconds or minutes after each attempt at the desired behavior.	Teacher waits before providing feedback.	Even a five-second delay appears sufficient to enhance learning. The feedback delay seems to allow the singer to evaluate performance/results based on intrinsic feedback before the teacher provides external feedback.
Frequency or Amount of Feedback	Feedback can be provided (a) after each effort, (b) after a specified number of efforts, or (c) randomly.	(a) Teacher responds after each vocalise attempt or phrase. (b) Teacher responds after every fourth repetition of a vocalise. (c) Teacher uses no fixed schedule to respond to student efforts.	A feedback reduction benefits learning of general motor programs (GMPs). Frequent feedback benefits learning specific parameters of an action.
Type of Feedback: KP versus KR	Knowledge of Performance (KP) addresses how the student undertook the task. Knowledge of Results (KR) addresses how the student's performance met a goal.	KP: "You opened your mouth quite wide when you sang that high note." KR: "You were right on the pitch on the last note of the phrase."	Both seem equally beneficial to learning. KP seems helpful when undertaking a new or unclear task, but may not be helpful to learning when providing feedback concurrent with a student's performance.
Attentional Focus: Internal versus External	Internal focus brings the singer's awareness to processes, sensations of performing the task; external focus brings the student's attention to a result of performing the specific task.	Internal: "Pay attention to the way your tongue moves as you go from /i/ to /a/." External: "When you do this lip buzz, make sure the Kleenex in front of your mouth stays in motion."	Using an external focus that is relevant to the task being performed has been shown to have a strong learning advantage over using an internal focus.

*Based upon Edwin Maas, Donald A. Robin, Shannon N. Austermann Hula, Skott E. Freedman, Gabriele Wulf, Kirrie J. Ballard, and Richard Schmidt, "Principles of Motor Learning in Treatment of Motor Speech Disorders," *American Journal of Speech-Language Pathology* 17, no. 3 (August 2008), Tables 1–2, 282, and upon Christine Bergan, "Motor Learning Principles and Voice Pedagogy: Theory and Practice," *Journal of Singing* 66, no. 4 (March/April 2010): 458–466.

- 3–5 exercises addressing skills needed for the music to be sung done in circuit training fashion (exercise A, B, C, D, A, C, B, A, D, etc.), changing initial consonants and vowels in order to further facilitate motor learning. Difficulty level should gradually increase as the session progresses.
- Selected phrases from repertoire are mixed in with the exercises.
- A musical selection in preparation is addressed, first through singing the entire piece or a large section nonstop, then by alternating back and forth between

exercises and selected phrases as needed. The complete selection is sung nonstop one more time for synthesis.

- Warm down, using one of the first exercises from the beginning of the session; the singer evaluates how the exercise feels and sounds after having had a vocal "workout."
- The last vocalise is alternated with speaking common phrases ("Hi, my name is . . .," "Hello, this is . . .") to transfer good habits from singing voice production into speech.

The session moves from general to specific and from reassurance of acquired skills to developing new skills; skills are transferred from exercises to vocal repertoire, and basic principles are reviewed at the end.

But how does one juggle optimal motor learning-based practice with the emotional well-being of the singer? Take, for example, a talented but self-critical singer, who becomes too easily discouraged when he or she cannot succeed in short order. With this type of student, a careful balance must be struck between blocked constant and random variable practicing. Some singers need the reassurance of blocked practicing, where immediate performance is enhanced through repetitions of similar tasks, before they venture out on the limb of learning-enhancing (and perhaps more immediately frustrating) random practice.⁷ On a less drastic basis, the intentional use of limited amounts of blocked practice can be helpful for students of all temperaments.

PLANNING A MAJOR PERFORMANCE

Anyone who has sung a long operatic role or an extensive art song recital can confirm that vocal endurance—as acquired gradually through periodic massed practice sessions—is a necessity in preparing for such a performance. A sample practice plan is provided below for a singer preparing a one hour solo recital:

- 3 months prior to the performance: distributed practice.
- 1 month prior to performance: 4 days per week distributed practice, 2 days per week massed (similar to performance conditions), 1 day per week rest (post massed practice).
- 2 weeks prior to performance: alternate 1 day distributed, 1 day massed (with all aspects as similar to actual performance as possible, including time of day, location, room acoustics, wearing performance-related articles of clothing, etc.), saving 1 day per week for rest following a massed practice day.
- performance day: massed, blocked, constant warm-up of skills needed in recital; sing the recital; brief warm down afterward.

In summary, teachers must become acquainted with current exercise physiology and motor learning literature in order to best design and implement vocal exercises, accurately assign repertoire, and plan lessons and practice schedules. Best teaching practices include

the creation of individualized plans for each singer based on the strengths and weaknesses of the student and his or her learning style. These plans should include sequencing of technical skills to be developed, specific repertoire challenges, types of practicing (blocked, random, distributed, etc.) to be used, and the scheduling of performance targets.⁸

ACKNOWLEDGEMENT

This article was adapted with permission from “Systematic Development of Vocal Technique,” a chapter in the forthcoming *Oxford Handbook of Singing*, Graham Welch, David Howard, and John Nix, eds.

SUGGESTED READING

Readers may find Keith G. Saxon and Carole M. Schneider’s book *Vocal Exercise Physiology* (San Diego: Singular, 1995) to be a good introduction to exercise physiology as it relates to vocalization. Chapters 1–2 of Ingo Titze’s *Principles of Voice Production* (Iowa City: NCVS, 2000) also discuss vocal physiology in some detail. In addition to the previously mentioned “Master Class Syndrome” article, the “Mindful Voice” column has featured a number of articles on motor learning:

Helding, Lynn. “Motor Learning and Voice Training, Part II. Locus of Attention: Internal or External? That is the Question.” *Journal of Singing* 72, no. 5 (May/June 2016): 621–627.

Helding, Lynn. “Motor Learning and Voice Training: Locus of Attention.” *Journal of Singing* 72, no. 1 (September/October 2015): 87–91.

Helding, Lynn. “Connecting Voice Science to Vocal Art: Motor Learning Theory.” *Journal of Singing* 64, no. 4 (March/April 2008): 417–428.

Maxfield, Lynn. “Improve Your Students’ Learning By Improving Your Feedback.” *Journal of Singing* 69, no. 4 (March/April 2013): 471–478.

NOTES

1. Ingo Titze and Katherine Verdolini-Abbott, *Vocology* (Salt Lake City, UT: National Center for Voice and Speech, 2012), 191–193; Keith G. Saxon and Samuel Berry, “Vocal Exercise Physiology: Same Principles, New Training Paradigms,” *Journal of Singing* 66, no. 1 (September/October 2009): 52–53.
2. John Nix, “Criteria for Selecting Repertoire,” *Journal of Singing* 58, no. 3 (January/February 2002): 217–221; John Nix,

“Vocology and the Selection of Choral Repertoire,” *Australian Voice* 13 (2008): 36–42.

3. Titze and Verdolini-Abbott, 192–193; Saxon and Berry, 53–54.
4. Titze and Verdolini-Abbott, 219–220; Edwin Maas, Donald A. Robin, Shannon N. Austermann Hula, Skott E. Freedman, Gabriele Wulf, Kirrie J. Ballard, and Richard Schmidt, “Principles of Motor Learning in Treatment of Motor Speech Disorders,” *American Journal of Speech-Language Pathology* 17, no. 3 (August 2008): 278; Christine Bergan, “Motor Learning Principles and Voice Pedagogy: Theory and Practice,” *Journal of Singing* 66, no. 4 (March/April 2010): 457.
5. Lynn Holding, “Master Class Syndrome,” *Journal of Singing* 67, no. 1 (September/October 2010): 73–78.
6. Maas, 278.
7. Katherine Verdolini-Abbott, personal conversation with the author (July 1, 2006).
8. John Nix, “Systematic Development of Vocal Technique,” in Graham Welch, David Howard, and John Nix, eds., *The*

Oxford Handbook of Singing (New York: Oxford, 2017); <http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199660773.001.0001/oxfordhb-9780199660773-e-001?rskey=hPOzLK&result=1> (accessed May 31, 2017).

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