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Motor Learning and Teaching Singing: An Overview

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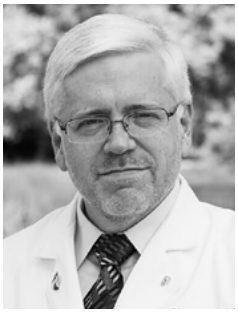

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MOTOR LEARNING: INTRODUCTION

What is "motor learning?" The scientific literature defines it as processes that, with practice and experience, may lead to changes in the ability to perform a motor activity.[1] Motor learning research examines how skilled tasks are acquired, practiced, and learned so they can be executed autonomously and with minimal energy expenditure.[2] Motor tasks can be as varied as riding a bicycle, learning to swim, dancing the foxtrot, and negotiating the *passaggio* in a Verdi aria. Singing may be one of our most complex neuromuscular coordinations.

How we teach (e.g., demonstrating and giving feedback) is just as important as *what* we teach (e.g., breathing, postural alignment).[3] Motor learning research may improve the *how*.

Why should voice teachers care? Many of us teach as we ourselves were trained. This may serve students whose voices are similar to our own, but how often is that the case?[4] Students bring a tremendous diversity to our studios, and they frequently want to sing in ways that we ourselves have not sung. Our professional ethics demand we serve *all* of our students to the best of our abilities.[5] Motor learning research offers a fact-based framework to improve teaching and learning.[6]

Current singing instruction is predominantly teacher centered. At first glance, this seems logical; the teacher is the expert, and the student is the learner. However, a teacher centered model of voice instruction may create an unhealthy or unproductive power dynamic that deemphasizes student autonomy and learning, causing dependency on the teacher, as well as stress and dissatisfaction with training.[7] Recent studies suggest that teachers spend *much* more time talking and dispensing knowledge in voice lessons than the student does singing.[8] In fact, Crocco et al. found that teachers gave their students copious amounts of verbal instruction, modeling, and feedback, but spent surprisingly little time having them sing.[9] Similar results have been found with teachers of other instruments.[10] This is a clear area where lessons from motor learning research may support improvement in teaching and learning.

Even in the best of circumstances, students may have difficulty developing artistic independence and professional self-direction.[11] Motor learning principles promote student autonomy and an adaptive, flexible approach

to teaching and learning. This resilience and independence is increasingly necessary for a successful career in the arts.[12]

Motor learning researchers in various disciplines have highlighted principles of how we teach, including *motivation, perceptual training, modeling, instruction*, and *feedback*, and important components of learning such as *autonomy* and *internal reference-of-correctness*.[13] This article presents an overview of these principles, recommendations for applying them in teaching, and what recent research suggests about current use of these principles in one to one singing lessons.

PHASES OF LEARNING

Voice students may be able to sing a new task correctly during a voice lesson, but their performance in a lesson may be temporary and does not reliably indicate that learning has occurred.[14] This is especially easy to observe in the guest master class setting. Motor learning research suggests that learning cannot clearly be seen but can be inferred by performance changes over time.[15] Motor skill learning is demonstrated in three phases: 1) *acquisition*: the *initial* attempt at and subsequent *practice* of a new skill; 2) *retention*: changes in a student's *capability* to execute the skill after the completion of practice (i.e., learning) and retained over time; and 3) *transfer*: whether a student's change in *capability* can be transferred to other similar, untrained skills.[16]

Recognizing at what stage of learning your student is, is important for implementing the recommendations presented here. Performance changes during a lesson or a student's private practice do not depict learning (i.e., retention/transfer).[17] Instead, learning may be inferred by how a student performs once practice has stopped. True *performance* of a skill is when the student can sing accurately in various performance environments and conditions.[18]

INTERNAL REFERENCE-OF-CORRECTNESS

In voice lessons, students may feel as if they are borrowing their teacher's brain—relying on the teacher to both diagnose and correct issues with their technique. The problem with this arrangement is that they need to leave that borrowed brain behind when the lesson is over. Students need to be trained to assess their own singing so that they can detect what is right and wrong for themselves when they leave the lesson and practice independently. In motor learning literature, this is known as an "internal reference-of-correctness."[19] The teacher may help students develop their internal reference-of-correctness by: 1) ensuring that students have an understanding of the target and goal;[20] 2) asking students what they hear/feel;[21] 3) slowly withdrawing feedback and asking students to assess their own performance.[22] Ideally, we are training them to become their own voice teacher and to independently use the tools we help them develop.

MOTIVATION: INFLUENCES AND IMPORTANCE

Motivation refers to student perception of self-efficacy, competence, and autonomy.[23] Teachers may assume that because students are in singing lessons, they are intrinsically motivated. However, *successful* skill acquisition, learning, and performance require *explicit* teaching behaviors that enhance student sense of competence, self-efficacy, and autonomy, which in turn make up student motivation.[24] Teachers know that a singer's emotions influence the physical and psychological mechanisms involved in singing. A student's level of motivation does the same.

Teachers may explicitly enhance a student's sense of self-efficacy, competence, and autonomy by: 1) discussing and setting clear, achievable goals so that students know *what* they're doing and *why*;[25] 2) providing more positive feedback, (e.g., "correct"/"good");[26] 3) providing feedback on larger, rather than smaller errors;[27] 4) asking the student what they hear/feel;[28] 5) asking the student to assess themselves after performing a task, before or even instead of the teacher's input;[29] and 6) supporting and tending to the teacher-student relationship through open-communication, and mutual trust.[30]

As that list may suggest, we influence student feelings of competence, self-efficacy, and autonomy with each of our teaching behaviors. These influences can leave longlasting effects on the student motivation. For example, a student's sense of self-efficacy, competence, and autonomy may be negatively influenced by: 1) providing *instruction* and/or *feedback* that is lengthy

or complex; 2) providing too much instruction, modelling and/or feedback; 3) little or no active attention to building a student's reference-of-correctness and ability to self-evaluate; and 4) not establishing goals, or setting goals without providing clear and simple directives, or without determining whether the student has truly understood the task.

Crocco et al. (2020) found that voice teachers displayed low use of motivational behaviors. This finding may come as a shock to teachers, but it suggests that teachers rely too much on student inherent love for singing to feed a willingness to continue training. Current motor learning research suggests that optimal learning requires explicit attention to motivational teaching behaviors.[31] Actively tending to students' sense of self-efficacy, competence, and autonomy, especially for a fine and complex skill such as singing, will increase their motivation, support optimal skill acquisition, learning and performance, and potentially lower their level of stress.[32]

PERCEPTUAL TRAINING: ACTIVE VS. PASSIVE

Teachers engage in perceptual training when aiming to improve student perception of sensations related to singing.[33] There is a difference between *active* and *passive* listening and/or watching. *Actively* attending to perceptual training assists in building student autonomy and helps them develop a reference-of-correctness for what they "should" do when they repeat the task, and when they are in their own independent practice.[34] Delivering perceptual training *actively* may be done by: 1) asking students "what did *you* see/feel/hear/notice about what you just did?"; 2) asking students to direct attention to a sensation/perception; 3) asking students to *make their own evaluation* about a sensation/perception, particularly before telling them what *you* saw or heard; 4) defining or explaining a sensation/perception, "the tension in the throat I'm talking about is like what your throat feels like when you lift something heavy."

We may think that this is something singing teachers do often; however, recent research may suggest otherwise. If students *passively* watch/listen to the teacher demonstrating/modelling a task, without the teacher actively directing their attention, students may not reliably generate stable changes in behavior.[35] Indeed, Crocco et al. found that perceptual training was one of the least used behaviors by teachers.[36] Considered alongside the finding that modelling was one of the *most used* behaviors, this finding suggests that teachers may have not *actively* attended to perceptual training.[37]

MODELING: FREQUENCY AND PURPOSE

Modelling is ubiquitous in singing training, and it can be a useful teaching tool. Crocco et al. found that teachers delivered copious models/demonstrations for their students.[38] Modelling allows students to observe things that are not easily described and may help them establish a reference-of-correctness. However, demonstrating too frequently can encourage *imitation* rather than skill acquisition.[39] Motor learning research recommends that modelling should be offered sparingly, and even avoided in the early stages of learning a complex task.[40] Doing so allows students to explore a given task for themselves before the teacher models it for them or gives them more instruction, in turn fostering student autonomy.[41]

To determine whether or not modelling is appropriate, consider asking, "What exactly do I want to convey to the student with this model?" If this question is hard to answer, consider using another method instead of modeling. When you *do* choose to use a demonstration, be sure to tell the student the goal of the task before modeling.[42]

INSTRUCTION: TYPE, AMOUNT, AND DELIVERY

How singing teachers deliver instruction matters. Examples of instruction may be, "Sing the last phrase on vowels only," or "Show me the melisma you've been practicing." The teacher may also use gestures to ask students to increase or decrease their loudness. Crocco et al. found that the teachers studied used *instruction* most out of all motor learning behaviors (alongside feedback), having provided instruction on all task attempts the students made.[43] Although this finding may suggest that instruction may be essential for a complex skill like singing, it also suggests that teachers may be overinstructing and flooding students with more information (factoids) than is beneficial.[44] When teachers overload

students with factoids, they can go into information overdrive,[45] making it difficult for them to process what you say in the lesson, and to remember and/or apply it in the practice room.[46] As a result, students may not understand how to address the technical problem, or even recognize when they have done something right or wrong. When giving instructions, teachers should aim to: 1) clarify both the task *and* the goal, taking into consideration the difficulty of the task and the skill level of the student;[47] 2) reduce potential difficulties by *clearly* and *simply* defining the task and goal;[48] and 3) help students develop a reference-of-correctness by providing *useful* information that slowly establishes the student's ability to detect their own errors.[49]

Motor learning research has identified two types of instruction: goal related and movement related instruction.[50] Goal related instruction focuses on what the student is trying to achieve. Movement related instruction relates to specific body movements needed in singing. Motor learning research suggests that goal related instruction is more effective, especially when learning a complex skill, as it directs the student's focus to something external (see feedback for more information on focus of attention).[51]

Along with instruction, further explanation may be offered, where the teacher explains the *why* or *how* of something related to the task. For example, "We've slowed this down so that you can get the intonation more accurate," or "Your belt won't get higher until you change your jaw shape." However, like instruction, less is more, so keeping it clear and simple is paramount in order to avoid cognitive overload.[52] Students get overloaded when we flood them with too many things to think about at once.

Overall, remember to keep instructions simple, concise, and clear with an external *what* focus (e.g., "Modify your vowel toward a schwa") whenever possible, rather than an internal *how* focus (e.g., "Raise your soft palate," or worse yet, the infamous "Use more support"). The more complex and difficult a task, the clearer and simpler the instruction should be. That being said, withholding instruction has still shown even greater learning and performance outcomes.[53] This may seem counterintuitive, but withholding or reducing instruction may encourage students to focus more on feedback, and ultimately perform better.[54]

FEEDBACK: PURPOSE AND APPLICATION

Type of Feedback

Our bodies naturally provide us with feedback through the sensory systems linked to the movement we are doing; this is called "task-intrinsic feedback."[55] Feedback that comes from external sources, in this case from the voice teacher, is called "augmented feedback."[56] This external feedback is considered one of the most important features of motor learning, as it helps students to understand their own task-intrinsic (internal) feedback and in turn practice autonomously and effectively.[57] Motor learning research has examined two types of augmented feedback.

Knowledge of results (KR) is feedback about how *accurately* a skill is performed.[58] After the student attempts a task, the teacher gives feedback about the student's *outcome*, in relation to the *goal* of the task.[59] For example, if the task is to sing the aria's climactic note with vibrato, the teacher tells the student if vibrato was or was not present with simple statements such as "correct/incorrect" or "yes/no." Furthermore, KR suggests positive/negative performance outcomes.

The simple information offered by KR is ideal for larger rather than smaller errors made by the student.[60] It also has both a motivational and instructional role. Offering the student this type of augmented feedback after more accurate attempts may result in better feelings of self-efficacy and competence, therefore impacting motivation, and subsequently skill acquisition, learning, and performance.[61]

Knowledge of performance (KP) is feedback where the teacher delivers information in a *descriptive* (i.e., what the student did), or *prescriptive* (i.e., how to fix it) manner.[62] For example, if a student is working on obtaining a tall, narrow mouth shape on an aria's high note, the teacher could use descriptive KP and say, "Your jaw was lower than last week, and you were still spreading a bit," or prescriptive KP where the teacher tells the student how to correct the error(s): "Watch yourself in the mirror and imagine you are yawning as you sing the note."

Prescriptive KP is best used when the student is attempting a new task, or when the student doesn't have a reliable internal reference-of-correctness.[63] A more skilled student may be more capable of effectually utilizing either descriptive or prescriptive KP.[64] However, if

your student has a strong reference-of-correctness and a clear idea of the task goal you are working towards, the simple outcome information offered by KR may be more effective than KP.[65]

Both KR and KP are useful in teaching students new motor skills. For feedback to be effective *and* efficient however, we need to know three things: 1) the *target* of our feedback, 2) the *type* of feedback that should be offered, and 3) *when* and *how* often to deliver it.[66]

Target of Feedback

The target of your feedback and the amount of feedback you deliver should be restricted to what your student needs and can apply effectively to achieve the goal.[67] Theoretically, singing students can make several errors simultaneously in a lesson, which may tempt the teacher to give a great deal of feedback. Crocco et al. reported this, showing that feedback was the highest delivered teaching practice by classical singing teachers, next to instruction.[68] It is important to consider that people may retain only small amounts of information at a given time. Motor learning research encourages teachers to reduce information offered via feedback, by focusing on the most important ingredients of the task that you are working on, and offering feedback only on larger rather than smaller errors.[69] For example, when working on a particular phrase of a song with the student, consider the analogy of a recipe: every recipe has a list of ingredients, and some are more important than others. Let's say your student sings a phrase and makes several errors (the ingredients were incorrect). Instead of offering feedback on every small thing (ingredient) that was incorrect in that phrase, try to offer feedback only on the most important ingredient that the student performed incorrectly.[70] Ultimately, you are targeting augmented feedback on the error that has highest priority.[71]

Frequency of Feedback

Motor learning research suggests that reduced frequency of feedback, rather than frequent feedback following each student attempt, may lead to more optimal learning outcomes.[72] Rather, Crocco et al. demonstrated that voice teachers offered feedback on every attempt the student made.[73] Frequent feedback may produce less accurate and less stable performance.[74] For example, frequent KR may result in students becoming dependent on feedback rather than their own intrinsic feedback, while less frequent KR or reducing KR over time has shown to enhance student retention of a skill.[75]

Be mindful of the difficulty of the task you are working on with the student, and the student's skill level. With simple tasks, reduced feedback may be more effective, but more complex tasks may require more frequent feedback as the student develops a reference-of-correctness.[76] For example, if the student is a beginner and what you are teaching is complex relative to his/her ability, feedback that is easy to understand and offered *frequently* may be more effective.[77] For a simpler task, students of all levels may benefit from *less frequent* feedback.[78]

Focus of Attention

Augmented feedback may direct student attention internally (e.g., attention to body movement) and/or externally (e.g., attention to effect of movement). When offering augmented feedback, directing the student's attention externally rather than internally, even if feedback is delivered frequently, may be more beneficial to learning.[79] The learning advantages of an external focus of attention when delivering feedback have consistently been found for a variety of skills, age groups, and skill levels.[80]

Internal Reference-of-Correctness

Giving feedback that is clear, related to a specific target/goal, and withdrawn over time, is essential. It helps students build an internal reference-of-correctness that allows them to independently and autonomously perceive errors during the lesson, and errors during their own independent practice where augmented feedback is unavailable.[81] High frequency feedback is effective only when *students* determine their own correct/incorrect performance.[82]

CONCLUSION

In summary, voice teachers can incorporate motor learning principles by considering the following:

- Think about at what stage of learning the student is.
- Ask students to evaluate themselves. Developing student autonomy and a reference-of-correctness is key.
- Ask students what they hear and feel after they sing.

- Just because students are taking lessons doesn't mean they're motivated. Student motivation matters and is influenced by what teachers do.
- Model sparingly. What exactly do you need to demonstrate? Be sure to state the goal first.
- When you ask your student to do something, be able to articulate why.
- Keep instructions simple, concise, and clear with an external focus. Less is more.
- Focus feedback on the most important "ingredients" of what you're working on.
- Offer feedback on larger rather than smaller errors.
- Keep feedback clear and simple.
- Pay attention to how much you are speaking in the lesson. Again, less is more.

The benefits of incorporating motor learning principles in the training of singers have been discussed for over a decade. Teachers such as Christine Bergan, Lynn Helding, Wendy Le Borgne, and Katherine Abbot Verdolini have spearheaded efforts to bring this science to the singing voice community.[83] Emerging studies by Lynn Maxfield, and Laura Crocco have provided evidence for how motor learning may directly improve teaching.[84] This evidence has been slow to emerge, in part because systematic observation of one to one lessons is difficult.[85] But now, with the help of neighboring fields that have faced similar difficulties, emerging preliminary evidence offers singing teachers objective research on how they are teaching, and suggests evidence-based methods of improvement.[86]

The world of singing is forever changing. This has never been as demonstrably true as today: Covid-19 has transformed the performing arts, and many of these changes will persist following the pandemic. Those who teach preprofessional singers are preparing them for careers that teachers cannot fully imagine. Students are beginning a lifetime of specialized work requiring multiple advanced skill sets in which they will continually learn and relearn skills for performance in roles that may not have been invented yet.[87] If the singing voice community fails to grow beyond a top down, didactic manner of instruction, we may not adequately prepare students for the future.[88]

As Tosi wrote in 1743, "From the first Lesson to the last, let the Master remember, that he is answerable for any Omission in his Instructions, and for the Errors he did not correct."[89]

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