The Voice Foundation

VOICE OF THE EDITOR

THE VOICE

VOLUME 24, ISSUE

The Voice

In This Issue:

Challenging Points of View

By Mary Sandage, PhD

Questioning common wisdom and bravely asserting new standards for voice habilitation and rehabilitation should be welcomed in the discipline of voice care. We can settle in with our commonly-held beliefs regarding the *why* and *how* of what we do when we shape the singing voice or rehabilitate the injured voice. But we only really advance the discipline when we propose novel ideas, re-examine well-regarded clinical practice or transfer a commonly used model of behavior modification from the clinic to the studio.

The three individuals I include in this issue challenge us to see voice through lenses that we may not have considered before. Ken Bozeman, from whom I learn something new every time we speak or I hear him lecture, offers his perspective on absolute spectral tone color theory. While admittedly somewhat controversial, this theoretical framework provides a construct for evaluating voice perceptually. David Meyer and Laura Crocco explore the manner in which motor learning principles, that are fairly well established in clinical voice care, can be useful in the studio to build student agency and self-efficacy as they transition from the studio environment to a performance career. Finally, Jarrad Van Stan challenges clinicians to closely examine the "contents of the voice therapy box" before endeavoring to understand how motor learning takes place.

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Challenging common wisdom, asserting new theoretical constructs, and borrowing from related disciplines helps keep us honest, challenged, and motivated to continue doing the work that we so love.

The Explanatory Efficacy of Absolute Spectral Tone Color Theory for Vowel Migration and Modification

By Kenneth Bozeman, Frank C. Shattuck Professor of Music, Lawrence University

In 2016 New England Conservatory voice teacher Ian Howell introduced into voice pedagogy from the field of psychoacoustics the concept of absolute spectral tone color. This theory maintains that just as humans perceive light frequencies as colors, the individual frequencies of a complex sound have an inherent tone color to human perception that is on a low to high, dark to bright, and /u/ to /i/ vowel-like continuum, such that a lower frequency imparts a dark, /u/-like quality to the composite tonal timbre, while a higher frequency imparts a bright, /i/-like quality. Other tone color components lie in between:

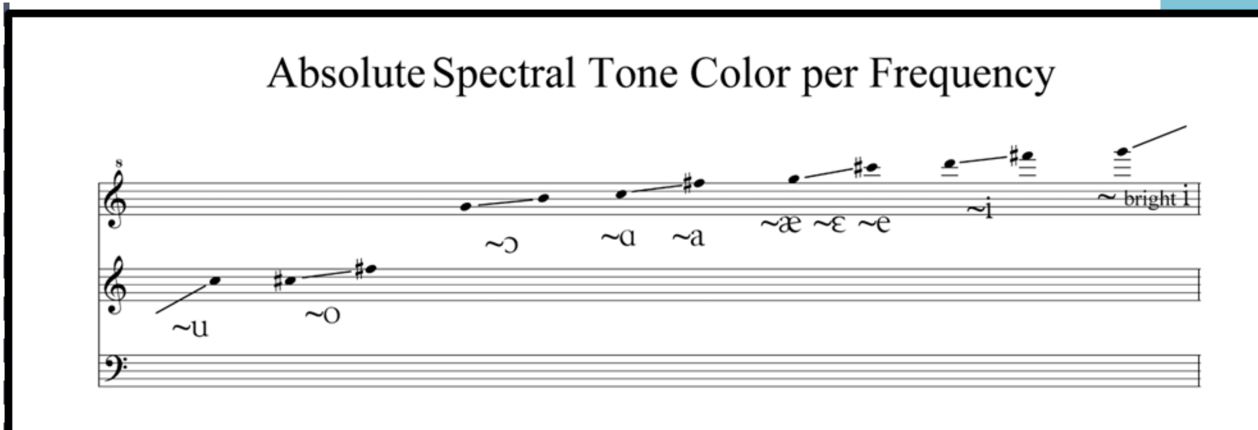

Figure 1: Absolute Spectral Tone Colors
(adapted from Howell with permission)

The implications of frequency-dependent spectral tone colors for voice pedagogy are game-changing. Firstly, the realization that the human brain processes *all* sounds as mixtures of vowel-like tone colors is significant. While there are other dimensions as well (attack, intensity, duration, pitch, etc.), all sounds can be decoded for their spectral components, each of which imparts a vowel-like tone color to the whole. Therefore, for sung tones, the tone color contributions of the voice source harmonics being featured by a given vocal tract resonance structure will determine the composite vowel and timbre of the resultant sound. If more than one harmonic is featured within the bandwidth of a given vocal tract resonance, the tone color of the resultant formant will be determined by its spectral centroid, an intensity weighted average of those two to three featured harmonics.

I have previously noted that the first (lowest) resonances of the vocal tract for all vowels, and hence the resultant first formants, lie in contact with the treble clef, from ca. D4 to G5. You will notice from the above chart that the spectral tone colors of those frequencies range

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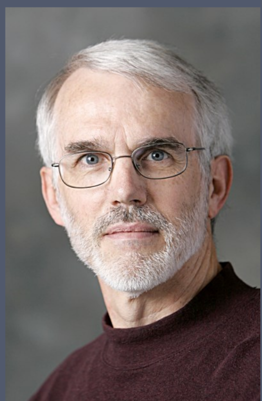
“THE IMPLICATIONS OF FREQUENCY-DEPENDENT SPECTRAL TONE COLORS FOR VOICE PEDAGOGY ARE GAME-CHANGING”



Kenneth Bozeman, Professor at Lawrence University, holds performance degrees from Baylor University and the University of Arizona, and also studied at the Conservatory of Music in Munich. He chaired the voice department for twenty-six years at Lawrence University, where he received two Lawrence awards for excellence in teaching and the *Van Lawrence Fellowship* by The Voice Foundation and NATS Foundation for his interest in voice science. He is the author of: ***Practical Vocal Acoustics: Pedagogic Applications for Teachers and Singers*** and ***Kinesthetic Voice Pedagogy: Motivating Acoustic Efficiency.*** .
He has presented at several NATS conventions and was a master teacher for the 2013 and 2017 NATS Intern Programs. https://faculty.lawrence.edu/bozemank/

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from /u/ up to C5, /o/ from C#5 up to F#5, with a bit of /ɔ/ at G5. The vast majority of first formants lie between ca. A4 and F5, in the territory of /u/ and /o/. This means that the first resonance and its resultant formant are always contributing an /u/- to /o/-like quality to the tone (with occasional /ɔ/-like color for treble voices singing /a/ or pitches above the treble clef). I have elsewhere observed that the first formant is responsible for the percept of timbral depth, warmth, or roundness. These tone colors (/u o ɔ/) give explanatory specificity to that percept. This also means that the defining identity for the vowels [u] and [o] primarily comes from the first formant. In the voice studio I refer to the lower pitched tone color contribution of the first formant as the "under-vowel" component. Although—as just explained—this component actually has an /u/ to /o/- like tone color, unless one hears spectrally (hears harmonics individually), most of us tend to hear the under-vowel component as somewhat blended with the over-vowel tone color component. This results in interesting mixed vowel colors reminiscent of active vowel modifications. (See figure on page 4.)

The second resonance of the vocal tract, which gives rise to the second formant in the radiated spectrum, typically lies between about G5 and D7. This spans the spectral tone colors of /ɔ ɑ a æ ɛ e i/. The primary identity of those vowels is therefore due to harmonics being featured by the second formant. The second formant is also responsible for a brightness component, given its higher frequency range. I refer to this higher tone color contribution as the "over-vowel" component. The singer's formant cluster lies higher yet, in the top octave of the piano, in the tone color range of /i/ to hyper bright /i/.

A vowel is then comprised of at least two primary color components—the tone colors of the featured frequencies of the first two formants. If the singer's formant is also present, it contributes a "ringing" quality that is essentially additional /i/-like color atop the two vowel tone color components. As a sung pitch is raised, its harmonics inevitably move through the tone color spectrum and in and out of vocal tract resonances, changing their inherent colors and relative intensities, and resulting in vowel and timbral migrations.

An additional important component that Howell's work brings over from psychoacoustics is called necessary roughness. This does not refer to the aperiodic chaos of a source signal caused by vocal fold pathology. Rather, this arises from the long established phenomenon that harmonic frequencies within a minor third of each other introduce an auditory roughness component to the sound—they "beat" against each other. Harmonics above $5f_0$ are increasingly closer than a minor third in proximity. If they are present in the signal and are being resonated, they inevitably ("necessarily") add a buzzy quality to the overall tonal percept. Lower voices, especially in mode one laryngeal register, generate more, higher numbered harmonics that also fall within vocal tract resonances. Hence, basses have a lot of strong "necessary roughness" (buzziness) while sopranos, especially

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on higher tones, have significantly less. The higher the fundamental frequency, the smoother or "creamier" and less intense the necessary roughness component, though still present in dramatic voice categories.

From the perspective of pedagogic strategy, one can draw students' attention to the two component tone colors of their vowels, teach them to sense how they are being formed, and teach them how to vary their percentage contribution for best result. A chart of approximate tone color perceptions is offered below.

Figure 2: Perception of the Tone Color Contributions of Vowel Formants

(from *Kinesthetic Voice Pedagogy: Motivating Acoustic Efficiency,* Inside View Press, 2017)

For more detail and suggested application strategies, see the resources below, especially the Howell and Bozeman *VOICEprints* article.

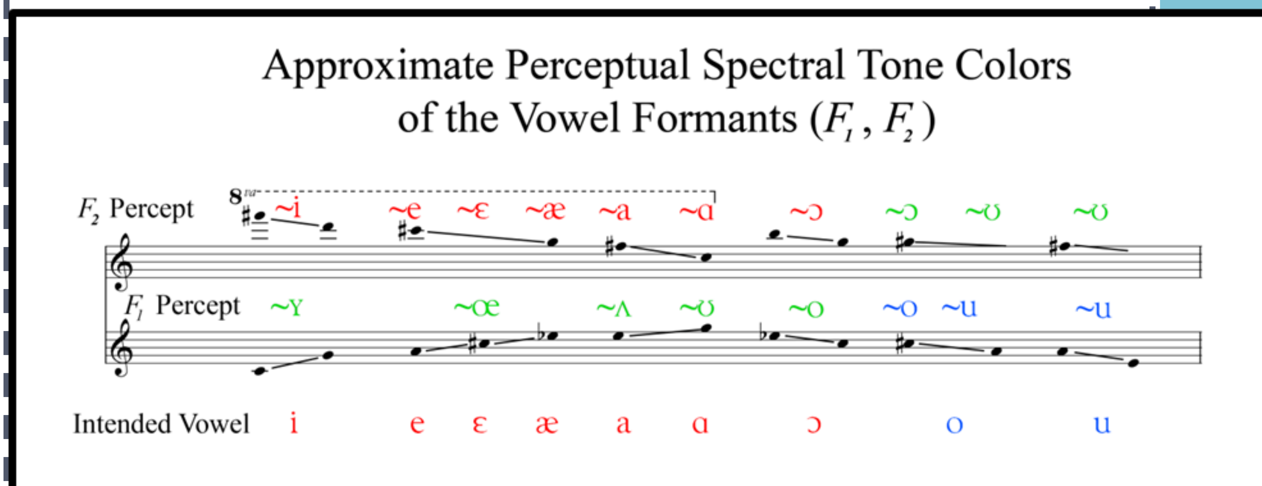

Figure 2: Perception of the Tone Color Contributions of Vowel Formants
(from *Kinesthetic Voice Pedagogy: Motivating Acoustic Efficiency,* Inside View Press, 2017)

Sources

Bozeman, Kenneth. *Practical Vocal Acoustics, Pedagogic Applications for Teachers and Singers.* Hillsdale, NY: Pendragon Press: 2013.

Bozeman, Kenneth. *Kinesthetic Voice Pedagogy: Motivating Acoustic Efficiency.* Gahanna, OH: Inside View Press: 2017.

Bozeman, Kenneth. "The Pedagogic Use of Absolute Spectral Tone Color." *Journal of Singing.* November/December 2017; Volume 74, No. 2: 179-183.

Bozeman, Kenneth. "Vowel Migration and Modification," VOICE*prints,* the NYSTA e-journal. November/December, 2018; Vol. 16, no. 2: 32-38.

Howell, Ian, "Parsing the Spectral Envelope: Toward a General Theory of Vocal Tone Color." DMA thesis, New England Conservatory of Music, 2016. Retrieved from https://www.academia.edu/29162454.

Howell, Ian, "Necessary Roughness in the Voice Pedagogy Classroom," VOICE*prints,* the NYSTA e-journal. May/June, 2017; Vol. 14, no. 5: 4-7.

What the Studio Voice Teacher Needs to Know About Motor Learning

By David Meyer, DM and Laura Crocco, MSc

Motor learning research looks at the acquisition, learning and relearning, and performance of motor skills. Examples include tasks as varied as picking up a glass, riding a bicycle, doing a triple Lutz jump in ice skating, and negotiating the passaggio in a Verdi aria.

Why should voice teachers care? We often teach as we ourselves were taught, and this may or may not best prepare our singers for today's music marketplace. Our pedagogy, rooted in centuries of rich tradition, needs to be forward looking, and motor learning research can help.

How we teach (e.g., demonstrating and giving feedback) is just as important as *what* we teach (e.g., breathing, postural alignment). Motor learning research can improve the *how*. Take, for example, the development of student autonomy. Have you had a technical or interpretative breakthrough with a student, only to see the improvement disappear by the next voice lesson? Generally, studio time is focused on the dispensing of expertise by the teacher. This deemphasizes student autonomy and may not prepare singers to leave us when their period of study is completed. Principles of motor learning embed student autonomy into pedagogy, improving student learning, performance, artistic independence, and vocal and emotional health. Without autonomy, singers may not realize their vocal potential outside of the studio.

Motor learning researchers have highlighted principles of how we teach: *motivation, perceptual training, modeling, instruction*, and *feedback.* This article presents an overview of these principles, recommendations for applying them in teaching, and a list of resources that explore these topics in more depth.

Motivation. This refers to the learner's perception of self-competence and self-efficacy. Just because students are in lessons doesn't mean that they're motivated, as many teachers can attest. We can enhance students' motivation in the following ways:

1. Set and discuss achievable goals.
2. Give encouraging feedback.
3. Help them understand why we are asking them to do something.

If we support our students' expectations of success and cultivate their love for singing, they will be motivated and more successful learners.

Perceptual training. According to research in motor learning, teachers should support their students' awareness of physical sensations during singing. Actively asking them to focus on their sensations during singing is much more helpful than talking about sensations in general. Ask them, "What did *you* see (or feel, hear, notice) about what you just did?" before you *tell*

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Co-published with the The Voice Foundation and NATS Journal of Singing

"IF WE SUPPORT OUR STUDENTS' EXPECTATIONS OF SUCCESS AND CULTIVATE THEIR LOVE FOR SINGING, THEY WILL BE MOTIVATED AND MORE SUCCESSFUL LEARNERS."

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them what you saw or heard. This will build student autonomy and long-term improvements in voice.

Modeling can be a powerful tool. It allows students to observe things that cannot be easily described and may help them know what is vocally correct or incorrect. But, demonstrating too frequently can encourage imitation rather than skill acquisition. Use modeling sparingly, especially with novice singers. Letting singers vocally explore a given task before modeling it for them or giving more instruction promotes autonomy.

"WITHOUT AUTONOMY, SINGERS MAY NOT REALIZE THEIR VOCAL POTENTIAL OUTSIDE OF THE STUDIO."

Instruction. We have so much to teach our students, but research shows that how we deliver information matters. Do you have a student who is thinking too much? Maybe you're overloading them with information. Motor learning fundamentally depends on experiential—not verbal or analytical—processes. Instead of prescriptive instructions where you *tell* students what they need to do, try using an exploratory approach and ask them what they noticed in their singing. When you need to give instructions, they should be concise, simple, and clear with an external *what* focus (e.g., the sensation or sounds of singing) rather than an internal *how* focus (e.g., "raise your soft palate"). The more complex and difficult a task, the more external and simple the instruction should be. This principle of motor learning helps students respond more effectively to feedback, identify unwanted behaviors, and avoid getting mentally stuck.

Feedback. Researchers suggest the type and frequency of feedback matters. Two types of feedback have been extensively researched:

1. Telling the student the outcome of their attempt at a task (e.g., "yes/no")
2. Giving the student a simple and clear description of what they did (e.g., "That sounded vibrant.")

Giving only an outcome won't help students detect correct or incorrect sensations. Telling a student what they *did* helps them develop an internal reference of correctness, especially when learning a new skill.

Frequency of feedback is also important. Learning improves when feedback is intermittent and delayed. When feedback is given too frequently, the student may become teacher-dependent, confused, and flooded with information. When this happens, performance and

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motivation suffer. Be mindful of when, how often, and what type of feedback you offer students.

A 2019 study (in press) by Crocco and colleagues reports that teachers give a lot of instruction, modeling, and feedback in lessons and may actually spend more time speaking than the student did singing. Teachers in that study gave very little motivation or active perceptual training. These data suggest there is room for improvement. We should pay attention to how much we are speaking in a student's lesson and what we are talking about. Optimally, we should use our words to increase student motivation and focus on the student's perceptions, not our judgments of their performance. If we avoid overloading them with factoids about vocal minutiae, we may produce better learners and singers.

Dr. Kittie Tuller Verdolini Abbott is a gifted pedagogue and voice scientist who successfully incorporates motor learning principles in her work with singers. Rather than go through a laundry list of faults in the student's performance, she asks guiding questions, offers feedback and modeling sparingly, and builds autonomy as she addresses the singer's vocal goals. She has developed the following teaching framework (with thanks to Dr. Mary Sandage):

Scan. Have the singer mentally scan their body during singing and note any sensations: tightness, working too hard, ease, whatever. They should not try to change what they find but simply experience it fully. Processing perceptual information (without judgment or analysis) is a powerful tool in motor learning

Gel. Shift the focus to physical manipulation of the specific body part or voice subsystem that needs work.

Show. Model the desired singing behavior.

Tell. Talk with the singer and tell them what to do. This should be done only after steps 1 to 3.

Negative practice. As a last resort, tell the singer to exaggerate whatever it is that they are doing incorrectly and make it worse. Then work to reverse the "worseness."

This framework is one of the best starting points for voice teachers interested in incorporating what we know about motor learning and is integral to Lessac-Madsen Resonant Voice Therapy (LMRVT), a technique that Dr. Verdolini Abbott developed.

How we teach has a major impact on how students learn. Motor learning research can help us more effectively guide students toward vocal goals and lives enriched by music. To learn more about motor learning, see the following reading list on page 8 and consider attending The Voice Foundation's Symposium: *Care of the Professional Voice Symposium* in Philadelphia annually (the weekend after Memorial Day).

> "TELLING A STUDENT WHAT THEY *DID* HELPS THEM DEVELOP AN INTERNAL REFERENCE OF CORRECTNESS, ESPECIALLY WHEN LEARNING A NEW SKILL."

Recommended Reading:

Crocco, L., P. McCabe, and C. Madill. Principles of motor learning in classical singing teaching: A pilot study. *Journal of Voice.* (In press.)

Gallwey, T. 2010. *The Inner Game of Tennis: The Classic Guide to the Mental Side of Peak Performance* (1st ed.). New York: Random House.

Hodges, N.J., and I.M. Franks. 2001. Learning a coordination skill: Interactive effects of instruction and feedback. *Research Quarterly for Exercise and Sport,* 72; 132-142. doi:10.1080/02701367.2001.10608943

Hodges, N.J., and I.M. Franks. 2002. Modelling coaching practice: The role of instruction and demonstration. *Journal of Sports Sciences,* 20; 793-811.

Hodges, N.J., and A.M. Williams. (Eds.). 2012. *Skill acquisition in sport: Research, theory and practice* (2nd ed.). Abingdon, United Kingdom: Routledge.

Hodges, N.J., A.M. Williams, S.J. Hayes, and G. Breslin. 2007. What is modelled during observational learning? *Journal of Sports Sciences,* 25; 531-545.

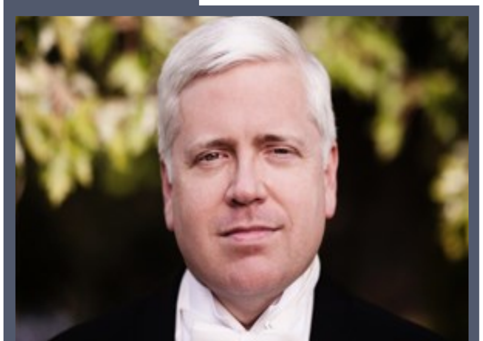
Lee, T.D. S.P. Swinnen, and D.J. Serrien. 1994. Cognitive effort and motor learning. *Quest*, 46, 328–344. doi:10.1080/00336297.1994.10484130

Locke, E.A., and G.P. Latham. (Eds.). 2013. New developments in goal setting and task performance. New York: Routledge.

Titze, I., Verdolini, K. "Perceptual-Motor Learning Principles: How to Train" 2012. In *Vocology – The Science and Prafctice of Voice Habilitation*, Pages 217-238. Salt Lake City, National Center for Voice and Speech.

Verdolini, K. 2000. "Principles of skill acquisition applied to voice training," In *The Vocal Vision: Views on Voice by 24 Leading Teachers, Coaches and Directors* edited by M, Hampton and B. Acker, Pages 65-80. Applause Books.

Wulf, G., and R.Lewthwaite. 2016. Optimizing performance through intrinsic motivation and attention for *learning: The optimal theory of motor learning, Psychonomic Bulletin & Review, 23; 1382-1414. doi:10.3758/s13423-015-0999-9*



A leading scholar and researcher of the singing voice, baritone **David Meyer** is an active performer, teacher, clinician, and voice scientist. He serves as associate professor of voice and voice pedagogy at Shenandoah Conservatory, and is Director of the Janette Ogg Voice Research Center. He is also a member of the Advisory Board of The Voice Foundation and is the Chairman of the Voice Science Advisory Committee of the National Association of Teachers of Singing. In 2010 he received the Van L. Lawrence Fellowship, a prestigious national award in recognition of his contributions to the field of teaching singing and the use of voice science. Dr. Meyer's students have won numerous awards and have sung in major venues worldwide.

Laura Crocco is a musician and researcher. She recently completed her master's of applied science in speech pathology at the University of Sydney. In her thesis she examined a systematic approach to one-to-one classical singing training. She earned a bachelor of music degree from the Sydney Conservatorium of Music in 2013, majoring in voice performance. Laura's research interest is in human motor behavior and teaching and learning in music performance training.

Trying to Decipher How Motor Learning Concepts are used in Voice Therapy

By Jarrad H. Van Stan, PhD, CCC-SLP

"WHAT THE CLINICIAN DOES DURING TREATMENT WAS UNCLEAR"

This article was originally intended to describe how speech-language pathologists (SLPs) incorporate motor learning concepts into voice therapy. However, a simple descriptive exercise quickly turned into a complex deciphering task. Because, after perusing multiple published voice therapy studies, what the clinician does during treatment was unclear. This should not have been surprising, since it is well known that rehabilitation research spends more effort on understanding outcome measurement compared to the therapeutic process responsible for the measured improvements (Dijkers, Hart, Tsaousides, Whyte & Zanca, 2014). In fact, opaque therapy descriptions have been so common, treatments (including voice therapy) are routinely represented as "black boxes" that mysteriously create clinical outcomes (Whyte & Hart, 2003). However, this approach has produced tremendous advancements in outcomes measurement, demonstration of treatment effectiveness of individual studies, and understanding the physiological processes of voicing. But without meticulously investigating the contents of the voice therapy box, most benefits of treatment research will be out-of-reach; e.g., combining data across studies, understanding what clinician actions were responsible for the treatment's effects, and systematically improving established approaches or everyday voice therapy (Van Stan et al., 2019). So instead of sticking to the original intent (describing how motor learning is used in voice therapy), it seemed more beneficial to outline one example of how learning a vocal motor skill might fit into a standard voice therapy protocol.

To clearly describe how a vocal motor skill fits into voice therapy, I will use a standardized framework for describing treatment across rehabilitation disciplines called the **Rehabilitation Treatment Specification System (RTSS)** (Hart et al., 2019). The RTSS categorizes rehabilitation treatments by a three-part structure: Ingredient(s) » Mechanism of Action » Singular Target. This three-part structure is called a treatment component (i.e., the smallest functional unit considered a "treatment"). Ingredients include what the therapist does to change a desired patient function. The treatment target is defined as the aspect of functioning that is directly changed by the

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ingredient(s) provided. Finally, the mechanism of action is the hypothesized way in which the ingredient (s) affect the singular treatment target. A key point is that all targets and ingredients must be measurable in principle (i.e., observable) while mechanisms of action are typically hypothetical.

What would a vocal motor skill look like through the lens of the RTSS? Let's imagine that a patient with vocal fold nodules was asked to complete the Vocal Function Exercise (VFE) program (Stemple, Lee, D'Amico & Pickup, 1994). Of note, the VFE program is meticulously described and has demonstrated effectiveness in more than 20 peer-reviewed articles. However, the reader may already be asking "how can an 'exercise' program be used to illustrate the application of motor learning?" This is a great question as the term "exercise" typically refers to treatment ingredients that target increased muscle strength or endurance. Treatment ingredients associated with learning motor skills would, instead, be practice-based and target improved accuracy of some vocal motor behavior. Many vocal exercises from the VFE program use an ingredient based on sustained vowels; specifically, the speech-language pathologist (SLP) asks the patient to sustain an /ol/ vowel, as softly as possible, for as long as comfortable. However, whether this is an exercise-based or practice-based ingredient hinges on the question "What is the target of the ingredient: an improvement in muscle physiology or an improvement in a vocal motor skill?"

One attempt at settling the "exercise versus practice" dilemma for this VFE ingredient (i.e., What is the treatment target?), is the RTSS's concept of a "tightly linked causal chain." When asking a patient to sustain a vowel (ingredient), tightly linked causal events (mechanisms of action) result in a modified patient function (target). In this sequence of events, one must decide where the mechanism of action ends and the target begins. Sustained voicing requires neural activation in the brain, which sends neural signals to muscles, then muscles of the voice and speech system begin to move, and finally, the patient attempts to control their voicing in a desired way. Which of these tightly linked functions is the target of the sustained voicing ingredient? To make this decision, the clinician must ask "what is the earliest *clinically relevant* function in the chain?" The term "clinically relevant" refers to the patient function that must change for the treatment ingredient(s) to be considered successful. In other words, why do SLPs ask their patients to perform sustained voicing? Is the clinical purpose to enact changes in the neuromuscular junction, muscle bulk, muscle torque, or some improved vocal motor skill?

The goal of sustained vocalization in the VFE program, as described by the developer (Dr. Stemple), is to voice for a specific length of time: patient's vital capacity divided by 80 mL/s of flow; or the length of time equal to the

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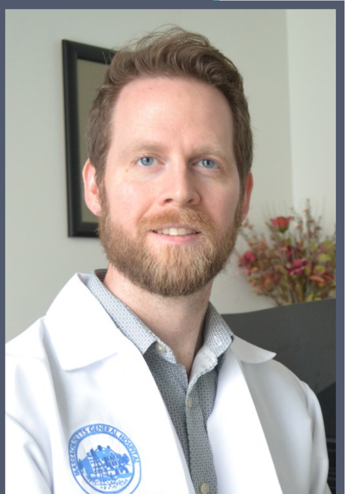
> "WHAT IS THE TARGET OF THE INGREDIENT: AN IMPROVEMENT IN MUSCLE PHYSIOLOGY OR AN IMPROVEMENT IN A VOCAL MOTOR SKILL?"

patient's longest held /s/. With this goal, it becomes apparent that if changes in muscle physiology happen without an increase in sustained voicing time, the ingredient would not be clinically successful. In other words, changes in muscle physiology would belong in the mechanisms of action and the target would be described as a vocal motor skill (e.g., "improved consistency of airflow during soft voicing" as measured by increases in sustained voicing time). Therefore, patient repetition of prolonged vowels in the VFE program would be labeled as "practice" (not exercise) because the ingredients are used to improve a vocal motor skill (not the strength or endurance of speech/voice musculature).

To be clear, this example pertains to a specific context: one VFE ingredient (sustained vowels) and a patient with vocal fold nodules. A muscle strengthening target (and exercise ingredient) could be present in another context (e.g., increased true vocal fold adduction in a patient with vocal fold paresis).

Describing how motor learning fits into voice therapy requires the clinician to think carefully about the desired functional change in the patient (target) and what they will do to directly affect that function (ingredient). Without a standard method for articulating the salient aspects of treatment, attempts to identify the active ingredients of vocal motor learning (and measure the improved skill) will be significantly limited.



Jarrad Van Stan, PhD, CCC-SLP is an Assistant Professor of Surgery at Harvard Medical School, a Speech-Language Pathologist at the Massachusetts General Hospital – Center for Laryngeal Surgery and Voice Rehabilitation, and an Adjunct Assistant Professor at the MGH Institute of Health Professions. His clinical research program hopes to improve the assessment and treatment of voice disorders through the use of cutting-edge technology (ambulatory monitoring, virtual environments, machine learning) and testing/developing clinical treatment theory.

REFERENCES:

Dijkers, M. P., Hart, T., Tsaousides, T., Whyte, J., & Zanca, J. M. (2014). Treatment taxonomy for rehabilitation: past, present, and prospects. *Archives of physical medicine and rehabilitation*, 95 (1), S6-S16.

Hart, T., Dijkers, M. P., Whyte, J., Turkstra, L. S., Zanca, J. M., Packel, A., Van Stan, J. H., Ferraro, M., & Chen, C. (2019). A theory-driven system for the specification of rehabilitation treatments. *Archives of physical medicine and rehabilitation*, 100 (1), 172-180.

Stemple, J. C., Lee, L., D'Amico, B., & Pickup, B. (1994). Efficacy of vocal function exercises as a method of improving voice production. *J Voice*, 8 (3), 271-278.

Van Stan, J. H., Dijkers, M. P., Whyte, J., Hart, T., Turkstra, L. S., Zanca, J. M., & Chen, C. (2019). The Rehabilitation Treatment Specification System: implications for improvements in research design, reporting, replication, and synthesis. *Archives of physical medicine and rehabilitation*, 100 (1), 146-155.

Whyte, J., & Hart, T. (2003). It's more than a black box; it'sa Russian doll: defining rehabilitation treatments. *American journal of physical medicine & rehabilitation*, 82 (8), 639-652.

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