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Clinical Focus

A Taxonomy of Voice Therapy

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Purpose: Voice therapy practice and research, as in most types of rehabilitation, is currently limited by the lack of a taxonomy describing what occurs during a therapy session (with enough precision) to determine which techniques/components contribute most to treatment outcomes. To address this limitation, a classification system of voice therapy is proposed that integrates descriptions of therapeutic approaches from the clinical literature into a framework that includes relevant theoretical constructs.
Method: Literature searches identified existing rehabilitation taxonomies/therapy classification schemes to frame an initial taxonomic structure. An additional literature search and review of clinical documentation provided a comprehensive list of therapy tasks. The taxonomy's structure underwent several iterations to maximize accuracy, intuitive function, and theoretical underpinnings while minimizing redundancy. The taxonomy was then used to classify established voice therapy programs.
Results: The taxonomy divided voice therapy into direct and indirect interventions delivered using extrinsic and/or intrinsic methods, and Venn diagrams depicted their overlapping nature. A dictionary was developed of the taxonomy's terms, and 7 established voice therapy programs were successfully classified.
Conclusion: The proposed taxonomy represents an important initial step toward a standardized voice therapy classification system expected to facilitate outcomes research and communication among clinical stakeholders.

It is generally agreed that outcomes research in the rehabilitation field is limited by a lack of attention and detail toward the measurement of therapeutic processes (Baker, Fiedler, Ottenbacher, Czyrny, & Heinemann, 1998; DeJong, Horn, Gassaway, Slavin, & Dijkers, 2004; Dijkers, 2014; Heinemann, Hamilton, Linacre, Wright, & Granger, 1995; Hoenig et al., 2000; Hoenig, Sloane, Horner, Zolkewitz, & Reker, 2001; Institute of Medicine, 2001; Reker et al., 2000). Rehabilitation intervention studies frequently have focused on changes in outcome measures without adequate description and classification of the therapeutic processes that caused the measurement changes. Even the most detailed programs use vocabulary specific to their protocol, resulting in different names for a single *therapy task* across interventions, which fundamentally hinders the field's ability to reliably determine the relative contributions of specific therapy tasks or components to changes in outcomes (e.g., identifying the "active ingredients" of an intervention; Whyte et al., 2014). In essence, rehabilitation treatments (which include voice therapy) have been portrayed as a "black box" (DeJong et al., 2004; Dijkers, Hart, Tsaousides, Whyte, & Zanca, 2014; Dijkers, Hart, Whyte, et al., 2014; Hart et al., 2014; Whyte & Hart, 2003), resulting in a decreased ability to determine why patients improve or which therapy tasks and associated treatment dosages were effective for specific patients and patient populations.

A review of the rehabilitation literature reveals two major reasons for the black box phenomenon. The first reason is due to an infrequency of theory-driven rehabilitative intervention research (Bode, Heinemann, Zahara, & Lovell, 2007; H.-T. Chen & Rossi, 1980; Whyte, 2008). Without sufficient theoretical underpinnings, even a well-designed randomized clinical trial may demonstrate the efficacy of treatment yet fail to enhance our understanding of the mechanisms underlying the improvement. The second reason is an absence of unifying standardized terminology in the description of therapeutic approaches (Barak, Klein, & Proudfoot, 2009; Bruton, Garrod, & Thomas, 2011; Page, Schmid, & Harris, 2012). Aspects of communication and organization that make healthcare professionals effective within groups (e.g., private language, authority recognition mechanisms, shared routines and culture) often make communication ineffective between groups (Lambe, 2007). Without standardized/accepted definitions and terminology, insight into the voice therapy process across disciplines

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(e.g., physicians, physical therapists, occupational therapists, physician assistants, etc.) and across levels of experience and expertise (e.g., patients, families, students, singers, and third party payers) is unnecessarily limited.

A taxonomy can be used to address the aforementioned limitations as its construction and application requires the development of standard terminology/semantics and an underlying theory to provide classification and *structure* for observations, phenomena, and concepts, such as therapeutic interventions (Lambe, 2007). There are many structures of taxonomies, and in the classical form they have provided hierarchical levels consisting of purely orthogonal categorizations, such as the Linnaean taxonomy of biology and the Dewey Decimal System. However, classifying the dynamic clinical interaction during a voice therapy session between a clinician and patient as they attempt to modify a complex sensorimotor and cognitive/affective human system does not lend itself to orthogonal categorization and strict *hierarchy*. Therefore, a well-developed taxonomy for voice therapy would allow for rule-based redundancy (i.e., areas of overlap between categories) and the interaction of various aspects of treatment both within and across a hierarchical setting. But what type of structure would best characterize the voice therapy process? *Polyhierarchies* provide categorization structures that allow items to be categorized in multiple hierarchical levels and/or categories, but there is often too much flexibility in these as they "break" their own rules of hierarchy (Lambe, 2007) and can easily lose their appearance as an organizational structure as they increase in complexity (Rosenfeld & Morville, 2002). In contrast, two other organizational approaches allow for rule-based redundancy and multiple dimensions without these complications: *matrices* and *facets*. Matrices require multiple dimensions of measureable attributes (Bailey, 1994; Kwasnik, 1999), such as the Periodic Table of Elements, which uses atomic mass and electron arrangement. However, the application of a multidimensional matrix may fail the test of categorizing the voice therapy process in a comprehensible manner because interventions delivered to patients in the real world frequently depend on multiple tasks—tasks that in themselves have multiple dimensions—being applied simultaneously. In addition, individual tasks can have different characteristics depending on the situation in which they are used (e.g., maximum phonation time to encourage increased vocal fold contact during a session for Parkinson's treatment vs. phonatory system rebalancing to minimize phonotrauma in methods such as Vocal Function Exercises [VFE]; Ramig, Countryman, Thompson, & Horii, 1995; Stemple, Lee, D'Amico, & Pickup, 1994). Faceted classification systems can handle this problem as categorization of items depends on what facets describe them (Ranganathan, 1967). Furthermore, because facets can describe and categorize an item, faceted classification systems can dynamically change in response to new knowledge and paradigm shifts in the field. It appears that voice therapy classification would be best suited with a faceted structure, as treatment ingredients may have multiple facets that permit their description in various contexts and categorical placement.

The taxonomy must also be linked to the development of a dictionary and thesaurus with clear definitions of all terms used to describe the components of the voice therapy process in a universally acceptable manner. Therefore, all who use the taxonomy would have a common conceptual structure and terminology to facilitate training, assessment, education, and dissemination of information. Establishing such "common ground" has been referred to in the taxonomy literature as creating boundary objects (Bowker & Star, 1999; Dijkers, 2014; Lambe, 2007; Star & Griesemer, 1989).

Once common ground has been established, a taxonomic model can help structure systematic investigation into the voice therapy process and may help guide the generation and testing of hypotheses, lead toward increased homogeneity in meta-analyses, and help identify potential areas where innovation may be possible. Furthermore, as clinical outcomes research improves its theoretical underpinnings through the use of a unifying framework, the taxonomy itself will benefit through an evolution of empirically based revisions in conceptual structure and the weighting of various treatments or categories grounded in efficacy/effectiveness findings for specific diagnoses. Such a model would facilitate improved consistency and clarity of clinical training in voice therapy across different educational programs. In addition, the development of a unifying model may also result in direct clinical benefit via the development of useful/efficient documentation templates and therapeutic coding schemes.

Categorical descriptions of the voice therapy process currently exist in the literature, but none have attempted to develop a comprehensive and detailed taxonomic model to be used as a classification tool, nor have they proposed a dictionary with definitions for its terminology or provided a classification structure capable of demonstrating rule-based interactions or overlap between categories and categorized items. The most common categorization of voice therapy has been the orthogonal distinction between direct or indirect methods (Behrman, Rutledge, Hembree, & Sheridan, 2008; Carding, Horsley, & Docherty, 1999; Dunnet, MacKenzie, Sellars, Robinson, & Wilson, 1997; Holmberg, Hillman, Hammarberg, Södersten, & Doyle, 2001). *Direct interventions*[1] include tools that modify vocal behavior through motor execution, *somatosensory feedback*, and auditory feedback (cf. Guenther, Ghosh, & Tourville, 2006), whereas *indirect interventions* include tools that modify the cognitive, behavioral, psychological, and physical environment in which voicing occurs (Roy et al., 2001; Thomas & Stemple, 2007). More detailed descriptions of voice therapy tasks have been made as well, but they are limited either by a nonpractical (i.e., not clinically useable) underlying theory or a lack of exhaustive standardized terminology (Boone, 1971; Gartner-Schmidt, Roth, Zullo, & Rosen, 2013; Reed,

[1]One purpose of creating a taxonomy is to establish a standard, accepted dictionary—so all italicized terms in this article and those listed in Figure 1 are defined in Appendix A (the dictionary).

1980; Thomas & Stemple, 2007). Thomas and Stemple (2007) used three categories to orthogonally classify voice therapy approaches: hygienic, symptomatic, and physiologic. These categories may be useful theoretical classifications, but even Thomas and Stemple (2007) admitted they "are more academic than practical." Because the original intention of these authors was to simply describe the current state of voice therapy and not develop a classification system, using this as a starting point for a taxonomy would be problematic. Gartner-Schmidt et al. (2013) attempted to quantify component parts of voice therapy as a two-level hierarchy—indirect and direct approaches in the first level and subgroupings of each in the second level—consisting of orthogonal categories. A single-institution prospective use of this classification scheme noted differences in direct and indirect therapy delivery according to various diagnoses; however, these results may have limited generalization as they reflect only the clinical practice patterns, semantics, and classification scheme of a single institution. Furthermore, the list of therapy tasks is not comprehensive, and a dictionary to provide a basis for standardized terminology was not provided.

As no universal conceptual framework of voice therapy currently exists, the purpose of this clinical focus article is to aggregate the vast amount of information from the voice therapy, rehabilitation, and taxonomy literature to (a) propose an initial conceptual model for the classification of voice therapy tasks and (b) provide a dictionary of standard terminology with clear definitions. Even more specifically, the focus of this taxonomy project is the classification of what happens during a voice therapy session. The focus is not to determine the optimal dosing of any putative active ingredient related to a particular voice therapy approach. Once a method for classifying the voice therapy process has been proposed and evaluated, the quantification of dosing (e.g., time in session, number of repetitions, number of therapy visits per week, etc.) can be subsequently added. Therefore the measurement of dosing is not explicitly addressed (Roy, 2012).

To conclude, the taxonomy's potential for successful clinical and academic use is tested through examples of educational benefits and the classification of established therapy approaches. With this initial effort towards the creation of a conceptual voice therapy framework, in-depth qualitative and quantitative research will be enhanced.

Taxonomy Development

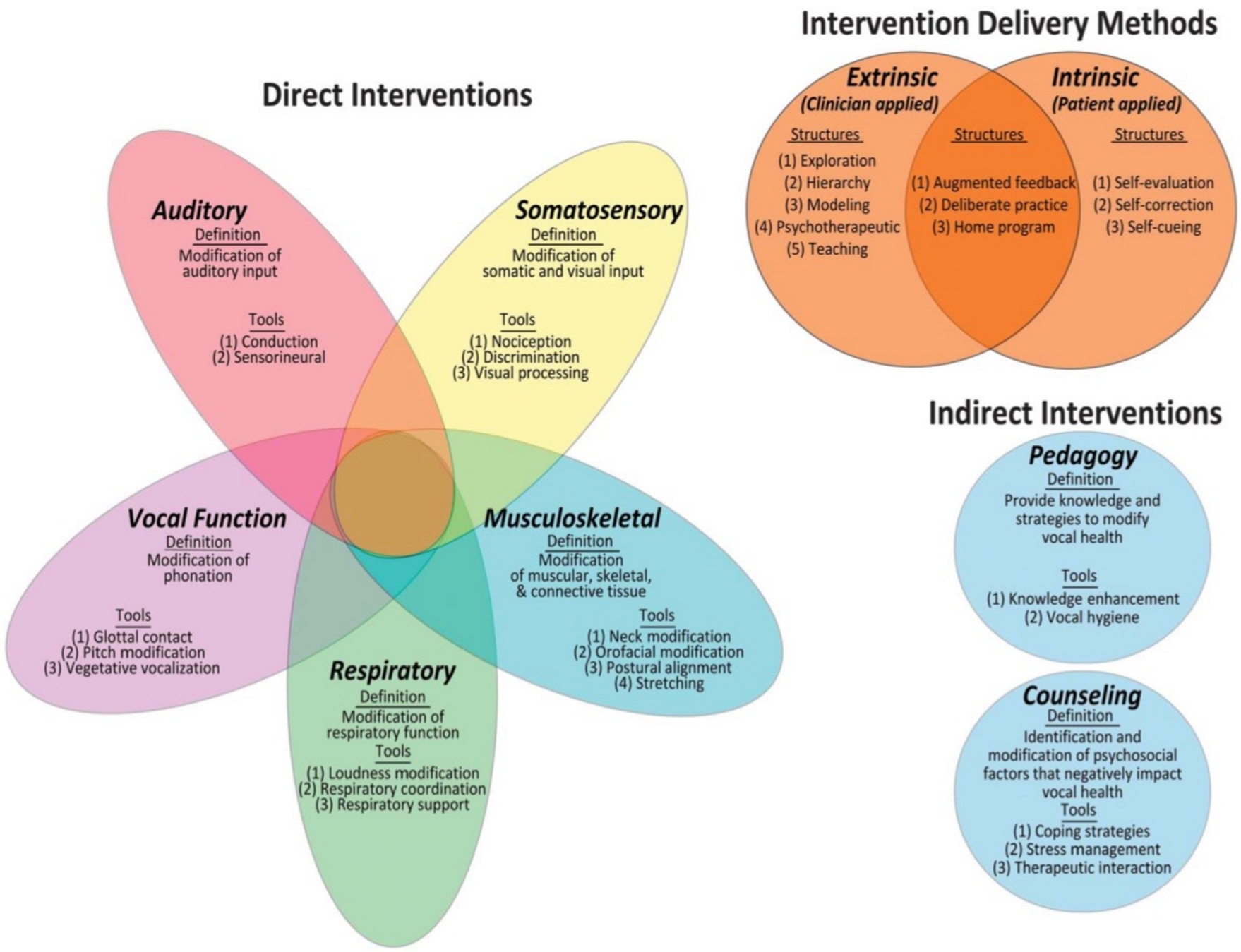
Before describing the process of developing the voice therapy taxonomy presented herein, the framework that emerged from this process, shown in Figures 1 and 2, will be briefly explained. Three overall categories are presented in the first level (Figure 1), which are direct interventions, indirect interventions, and *intervention delivery methods.* Each therapy task is labeled a *tool* and all tools are categorized under their respective direct and indirect interventions. To deliver a tool as a therapy task, it must be readied for delivery with a structure from the intervention delivery methods. For example, if a clinician wanted to use the tool of maximum phonation time, he or she would need to specify how it was structured in terms of *deliberate practice*. The second level of the direct intervention categories in Figure 1 is presented in Figure 2. Here the specific tools are categorized and their ability to have multiple characteristics (i.e., facets) is demonstrated by the areas of overlap or redundancy in the model.

The first step in creating this taxonomy was the development of rules regarding how treatments should be defined and categorized (Lambe, 2007). After completing extensive literature searches, it became apparent that reliance on empirical data of efficacy and effectiveness would not be adequate for the development of these rules—this is common throughout the field of rehabilitation (Whyte et al., 2014). Though empirical evidence will affect taxonomic development and revisions in the long term, it is more important initially to establish conceptual coherence. Therefore, our peer-reviewed literature, textbook, and clinical documentation searches were not used in terms of a conventional systematic review but instead to find examples to test our list of treatments, as well as the resulting categorizations and conceptual structure. When problems were identified, the taxonomy was revised in an iterative process until it proved robust to the complicating examples. Furthermore, the resulting taxonomic structure, theoretical underpinnings, definitions of terms, and categorization attempts included in this article were iteratively revised during multiple collaborative meetings until all authors were in agreement.

An initial list of voice therapy tasks was compiled by reviewing 3 months of therapy notes from the Massachusetts General Hospital Center for Laryngeal Surgery and Vocal Rehabilitation (Voice Center) between August and October of 2012. Published literature and textbooks (Aronson, 1990; Boone, McFarlane, & Von Berg, 2005; Colton, Casper, & Leonard, 2006; Sapienza & Ruddy, 2009; Stemple & Hapner, 2014) were then reviewed to augment the list of therapy tasks. To obtain a universal model that was as orthogonal as possible, existing therapy programs/packages were not listed but instead broken down into their individual therapy tasks. Once a comprehensive list of voice therapy techniques was compiled, a literature search for rehabilitation taxonomies was completed to identify existing taxonomies that might provide practical suggestions and/or a theoretical framework for the development of the voice therapy taxonomy described here.

Rehabilitation taxonomies (Apeldoom et al., 2010; Cahow et al., 2009; DeJong et al., 2004; Gassaway, Whiteneck, & Dijkers, 2009; Hart et al., 2014; Hoenig et al., 2000; Natale et al., 2009; Ozelie et al., 2009; Whyte et al., 2014) and voice therapy-related publications (Behrman et al., 2008; Carding et al., 1999; Dunnet et al., 1997; Gartner-Schmidt et al., 2013; Holmberg et al., 2001; Roy et al., 2002; Roy et al., 2003; Speyer, 2008) found in the literature search frequently referred to direct and indirect interventions. When reviewing clinical documentation and after discussions with the staff speech-language pathologists (SLPs) and co-authors, direct and indirect intervention categories appeared to provide

Figure 1. Demonstration of the structure and organization of the first layer of a taxonomy of voice therapy. In the direct intervention categories, notice that the pathways of voicing are temporally ordered from inferior to superior (e.g., the feedforward pathways are the three inferior categories, and the feedback pathways are the two most superior categories).

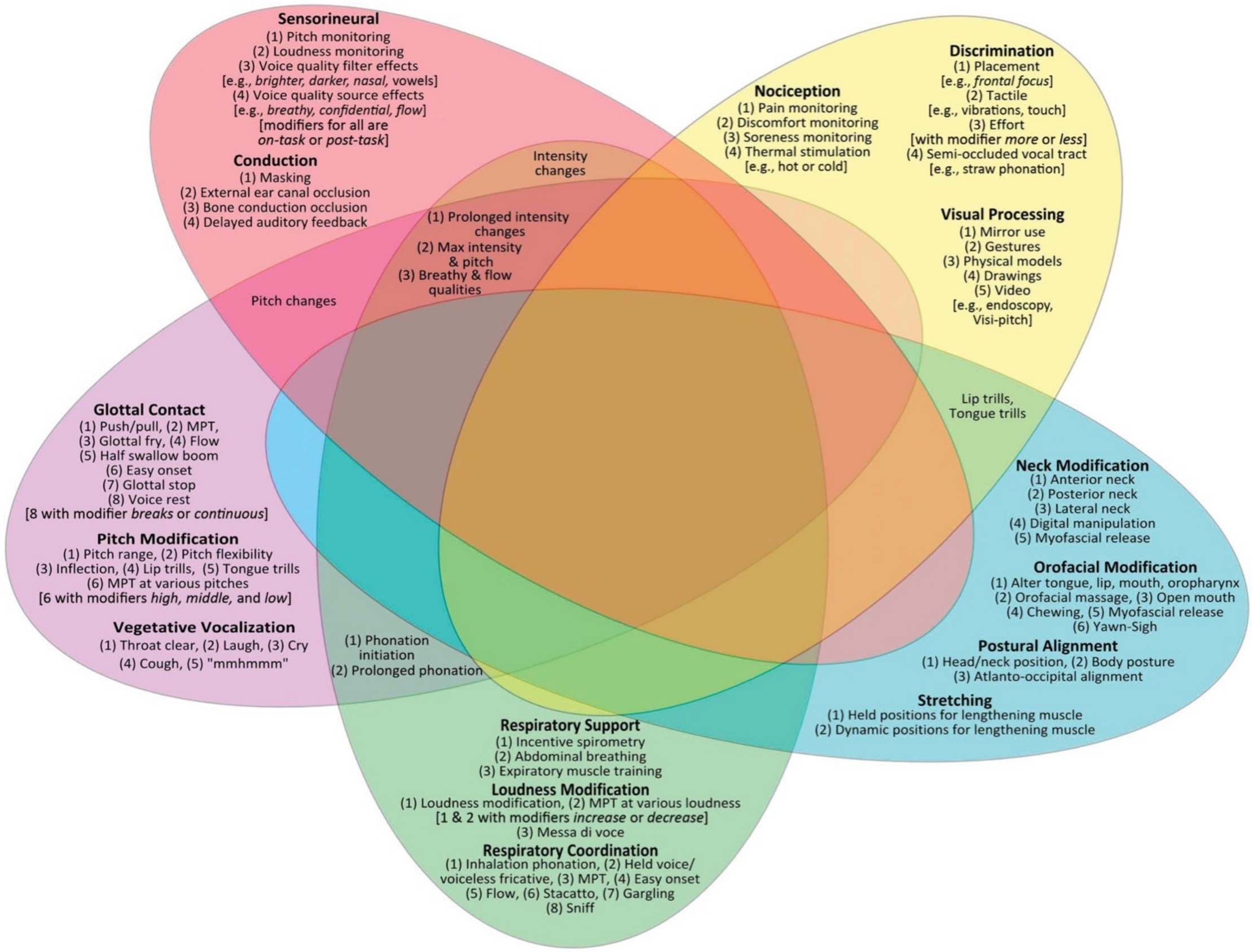


orthogonal divisions with therapy tasks. However, vital aspects of specific indirect and direct therapy tasks were not accounted for (e.g., task difficulty level). Upon further evaluation, it was noted that the structure of the therapy delivery method was being lost when only using direct and indirect categories. Therefore therapy delivery methods were also identified and categorized. This resulted in the three categories of direct interventions, indirect interventions, and intervention delivery methods illustrated in Figure 1 and designed to be orthogonal.

Direct interventions include tools that modify vocal behavior through motor execution, somatosensory feedback, and auditory feedback. Indirect interventions include tools that modify the cognitive, behavioral, psychological, and physical environment in which voicing occurs, and intervention delivery methods were defined as *extrinsic* (i.e., clinician-applied) or *intrinsic* (i.e., patient-applied) *structures* used to deliver an intervention. All direct and indirect therapy tasks were then labeled *tools*. Direct intervention tools appeared to group most orthogonally and evenly when placed into five categories. These five categories provided a description of what vocal subsystem was primarily engaged during the execution of a tool and were labeled *Auditory*, *Vocal Function*, *Musculoskeletal*, *Respiratory*, and *Somatosensory*. Indirect intervention tools appeared to group into two orthogonal categories conceptually related to education and counseling and so were labeled *Pedagogy* and *Counseling*.

When attempting to categorize intervention tools, overlap was noted in the direct intervention categories. Due to the literal redundancy of some intervention tools (various tools could be categorized in more than one direct intervention category as demonstrated in Figure 2) and the theoretical overlap of the five vocal subsystems (all are interrelated and cannot truly be addressed in isolation), the five categories of direct interventions were pictorially displayed as a Venn diagram (i.e., overlapping shapes). The Venn diagram was chosen over other visualization methods (specifically neural networks) due to its ability to demonstrate redundancy/overlap in a visually coherent manner. This form of presentation was felt to be vital for ease of interpretation and memorization when considering clinical or educational use. Although a graphic representation of this taxonomy could be produced using a neural network, the diagram would be visually cumbersome due to many lines interconnecting boxes of content words, and it would not benefit memorization/cognitive processing of the conceptual framework. Also, the areas of overlap in the Venn diagram are not areas of ambiguity, but rather areas of redundancy —this is logical considering the overwhelming redundancy

Figure 2. Demonstration of the individual tools contained within each direct intervention category. This can be thought of as the second level of the direct intervention categories. There are also second levels to the indirect intervention categories and intervention delivery method categories not depicted in this article.



contained in the human neural system at all levels (cf. Ajemian, D'Ausilio, Moorman, & Bizzi, 2013). After implementing a Venn diagram, the problem of where to place therapy tools persisted because they are not strictly orthogonal. This issue was addressed by using a conceptual framework from Bernstein's (1967) "Degrees of Freedom" theory. The theory postulates that there are many parts of a motor movement (e.g., joints, muscles, individual motor neurons, etc.), and it would be impossible for our executive awareness/consciousness to control all of them at once—which is the "problem" (Bernstein, 1967). Each part of a movement is a *degree of freedom*, and at the highest level of abstraction in our proposed taxonomy, we have five degrees of freedom that are directly related to vocal modification, and two degrees of freedom that are indirectly related. It is difficult to volitionally control seven interrelated aspects of voicing simultaneously, so the therapist directs a patient's attention to one degree of freedom (or intervention category) at a time. This way, learning to permanently modify a behavior becomes possible. Within this context, each tool is used to orient the patient's executive control (or attention) toward one of these intervention categories and allow vocal behavior modification. Therefore, within the current taxonomy, each therapy tool has been placed in a category according to where the patient's attention is focused during the therapy activity. Semi-occluded vocal tract phonation (SOVT) using a straw serves to illustrate this concept (Titze, 2006). When a patient phonates through a straw, the desired physiologic effect is to match impedances in the vocal tract, which then produces the sensory effect of increased vibrotactile sensation in the palate and anterior oral cavity/mask (*somatosensory* feedback, specifically *discrimination*; Titze, 2006; Verdolini-Marston, Burke, Lessac, Glaze, & Caldwell, 1995; Yiu, Chen, Lo, & Pang, 2012). The patient and clinician then use this somatosensory vibrotactile focus to evaluate their degree of correctness in the current activity

and during new, more difficult productions such as vowels, words, and speech. Therefore, this tool would be categorized under direct interventions–somatosensory–discrimination. It is also important to note that the other aspects of vocal behavior are unconsciously changing in response to the patient's directed attention toward the modification of one target or degree of freedom (the creation of a kinesthetic "buzz"). To make a task more difficult, the clinician may use two direct intervention categories (or degrees of freedom) at once so the patient's executive focus is *multitasking*. This could occur by asking the patient to focus on abdominal breathing at the same time as performing a SOVT task. Now the patient (at the highest level of abstraction) is modifying two degrees of freedom simultaneously: somatosensory and respiratory.

Intervention delivery methods are needed to adequately characterize a voice therapy session because a tool cannot simply be used by itself and result in a permanent behavior or functional change. A tool must be incorporated into a therapy session using a structure from the intervention delivery method categories, and a structure can be applied by either the clinician (i.e., extrinsic) or the patient (i.e., intrinsic). Once these two components (a tool and a structure) of the taxonomy have been combined, they can be described as a therapy task. What are typically thought of as therapy tasks can be divided into two categories: (a) *activities* and (b) *participations*, as defined by the World Health Organization (WHO) International Classification of Functioning, Disability, and Health (ICF; WHO, 2001). Activities are defined as "the execution of a task or action by an individual" and participations are defined as "involvement in a life situation." An example of an *activity therapy task* would be the use of SOVT exercises on a repetitive basis to improve general functioning of the voice—which is not something that necessarily helps the patient's participation in society. However, it should improve their act of voicing during that task. In contrast, a participation therapy task would be the use of SOVT concepts during a structured conversation or discussion—which will improve the act of voicing in the patient's societal functioning (e.g., work life, social life, conversation, etc.). In this context, the treatment focused taxonomy (Whyte, 2014) proposed here can be linked to the enablement/disability focused WHO ICF framework. The measurement of dosing was not included under intervention delivery methods because it can be accounted for by numerical additions representing the dosing count. The final structure of the voice therapy taxonomy is demonstrated in Figures 1 and 2.

Demonstration of Potential Utility

Classification. As an initial demonstration of the taxonomy's ability to provide a framework to classify voice therapy approaches, seven established therapy programs were classified in Table 1 using only direct interventions. The seven programs were Lee Silverman Voice Treatment (LSVT; El Sharkawi et al., 2002; Ramig, Countryman, O'Brien, Hoehn, & Thompson, 1996; Ramig et al., 1995; Ramig, Sapir, Fox, & Countryman, 2001), VFE (Roy et al., 2001; Sabol, Lee, & Stemple, 1995; Stemple et al., 1994), Manual Circumlaryngeal Therapy (MCT; Dromey, Nissen, Roy, & Merrill, 2008; Roy, Bless, Heisey, & Ford, 1997; Roy & Leeper, 1993; Roy, Nissen, Dromey, & Sapir, 2009), Laryngeal Manual Therapy (LMT; Mathieson, 2011; Mathieson et al., 2009; Van Lierde, De Ley, Clement, De Bodt, & Van Cauwenberge, 2004), Resonant Voice Therapy (RVT; S. H. Chen, Hsiao, Hsiao, Chung, & Chiang, 2007; Roy et al., 2003; Verdolini, Druker, Palmer, & Samawi, 1998; Verdolini Abbott et al., 2012; Verdolini-Marston et al., 1995; Yiu et al., 2012), Accent Method (Fex, Fex, Shiromoto, & Hirano, 1994; Kotby, El-Sady, Basiouny, Abou-Rass, & Hegazi, 1991; Kotby, Shiromoto, & Hirano, 1993), and Confidential Voice (Casper & Murry, 2000; Verdolini-Marston et al., 1995). Indirect interventions and intervention delivery methods were not detailed in this table because general consensus is that therapy programs do not differ significantly in these areas or are not described in detail for most peer-reviewed publications (cf. Casper & Murry, 2000). Only peer-reviewed publications were used to provide details for these voice therapy programs to have some external quality control of the information provided. In addition, three other review articles were used to characterize and describe each intervention program (Casper & Murry, 2000; Ramig & Verdolini, 1998; Thomas & Stemple, 2007). Table 1 is a summary of Tables B1 through B4 in Appendix B (Tables B1 through B4 categorize every individual therapy task for each therapy program). Appendix C lists the direct quotes and associated page numbers from each referenced therapy task in Appendix B. As can be seen in Table 1, the taxonomy *direct intervention* categories produced a distinct profile for each of the seven established therapy programs. These profiles provide an initial demonstration of the taxonomy's classification ability. Furthermore, as Table 1 is a stationary snapshot of these therapy programs, it is likely that the programs would differ even more if classified in a temporal manner—as they are used during a therapy session.

It is important to bear in mind that Table 1 is an agglomeration of treatment ingredients specified by the peer-reviewed literature—that is, the recipe of ingredients provided within Table 1 and Appendix B for each named therapy program is not meant to represent the only manner in which these approaches can be delivered clinically. In fact, in clinical practice, these named therapy approaches are likely to be different according to which SLP delivered the treatment, who the treating SLP was trained under, the specific patient's characteristics, and so forth. The overarching objective is to characterize what the SLP does during a therapy session through standard terminology and a unifying theoretical framework, regardless of what named therapy program is being attempted. The data in Table 1 simply reflect an exercise in classification feasibility and are not meant to be a literal template for any of the named therapy programs described.

Systemic investigation. A standard theoretical framework and terminology can provide structure for the development

Table 1. Seven established voice therapy programs classified according to the tools of each direct intervention category from the voice taxonomy. Tables B1 through B4 along with matched references for each therapy task may be found in Appendix B.

	Auditory		Vocal function			Somatosensory			Musculoskeletal				Respiratory		
Voice therapy programs	**Conduction**	**Sensorineural**	**Glottal contact**	**Pitch modification**	**Vegetative vocalization**	**Nociception**	**Discrimination**	**Visual processing**	**Neck modification**	**Orofacial modification**	**Posture**	**Stretching**	**Loudness modification**	**Respiratory coordination**	**Respiratory support**
LSVT		X	X	X			X						X	X	X
VFE		X	X	X			X			X			X	X	
Accent Method		X	X	X			X			X	X		X	X	X
Confidential Voice Therapy		X	X				X			X			X	X	X
RVT		X		X	X		X		X	X	X	X	X		X
LMT		X	X	X		X	X		X	X	X			X	X
MCT		X	X	X		X	X		X					X	

Note. LSVT = Lee Silverman Voice Therapy; VFE = Voice Function Exercises; RVT = Resonant Voice Therapy; LMT = Laryngeal Manual Therapy; MCT = Manual Circumlaryngeal Therapy.

and testing of hypotheses related to the process of voice therapy as well as helping to identify potential areas where innovation may be possible. As an example, from Table 1 it can be seen that certain voice therapy programs use similar tools; therefore, they should group together when broken into their component parts. The manual therapies (LMT and MCT) are grouped together by the unique inclusion of *nociception* and were the only therapy approaches to explicitly focus on pain/soreness/discomfort reduction in therapy. LSVT, VFE, and Accent Method provided very similar profiles due to their heavy focus on exercise physiology and kinesiology principles. But due to LSVT and VFE's unrelated patient populations and therapy goals, their striking similarities are also surprising. In fact, within each similar intervention tool, their goals are frequently at opposite sides of the spectrum. For example, both programs use discrimination, but LSVT asks for high effort during voicing when applied to patients with Parkinson's disease, and VFE asks for low effort when applied to patients with vocal hyperfunction. These differences in application between therapy programs necessitated the addition of modifiers for various direct intervention tools and can be seen in Figure 2. Using Table 1, one can also see similarities shared by all therapy programs. The two most striking similarities are the consistent inclusion of discrimination and *sensorineural* tools and the consistent exclusion of *visual processing* and *conduction tools* in all therapy programs.

Potential educational and clinical application. Teachers, students, and practicing clinicians can benefit from the structuring and organization of voice therapy information into meaningful categories with underlying theory. From a cognitive perspective, it is well established that "chunking" information into seven to nine categories with fewer than 15 items per category significantly increases a person's ability to remember and use information (Dunbar, 1993; Miller, 1956). The taxonomy adheres to these limitations of human information processing by using chunking through categorization, providing a visual organizational model, and not exceeding 15 items per specific category. In the educational setting, this benefit can be as obvious as improved memory and application of course material in class and in the student's first clinical experiences. Because the rehabilitation field in general is frequently cited as a "learn by doing" field (Kane, 1997), an educational tool such as this taxonomy can be valuable.

An example of clinical application will use Figure 2—specifically the direct intervention tool of "lip trills." This figure demonstrates the "second level" of the direct intervention categories and the areas of overlap represent spaces where a tool may be used anywhere from two to five different ways depending on where the patient's attention is directed during execution. Lip trills can be used in two different attentional foci: (a) somatosensory–discrimination or (b) musculoskeletal–orofacial modification. If the clinician is familiar with the taxonomy framework, it can provide a model and underlying theory to enable efficient problem solving during a therapy session with this task. For example, should a patient have difficulty attending to his or her vibrotactile/kinesthetic sensation (e.g., discrimination), the clinician can switch the patient's focus to the act of obtaining lip vibration (e.g., orofacial modification). This use of the taxonomy can minimize the probability of frustration and maximize the probability of success.

Future directions and limitations. An important limitation of the taxonomy presented here is that it only describes modifications to phonatory function (i.e., voicing). Therefore voice therapy for conditions including vocal cord dysfunction and alaryngeal voicing are not adequately addressed. However, the taxonomy is unique compared with previous attempts at categorizing voice therapy as it (a) incorporates rule-based redundancy without ambiguity through pertinent underlying theories and facets which allow tools to have multiple characteristics; and (b) allows for dynamic interaction across hierarchical categories, the ability to code for multiple tasks executed simultaneously,

and descriptions of learning variables through structures. A potential weakness of this type of framework is that the level of complexity could make application in real-life therapy delivery temporarily inconvenient to learn, but this would be true regarding the clinical introduction of any new taxonomy.

Future directions include continued refinement of a dictionary and thesaurus that can help in potentially establishing a coding scheme on the basis of this facet-type system for data retrieval and analysis (Kwasnik, 1999; Ranganathan, 1967; Rosenfeld & Morville, 2002; Wurman, 2001). Intra- and interrater reliability with voice clinicians will need to be established as well as various forms of validity. In addition to typical validity (e.g., construct, content), the taxonomy's usability for voice clinicians will be important as well. A clinically usable taxonomy should be efficient to navigate, and any redundancy should facilitate its use (Lambe, 2007). Also, this proposed framework—as is true for all taxonomies—is not considered a finished product, but a conceptual model now capable of vetting and accommodating refinements and modifications resulting from structured investigation into the voice therapy process and the taxonomy's ability to represent what occurs in a voice therapy session.

Conclusion

An initial taxonomy of voice therapy has been introduced that provides several potential benefits including the classification of therapy programs using standard terminology, use as a translation point between different groups of users and experience levels, and a framework that can help structure systematic investigation, improve education, and provide clinicians further insight into the voice therapy process. It is also important to note:

> No classification system, any more than any representation, may specify completely the wildness and complexity of what is represented. (Bowker & Star, 1999, p. 232)

All the nuance and complexity of what happens in voice therapy may never be entirely classifiable or measurable. But without some form of focused classification system, the "black box" of voice therapy will persist and slow the progress and development of the voice field. This is simply an initial attempt at the creation of a voice therapy taxonomy, and it is hoped that this will encourage further discussion regarding the development of a clinically useful classification tool.

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Appendix A (p. 1 of 2)

Dictionary

Activity Therapy Task: A combination of a tool and structure that involves the isolated execution of an action by the patient (WHO, 2001).
Auditory Intervention: A direct intervention that directs the patient's attention to the modification of auditory input.
Augmented Feedback Structure: A structure applied by the clinician or patient to deliver an intervention that provides more information than what is typically received in a task from the sensorineural system (Schmidt & Lee, 2011). Examples include delayed/immediate, summary, blocked/random, variable, and self-controlled feedback (Chiviacowsky & Wulf, 2002; Salmoni, Schmidt, & Walter, 1984).
Conduction: A direct intervention tool that requires the modification of auditory input by directing the patient's attention to an externally degraded acoustic signal.
Coping Strategies: An indirect intervention tool in which the clinician attempts to identify and modify psychosocial factors that negatively affect vocal health through reinforcement of positive emotional and lifestyle adaptations or discouragement of maladaptive patterns of behavior (Carver & Connor-Smith, 2010).
Counseling Intervention: An indirect intervention tool in which the clinician helps identify and modify psychosocial factors that negatively affect vocal health.
Deliberate Practice Structure: A structure applied by the clinician or patient to deliver an intervention using activities that have been specifically defined to improve the current level of performance (Ericsson, Krampe, & Tesch-Romer, 1993). It includes the ability to account for dose and distribution of dose (via time spent on task or number of days per week intervention was provided; Roy, 2012), variable or constant practice, and blocked or random practice (Schmidt & Lee, 2011).
Direct Intervention: Any intervention that modifies vocal behavior through motor execution, somatosensory feedback, and auditory feedback (cf. Guenther et al., 2006).
Discrimination: A direct intervention tool that requires the modification of somatic input by directing the patient's attention to their sense of position and movement (e.g., kinesthesia), effort, balance, tension, and fine touch such as vibrations and pressure (Fortier & Basset, 2012). This category has a neurological correlate to the posterior column/medial lemniscal neural sensory pathway (cf. Kandel, Schwartz, Jessell, Siegelbaum, & Hudspeth, 2012).
Exploration Structure: A structure applied by the clinician to deliver an intervention using activities that require the patient to explore an entire aspect of their voice (i.e., the "vocal task space"; Sutton & Barto, 1998). A popular clinical example is "negative practice."
Glottal Contact: A direct intervention tool that modifies the act of phonation by directing the patient's attention toward the amount of true vocal fold tissue interaction for a prolonged time period.
Hierarchy Structure: A structure applied by the clinician to deliver an intervention using a series of ranked activities in order of difficulty.
Home Program Structure: A structure applied by the clinician and patient to deliver an intervention using tools outside of the therapy session (e.g., in the patient's typical environment).
Indirect Intervention: Any intervention that modifies vocal behavior through modification of cognitive, behavioral, psychological, and physical environments in which voicing occurs (Roy et al., 2001; Thomas & Stemple, 2007).
Intervention Delivery Method: A structure applied by either the clinician or patient to deliver an intervention tool.
Knowledge Enhancement: An indirect intervention tool in which the clinician provides knowledge to modify vocal health through increased information.
Loudness Modification: A direct intervention tool that requires the modification of respiratory function by directing a patient's attention to vocal intensity for short or prolonged periods of time.
Modeling Structure: A structure applied by the clinician to deliver an intervention using tools that produce examples for imitation or judgment purposes (Ferrari, 1996).
Musculoskeletal Intervention: A direct intervention that directs the patient's attention to the modification of muscular, skeletal, and connective tissue.
Neck Manipulation: A direct intervention tool that requires the modification of muscular, skeletal, and connective tissue by directing the patient's attention to the physical movement of their anterior, lateral, and posterior neck.
Nociception: A direct intervention tool that requires the modification of somatic input by directing the patient's attention to pain, discomfort, soreness, or temperature. Nociceptive neurons are afferent connections to the central nervous system that respond to tissue injury and provide the physical correlate to pain sensation, as well as crude touch and temperature (Bennett, 2000; Kandel et al., 2012).

Appendix A (p. 2 of 2)

Dictionary

Orofacial Manipulation: A direct intervention tool that requires the modification of muscular, skeletal, and connective tissue by directing a patient's attention toward the physical movement of his or her face and oral cavity.
Participation Therapy Task: A combination of a tool and structure that involves the execution of an action by the patient in a societal context (WHO, 2001).
Pedagogy Intervention: An indirect intervention tool in which the clinician provides declarative knowledge and strategies to modify vocal health.
Pitch Modification: A direct intervention tool that modifies the act of phonation by directing the patient's attention to modification of pitch or maintenance of pitch.
Postural Alignment: A direct intervention tool that requires the modification of muscular, skeletal, and connective tissue by directing the patient's attention to the most efficient alignment of his or her own anatomical structures.
Psychotherapeutic Structure: A structure applied by the clinician to deliver an intervention using activities ordered or modeled by a theory of behavior change (van Leer, Hapner, & Connor, 2008).
Respiratory Coordination: A direct intervention tool that requires the modification of respiratory function by directing a patient's attention to respiratory modification via glottal and supraglottal maneuvers.
Respiratory Intervention: A direct intervention that directs the patient's attention to the modification of respiratory function.
Respiratory Support: A direct intervention tool that requires the modification of respiratory function by directing the patient's attention to subglottal airstream characteristics through exercise and modification of thoracic and abdominal muscle movements.
Self-Evaluation Structure: A structure applied by the patient to deliver an intervention using activities that increase attention to feedback inherent to the activity (Hogan & Yanowitz, 1978; Swinnen, Schmidt, Nicholson, & Shapiro, 1990).
Self-Correction Structure: A structure applied by the patient to deliver an intervention using activities that increase attention to on-task variations and errors.
Self-Cuing Structure: A structure applied by the patient to deliver an intervention using activities that increase anticipatory skills and avoidance of errors (Neumann, 1996).
Sensorineural: A direct intervention tool that requires the modification of auditory input by directing the patient's attention to their perception of pitch, loudness, or more complex auditory constructs (e.g., voice quality, metaphors, descriptors, etc.).
Somatosensory Intervention: A direct intervention that directs the patient's attention to the modification of somatic or visual input.
Stress Management: An indirect intervention tool in which the clinician attempts to identify and modify psychosocial factors that negatively affect vocal health through discussion and application of strategies to help patients manage their stress and anxiety levels in varying contexts.
Stretching: A direct intervention tool that requires the modification of muscular, skeletal, and connective tissue by directing the patient's attention toward external or internal forces exerting pressure on muscles and connective tissue for the purpose of increasing flexibility and range of motion (Behm & Chaouachi, 2011).
Structure: A method used to deliver indirect or direct therapy tools during a therapy session.
Teaching Structure: A structure applied by the clinician to deliver an intervention using activities ordered or modeled by a theory of declarative learning.
Therapeutic Interaction: An indirect intervention tool in which the clinician attempts to identify and modify psychosocial factors that negatively affect vocal health through discussion with the patient regarding psychological or emotional factors and effective problem solving.
Therapy Task: The combination of an intervention tool and an intervention delivery method structure.
Tool: A direct or indirect intervention that directs the patient to focus on a specific or a few specific degrees of freedom.
Vegetative Vocalization: A direct intervention tool that modifies the act of phonation by directing the patient's attention to instinctive, physiological, or nonword communicative voicing.
Visual Processing: A direct intervention tool that requires the modification of visual input by directing a patient's attention towards visual perception.
Vocal Function Intervention: A direct intervention that directs the patient's attention to modification of phonation.
Vocal Hygiene: An indirect intervention tool in which the clinician provides strategies to improve vocal health by modifying the physical environment of voicing.

Appendix B (p. 1 of 4)

Classification of Voice Therapy Treatments

Table B1. Each therapy task mentioned in peer-reviewed publications (citation for each task is superscripted and listed at the end of this appendix) is classified for Confidential Voice and Resonant Voice.

	Auditory		Vocal function			Somatosensory			Musculoskeletal				Respiratory		
Voice therapy task	**Conduction**	**Sensorineural**	**Glottal contact**	**Pitch modification**	**Vegetative vocalization**	**Nociception**	**Discrimination**	**Visual processing**	**Neck modification**	**Orofacial modification**	**Posture**	**Stretching**	**Loudness modification**	**Respiratory coordination**	**Respiratory support**
Confidential Voice															
Breath support[1]															**X**
Body relaxation exercises[3]						X				X					**X**
Easy production[1]						X									
Soft voice[1–3]		X											X		
Breathy voice[1–3]		X	X											X	
Resonant voice[1,2]						X									
Minimal effort[1,3]						X									
Resonant Voice															
Hearing voice[1,2]		X													
Lightness of tone[5]		X		X											
Voice quality of hum[8]		X													
Feeling vibrations[1–5,8]						X									
Stretch[1,2]												X			
Basic Training Gesture (BTG)[1,5]						X									
/m/ phonation[1,5,8]					X	X									
Vary pitch with BTG[1,5]		X		X		X									
Vary loudness with BTG[1,5]		X				X							X		
Manually address muscle[3]									X	X	X				
Easy voicing[1,2,4–6]						X									
Forward/frontal focus[5,6,8]						X									
Inverted megaphone posture[3]										X					
Head & neck alignment[3,8]											X				
Chanting[1,5]		X				X									
Chanting with inflection[5]		X		X		X									
Breath support[5]															**X**
Abdominal breathing[5]															**X**

Appendix B (p. 2 of 4)

Classification of Voice Therapy Treatments

Table B2. Each therapy task mentioned in peer-reviewed publications (citation for each task is superscripted and listed later in this appendix) is classified for Vocal Function Exercises (VFE) and Lee Silverman Voice Treatment (LSVT).

	Auditory		Vocal function			Somatosensory			Musculoskeletal				Respiratory		
Voice therapy task	**Conduction**	**Sensorineural**	**Glottal contact**	**Pitch modification**	**Vegetative vocalization**	**Nociception**	**Discrimination**	**Visual processing**	**Neck modification**	**Orofacial modification**	**Posture**	**Stretching**	**Loudness modification**	**Respiratory coordination**	**Respiratory support**
VFE															
Easy onset[1,12]			X			X								X	
Frontal focus[1,2,11,12]						X									
Soft phonation[1,2,11–13]	X												X		
Max sustained vowels[1,2,11–13]			X											X	
Max sustained /s/[1,12]														X	
Pitch glides[1,2,11–13]	X			X											
Sustained notes[1,2,11–13]			X	X										X	
Without strain[1,12]	X					X									
Inverted megaphone posture[12]											X				
LSVT															
Think loud[14–17]	X												X		
Speak at top of breath[14,15]														X	
Increase loudness[1,14–17]	X		X										X		
Max phonation time[1,14–17]			X											X	
Max low pitch[1,14–17]	X		X	X										X	
Max high pitch[1,14–17]	X		X	X										X	
Increased effort[1, 14–17]						X									
Pushing down/pull up[14–15]			X												
No strain[14–16]	X					X									
Deep breaths[14–16]															X

Table B3. Each therapy task mentioned in peer-reviewed publications (citation for each task is superscripted and listed later in this appendix) is classified for Manual Circumlaryngeal Therapy (MCT) and Laryngeal Manual Therapy (LMT).

	Auditory		Vocal function			Somatosensory			Musculoskeletal				Respiratory		
Voice therapy task	**Conduction**	**Sensorineural**	**Glottal contact**	**Pitch modification**	**Vegetative vocalization**	**Nociception**	**Discrimination**	**Visual processing**	**Neck modification**	**Orofacial modification**	**Posture**	**Stretching**	**Loudness modification**	**Respiratory coordination**	**Respiratory support**
MCT															
Pain reduction[18,19,21]						X									
Anterior neck massage[1,18,19,21]									X						
Digital manipulation[1,18,19,21]									X						
Humming[1,18,19,21]							X								
Prolonged vowels[1,18,19,21]			X										X		
Improved voice quality[1,18,19,21]	X														
Pitch changes[18]	X			X											
LMT															
Anterior neck massage[20–22]									X						
Lateral neck massage[20–22]									X						
Breathing with phonation[20]													X		
Head & neck posture[20,22]											X				
Abdominal breathing[20]															X
Orofacial massage[20,22]										X					
Decreased effort[20]							X								
Decreased strain[20]	X						X								
Vocal pitch glides[21,22]	X			X											
Decreased discomfort[21,22]						X									
Open mouth approach[20]										X					
Soft glottal attack[20]			X										X		
Chanting[20]	X						X						X		

Table B4. Each therapy task mentioned in peer-reviewed publications (citation for each task is superscripted and listed later in this appendix) is classified for Accent Method.

	Auditory		Vocal function			Somatosensory			Musculoskeletal				Respiratory		
Voice therapy task	**Conduction**	**Sensorineural**	**Glottal contact**	**Pitch modification**	**Vegetative vocalization**	**Nociception**	**Discrimination**	**Visual processing**	**Neck modification**	**Orofacial modification**	**Posture**	**Stretching**	**Loudness modification**	**Respiratory coordination**	***Respiratory support***
Accent Method															
Rhythmic breath[1,9]															**X**
Rhythmic body gestures[1]							X				X				
Abdominal breathing[1,2,9,10]															**X**
Punctuated fricative/vowels[1,2,9,10]													X		
Activate articulators[9]										X					
Widen pharynx[9]										X					
Pitch/intonation variation[1,9,10]	X			X											
Intensity variation[1,9,10]	X											X			
Prolonged phonation[1,9,10]		X											X		
Timing breath & voice onset[9]													X		
Auditory cuing[9]	X														
Optimal vocal effort[1,9]							X								
Body posture[1,9,10]											X				
Breathy voicing[9]	X	X											X		

List of References for Tables B1–B4

[1] Casper and Murry (2000)
[2] Thomas and Stemple (2007)
[3] Verdolini-Marston, Burke, Lessac, Glaze, and Caldwell (1995)
[4] Verdolini, Druker, Palmer, and Samawi (1998)
[5] Roy et al. (2003)
[6] Verdolini Abbott et al. (2012)
[7] Chen, Hsiao, Hsiao, Chung, and Chiang (2007)
[8] Yiu, Chen, Lo, and Pang (2012)
[9] Kotby, El-Sady, Basiouny, Abou-Rass, and Hegazi (1991)
[10] Fex, Fex, Shiromoto, and Hirano (1994)
[11] Stemple, Lee, D'Amico, and Pickup (1994)
[12] Roy et al. (2001)
[13] Sabol, Lee, and Stemple (1995)
[14] Ramig, Countryman, Thompson, and Horii (1995)
[15] Ramig, Countryman, O'Brien, Hoehn, and Thompson (1996)
[16] Ramig, Sapir, Fox, and Countryman (2001)
[17] El Sharkawi et al. (2002)
[18] Roy and Leeper (1993)
[19] Roy, Bless, Heisey, and Ford (1997)
[20] Van Lierde, De Ley, Clement, De Bodt, and Van Cauwenberge (2004)
[21] Mathieson (2011)
[22] Mathieson et al. (2009)

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Direct Quotes and Associated Page Numbers From Each Referenced Therapy Task

Confidential Voice Therapy

- Breath support
  - Casper and Murry (2000): "As this technique is introduced, the patient's breathing is observed. If there is evidence of poor breath management or other muscle tensions, these problems should be addressed" (p. 986). Later on: ". . . improved phrasing with frequent renewal of breath" (p. 986).
- Body relaxation exercises
  - Verdolini-Marston et al. (1995): ". . . general body relaxation, obtained for example by shaking out the jaw and shoulders and by breathing easily" (p. 77).
- Easy production
  - Casper and Murry (2000): "Attention is focused on the ease of voice production . . ." (p. 986).
- Soft voice
  - Casper and Murry (2000): "The reduction of vocal intensity in the confidential voice . . ." (p. 985).
  - Thomas and Stemple (2007): "The technique calls for individuals to speak in a soft, non-whispered, breathy tone . . ." (p. 67).
  - Verdolini-Marston et al. (1995): "For this type of therapy, the focus was (a) the production of . . . minimal loudness . . ." (p. 77).
- Breathy voice
  - Casper and Murry (2000): "It is a breathy voice . . ." (p. 985).
  - Thomas and Stemple (2007): "The technique calls for individuals to speak in a soft, non-whispered, breathy tone . . ." (p. 67).
  - Verdolini-Marston et al. (1995): "For this type of therapy, the focus was (a) the production of a minimal effort, minimal loudness, and slightly breathy phonation mode . . ." (p. 77).
- Resonant voice
  - Casper and Murry (2000): ". . . initiation of full voice, vocal focus, and resonance are introduced . . ." (p. 986).
  - Thomas and Stemple (2007): "Midway through the therapy experience, clients are trained in the use of a resonant voice pattern . . ." (p. 67).
- Minimal effort
  - Casper and Murry (2000): "Attention is focused . . . on the reduction of effort involved . . ." (p. 986).
  - Verdolini-Marston et al. (1995): "For this type of therapy, the focus was (a) the production of a minimal effort . . ." (p. 77).

Resonant Voice Therapy (RVT)

- Hearing one's voice
  - Casper and Murry (2000): "Therapy focuses on the production of this voice primarily through feeling and hearing" (p. 987).
  - Thomas and Stemple (2007): "On the use of auditory as well as tactile cues for achieving optimal resonance" (p. 71).
- Lightness of tone
  - Roy et al. (2003): Below the headings RT Hierarchy: Stage 1 "All voiced": "Increase 'lift' or the lightness of the tone (as if pitch were increasing)" (p. 683).
- Voice quality of hum
  - Yiu et al. (2012): Appendix: "Listen to the voice quality of the hum with comments on the performance given by the trainer."
- Feeling vibrations
  - Casper and Murry (2000): "The feeling is specific in terms of place of vibratory sensation (oral-alveolar)" (p. 987).
  - Thomas and Stemple (2007): "On the use of auditory as well as tactile cues for achieving optimal resonance" (p. 71).

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Direct Quotes and Associated Page Numbers From Each Referenced Therapy Task

- Verdolini-Marston et al. (1995): "... resonant voice involves vibratory sensations on the alveolar ridge and other facial plates during phonation" (p. 75).
- Verdolini et al. (1998): "... a voicing pattern involving oral vibratory sensations, particularly on the alveolar ridge and adjacent facial plates" (p. 316).
- Roy et al. (2003): "Discover the vibrations; experiment with broad and narrow vibrations" (p. 683).
- Yiu et al. (2012): Appendix: "... to find a pitch that results in maximum resonance/vibration."

- Stretch
  - Casper and Murry (2000): "The initial steps involve exercises to stretch or to reduce the activation of muscles of the thorax, shoulders, neck, mandible, lips, tongue, and laryngopharynx. The intent is to leave in a deactivated state those muscles that do not contribute to healthy phonation and whose actions might be counterproductive" (p. 987).
  - Thomas and Stemple (2007): Under the Resonant Voice Therapy heading: "First, inappropriate patterns of muscle use are deactivated" (p. 71).
- Basic Training Gesture
  - Casper and Murry (2000): "The resonant voice basic training gesture (RV BTG) is then taught" (p. 987).
  - Roy et al. (2003): "RT requires mastery of a basic training gesture" (p. 672).
- /m/ phonation
  - Casper and Murry (2000): It is written as "/m/" (p. 987).
  - Roy et al. (2003): "*molm*" and "*hmmm*" (p. 683).
  - Yiu et al. (2012): Appendix: It is written as "/m/" or "*uh-um*."
- Vary pitch with BTG
  - Casper and Murry (2000): "That hierarchy includes monotone chanting of phonemic-challenge syllable strings that move from nasal to non-nasal consonants (e.g., *ma*, *ma*, *pa*, *pa*, *ma*, *ma*), to chanting with variability of pitch and loudness within the sequence, to word sequences with similar phonetic characteristics" (pp. 987–988).
  - Roy et al. (2003): Appendix: In reference to "*molm-molm-molm*" gesture: "Use non-linguistic phrases; vary the rate, pitch, and loudness" (p. 683).
- Vary loudness with BTG
  - Casper and Murry (2000): "That hierarchy includes monotone chanting of phonemic-challenge syllable strings that move from nasal to non-nasal consonants (e.g., *ma*, *ma*, *pa*, *pa*, *ma*, *ma*), to chanting with variability of pitch and loudness within the sequence, to word sequences with similar phonetic characteristics" (pp. 987–988).
  - Roy et al. (2003): Appendix: In reference to "*molm-molm-molm*" gesture: "Use non-linguistic phrases; vary the rate, pitch, and loudness" (p. 683).
- Manually address muscle
  - Verdolini-Marston et al. (1995): "... using manual manipulations to reverse any obvious head, neck, or shoulder tensions ..." (p. 77).
- Easy Voicing
  - Casper and Murry (2000): "When easy, vibration-strong voice productions have been accomplished" (p. 987).
  - Thomas and Stemple (2007): "Second, easy phonation, characterized by vibratory sensations near the alveolar ridge, is established" (p. 71).
  - Verdolini et al. (1998): "... in the context of what subjects perceive as 'easy' phonation" (p. 316).
  - Roy et al. (2003): "Increase the ease of production by reducing the effort by 1/2 and 1/2 again" (p. 683).
  - Verdolini Abbott et al. (2012): "... anterior oral vibratory sensations in the context of 'easy' phonation" (p. 814.e2).

- Forward/frontal focus
  - Roy et al. (2003): "... tone production with the point of vocal tract constriction at the extreme end of the resonators" and "Extreme forward focus is required with appropriate breath support" (p. 683).
  - Verdolini Abbott et al. (2012): "... anterior oral vibratory sensations" (p. 814.e2).
  - Yiu et al. (2012): Appendix: "Put a finger on the nasal bridge to feel the vibration. The kinesthetic feedback of possible tingling sensation around the lip area is also explained."
- Inverted megaphone
  - Verdolini-Marston et al. (1995): "... using an 'inverted megaphone' facial posture (slightly expanded pharynx and a slight forward stretch in facial muscles, with labial protrusion)" (p. 77).
- Head and neck alignment
  - Verdolini-Marston et al. (1995): "... and to obtain good head and neck alignment" (p. 77).
  - Yiu et al. (2012): Appendix: "The participant is reminded to sit at a relaxed manner throughout the training."
- Chanting
  - Casper and Murry (2000): "... monotone chanting of phonemic-challenge syllable strings ..." (p. 987).
  - Roy et al. (2003): "Chant the following voiced phrases ..." (p. 683).
- Chanting with inflection
  - Roy et al. (2003): "Chant the following voiced phrases on the musical note ... Over-inflect these phrases as speech" (p. 683).
- Breath support
  - Roy et al. (2003): "... with appropriate breath support" (p. 683).
- Abdominal breathing
  - Roy et al. (2003): "Use abdominal breathing to support the tone production" (p. 683).

Vocal Function Exercises (VFE)

- Easy onset
  - Casper and Murry (2000): "Easy onset of phonation with front focus is stressed for the vowels" (p. 990).
  - Roy et al. (2001): "No hard glottal attack at initiation of phonation" (p. 295).
- Frontal focus
  - Casper and Murry (2000): "Easy onset of phonation with front focus is stressed for the vowels" (p. 990).
  - Thomas and Stemple (2007): "All exercises are performed with a frontal tone focus ..." (p. 68).
  - Stemple et al. (1994): "Subjects were encouraged to produce all tones ... with frontal focus" (p. 273).
  - Roy et al. (2001): "It is very important that the placement of the tone is forward (constricted, sympathetically vibrating lips) and pharynx is open (i.e., inverted megaphone shape)" (p. 295).
- Soft phonation
  - Casper and Murry (2000): "Perhaps the primary caveat is to assure that the exercises are being done correctly, softly ..." (p. 990).
  - Thomas and Stemple (2007): "All exercises are performed with ... a low loudness level" (p. 68).
  - Stemple et al. (1994): "Subjects were encouraged to produce all tones softly ..." (p. 273).
  - Roy et al. (2001): "All exercises are produced as softly as possible ..." (p. 295).
  - Sabol et al. (1995): "... subjects were instructed to produce phonation in the very soft part of their dynamic ranges" (p. 29).

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Direct Quotes and Associated Page Numbers From Each Referenced Therapy Task

- Max sustained vowels
  - Casper and Murry (2000): "For vocal warm-up, patients are instructed to sustain the vowel, /ee/, as softly as possible and for as long as possible . . ." and "The vowel /o/ is sustained for as long as possible on selected pitches to improve adductory power" (p. 990).
  - Thomas and Stemple (2007): "The final exercise has the patient sustain five, sequential notes as long as possible" (p. 68).
  - Stemple et al. (1994): "Sustain /i/ as long as possible on a comfortable note (these subjects used F above middle C)" (p. 273).
  - Roy et al. (2001): ". . . sustain vowel /i/ as long as possible . . ." (p. 295).
  - Sabol et al. (1995): "Sustain /i/ as long as possible on a comfortable note (these subjects used F above middle C)" (p. 29).
- Max sustained /s/
  - Casper and Murry (2000): ". . . equal to the longest /s/ the patient is able to sustain . . ." (p. 990).
  - Roy et al. (2001): Appendix B: ". . . (i.e., as long as maximum sustained /s/ production)" (p. 293).
- Pitch glides
  - Casper and Murry (2000): "For stretching, a pitch glide is used from lowest pitch to highest . . ." (p. 990).
  - Thomas and Stemple (2007): ". . . a stretching exercise, requires that the patient slowly glide upward through the pitch range" (p. 68).
  - Stemple et al. (1994): "Glide from the lowest to the highest note in the frequency range, using /o/" (p. 273).
  - Roy et al. (2001): "Exercise 2 – 'Stretching exercise' – Glide upward from your lowest to your highest note on the word 'knoll'" (p. 295).
  - Sabol et al. (1995): "Glide upward from your lowest to your highest note . . ." (p. 29).
- Sustained various notes
  - Casper and Murry (2000): "The vowel /o/ is sustained for as long as possible on selected pitches to improve adductory power" (p. 990).
  - Thomas and Stemple (2007): "The final exercise has the patient sustain five, sequential notes as long as possible" (p. 68).
  - Stemple et al. (1994): "Sustain the musical notes middle C and D, E, F, and G above middle C for as long as possible . . ." (p. 273).
  - Roy et al. (2001): "Exercise 4 – 'Low impact adductory power exercise' – Sustain the musical notes (C-D-E-F-G) for as long as possible . . ." (p. 295).
  - Sabol et al. (1995): "Sustain the musical notes (C-D-E-F-G) for as long as possible. . ." (p. 29).
- Without strain
  - Casper and Murry (2000): ". . . softly but . . . without excess strain" (p. 990).
  - Roy et al. (2001): "The tone should not be muscled at the larynx . . ." (p. 295).
- Inverted megaphone posture
  - Roy et al. (2001): ". . . and pharynx is open (i.e., inverted megaphone shape)" (p. 295).

Lee Silverman Voice Therapy (LSVT)

- Think loud
  - Ramig et al. (1995): Table 1: "Think loud/shout."
  - Ramig et al. (1996): Table 1: "Think loud/shout."
  - Ramig et al. (2001): "Patients are . . . given frequent encouragement to 'think loud'. . ." (p. 81).
  - El Sharkawi et al. (2002): ". . . and carry over exercises focusing on 'think loud'" (p. 32).

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Direct Quotes and Associated Page Numbers From Each Referenced Therapy Task

- Speak at the top of breath
  - Ramig et al. (1995) and Ramig et al. (1996): "... and speak 'on top of the breath'" (p. 1240 and p. 1498, respectively).
- Increase loudness
  - Casper and Murry (2000): "... in as loud a voice as possible..." (p. 991).
  - Ramig et al. (1995): "The voice and respiratory treatment (LSVT) focused on increased vocal loudness ..." (p. 1240).
  - Ramig et al. (1996): "... during sustained phonation with instruction to 'increase loudness'" (p. 1498).
  - Ramig et al. (2001): "Attention is given to the respiratory system in the form of general reminders for subjects to take deep breaths 'to be loud'" (p. 81).
  - El Sharkawi et al. (2002): "... and maximum functional speech loudness drill" (p. 32).
- Max phonation time
  - Casper and Murry (2000): "... of sustained phonation of the vowel /a/ in as loud a voice as possible for as long as possible" (p. 991).
  - Ramig et al. (1995): Table 1: "Increase maximum duration vowel phonation..."
  - Ramig et al. (1996): Table 1: "Increase maximum duration vowel phonation..."
  - Ramig et al. (2001): "Maximum prolongation of '*ah*'..." (p. 81).
  - El Sharkawi et al. (2002): "... patients practiced three daily exercises including maximum duration of sustained vowel phonation..." (p. 32).
- Max low pitch and max high pitch
  - Casper and Murry (2000): "The patient produces the highest pitch possible and then the lowest" (p. 991).
  - Ramig et al. (1995): Table 1: "Sustained phonation at highest and lowest pitches" and "High/low pitch glides."
  - Ramig et al. (1996): Table 1: "Sustained phonation at highest and lowest pitches" and "High/low pitch glides."
  - Ramig et al. (2001): "... maximum pitch range (both high and low pitches) tasks are taught" (p. 81).
  - El Sharkawi et al. (2002): "... patients practiced three daily exercises including ... maximum fundamental frequency range" (p. 32).
- Increased effort
  - Casper and Murry (2000): "... it is necessary to push the entire phonatory mechanism to exert greater effort ..." (p. 990).
  - Ramig et al. (1995): "... (The Lee Silverman Voice Treatment [LSVT]) that focuses on increasing vocal loudness by increasing phonatory effort ..." (p. 1233).
  - Ramig et al. (1996): Table 1: "Treatment philosophy is high-effort ..."
  - Ramig et al. (2001): "The LSVT maximizes phonatory efficiency by improving vocal fold adduction and overall laryngeal muscle activation and control through the use of high-effort loud phonation" (p. 81).
  - El Sharkawi et al. (2002): "... and 'to feel effort' ..." (p. 32).
- Push down/pull up
  - Ramig et al. (1995): Table 1: "Increase vocal fold adduction via isometric effort (pushing, lifting) during phonation."
  - Ramig et al. (1996): Table 1: "Increase vocal fold adduction via isometric effort (pushing, lifting) during phonation."
- No strain
  - Ramig et al. (1995): "It is never the goal of treatment to increase vocal fold adduction so the voice becomes pressed or hyperadducted" (p. 1240).
  - Ramig et al. (1996): "It is never the goal of treatment to increase vocal fold adduction to the point that the voice becomes pressed or hyperadducted" (p. 1498).

- Ramig et al. (2001): "Special care is taken to increase vocal fold adduction without causing vocal hyperadduction and strain" (p. 81).

- Deep breaths
  - Ramig et al. (1995): "Attention was directed toward the respiratory system only by encouraging these subjects to take deep breaths frequently . . ." (p. 1240).
  - Ramig et al. (1996): "Attention was directed toward the respiratory system only by encouraging these subjects to take deep breaths frequently . . ." (p. 1498).
  - Ramig et al. (2001): "Attention is given to the respiratory system in the form of general reminders for subjects to take deep breaths . . ." (p. 81).

Manual Circumlaryngeal Therapy (MCT)

- Pain reduction
  - Roy and Leeper (1993): ". . . and reduction in pain. . ." (p. 249).
  - Roy et al. (1997): ". . . pain in response to pressure in the region of the larynx . . ." (p. 330).
  - Mathieson (2011): Table 1: "Sites of focal tenderness, nodularity or tautness given more attention."
- Anterior neck massage
  - Casper and Murry (2000): Therapy Protocol, Points 1 and 2 (p. 989).
  - Roy and Leeper (1993): Appendix B, Point IV (p. 249).
  - Roy et al. (1997): Appendix B, Point IV (p. 331).
  - Mathieson (2011): Table 1 illustrates the massage program in detail.
- Digital manipulation; Humming; Prolonged vowels

Note. *Digital manipulation* here is specifically defined as the physical manipulation of the anterior neck during voicing. It is important to note that this definition includes voicing during anterior neck manipulation, not just pitch modification as described in Boone (1971), McFarlane (1988), Maryn, De Bodt, and Van Cauwenberge (2003), and Thomas and Stemple (2007).

  - Casper and Murry (2000): "With fingers along the superior border of the thyroid cartilage, the larynx is gently moved downward and, occasionally, laterally. The patient is instructed to hum or prolong a vowel during this procedure . . ." (p. 989).
  - Roy and Leeper (1993): "The patient was asked to hum or prolong vowels during the above procedures . . ." (p. 249).
  - Roy et al. (1997): "The patient was asked to hum or prolong vowels during the above procedures . . ." (p. 331).
  - Mathieson (2011): Table 1: "Patient is asked to sustain vowels or to hum during the manual procedures."
- Improved voice quality
  - Casper and Murry (2000): "Improvement in voice quality is reinforced . . ." (p. 989).
  - Roy and Leeper (1993): "The patient was asked to hum or prolong vowels during the above procedures, noting changes in vocal quality or pitch" (p. 249).
  - Roy et al. (1997): ". . . the patient was asked to hum or prolong vowels during the above procedures, while changes in vocal quality were noted. Improvement in voice was immediately reinforced" (p. 331).
  - Mathieson (2011): Table 1: "Improved voice is shaped from vowels . . ."
- Pitch changes
  - Roy and Leeper (1993): "The patient was asked to hum or prolong vowels during the above procedures, noting changes in vocal quality or pitch" (p. 249).

Laryngeal Manual Therapy (LMT)

- Anterior neck massage
  - Van Lierde et al. (2004): Table 1 specifically describes manual manipulation of anterior neck structures such as the sternohyoid, geniohyoid, etc.
  - Mathieson (2011): Table 1 specifically describes manual manipulation of anterior neck structures such as the sternocleidomastoids (SCMs), supralaryngeal area, etc.
  - Mathieson et al. (2009): Appendix B specifically describes manual manipulation of anterior neck structures such as the SCMs, perilaryngeal area, etc.
- Lateral neck massage
  - Van Lierde et al. (2004): Table 1 specifically describes manual manipulation of the trapezius and superior/lateral SCMs.
  - Mathieson (2011): Table 1 specifically describes manual manipulation of the SCMs along their entire length.
  - Mathieson et al. (2009): Appendix B describes, and shows via pictures, massage of the lateral aspect of the SCMs.
- Breathing with phonation
  - Van Lierde et al. (2004): "Practicing the abdominal breathing pattern during phonation" (p. 470).
- Head and neck posture
  - Van Lierde et al. (2004): "Correction of the general posture and especially the head position" (p. 470).
  - Mathieson et al. (2009): "The clinician ensures that the subject is seated well back on the seat of the chair, that the spine is straight and that the head is in a neutral position, so that the chin is not raised, depressed, retracted, or protruded" (p. 364).
- Abdominal breathing
  - Van Lierde et al. (2004): "Practicing and repeating the principles of abdominal breathing" (p. 470).
- Orofacial massage
  - Van Lierde et al. (2004): Table 1 demonstrates and describes masseter manipulation.
  - Mathieson et al. (2009): "A kneading action is applied upwards and backwards from the midpoint of the mandible with the pads of the fingers of the index, second, and third fingers" (p. 365).
- Decreased effort and decreased strain
  - Van Lierde et al. (2004): "With this combination, the subjects attempted to use their vocal mechanism with less effort and strain" (p. 470).
- Vocal pitch glides
  - Mathieson (2011): Table 1: "Counting, days of the week, vocal glides and spontaneous speech are then encouraged."
  - Mathieson et al. (2009): "Counting days of the week, vocal glides, and spontaneous speech are then encouraged" (p. 365).
- Decreased discomfort
  - Mathieson (2011): Table 1: ". . . allows phonation to be attempted with optimum muscle tone and reduced/eliminated discomfort."
  - Mathieson et al. (2009): "Clinical experience suggests that massage of these muscles lateral to the larynx reduces this tension, thereby reducing the patient's discomfort . . ." (p. 354).
- Open mouth approach
  - Van Lierde et al. (2004): "The open mouth approach was repeated with the habitual voice pitch" (p. 470).
- Soft glottal attack
  - Van Lierde et al. (2004): ". . . and an obvious softening of glottal attack" (p. 470).
- Chanting
  - Van Lierde et al. (2004): "After manipulation of the different muscles, the chant-talk approach proposed by Boone and McFarlane was explained and demonstrated by the voice therapist and imitated by the subjects" (p. 470).

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Direct Quotes and Associated Page Numbers From Each Referenced Therapy Task

Accent Method

- Rhythmic breath
  - Casper and Murry (2000): "Breathing is practiced first with an accented rhythm (often a drum accompaniment setting the rhythm) to create awareness of the respiratory muscles" (p. 994).
  - Kotby et al. (1991): "Relaxation is achieved through the regular, rhythmic diaphragmatic breathing that is an integral part of the training method" (p. 317).
- Rhythmic body gestures
  - Casper and Murry (2000): "Rhythmic body gestures, such as swaying, tapping on a table, and so forth, are added" (p. 994).
- Abdominal breathing
  - Casper and Murry (2000): ". . . and attention is paid primarily to an abdominal/diaphragmatic breathing pattern" (p. 994).
  - Thomas and Stemple (2007): "The Accent Method protocol begins with training the abdominodiaphragmatic breath" (p. 69).
  - Kotby et al. (1991): "Diaphragmatic breathing is trained . . ." (p. 317).
  - Fex et al. (1994): "The accent method focuses on developing . . . abdominal breathing . . ." (p. 164).
- Punctuated fricatives/vowels
  - Casper and Murry (2000): "When the rhythmic breathing has become established, voicing is superimposed with a gentle stream of syllables (e.g., *ha*, *ha*, *ha*) while the rhythm is maintained" (p. 994).
  - Thomas and Stemple (2007): ". . . strings of rhythmic, punctuated fricative-vowel productions" (p. 69).
  - Kotby et al. (1991): ". . . rhythms are introduced, aiming at the production of repeated short phonations with an increasing length of the series of utterances" (p. 317).
  - Fex et al. (1994): "Sustained phonation with variations in loudness (accents) comprises a phrase produced by the therapist that is then imitated by the patient" (p. 164).
- Activate articulators
  - Kotby et al. (1991): ". . . activation of the articulators . . ." (p. 317).
- Widen pharynx
  - Kotby et al. (1991): ". . . widening of the pharynx" (p. 317).
- Pitch/intonation variation
  - Casper and Murry (2000): "The rhythm, pitch, and syllables used may be varied" (p. 994).
  - Kotby et al. (1991): "When the above goals are achieved, the patient is able to produce the most suitable and comfortable pitch" (p. 317).
  - Fex et al. (1994): "The rhythm, the pitch, and intonation variations are important" (p. 164).
- Intensity variation
  - Casper and Murry (2000): "The rhythm, pitch, and syllables used may be varied" (p. 994).
  - Kotby et al. (1991): "Loudness variation is an integral part of the voice training program" (p. 317).
  - Fex et al. (1994): "The rhythm, the pitch, and intonation variations are important" (p. 164).
- Prolonged phonation
  - Casper and Murry (2000): "The phonation is interconnected over the rhythmic, accented pattern on a single breath" (p. 994).
  - Kotby et al. (1991): "Using the newly acquired diaphragmatic breathing, the patient is allowed to 'sing' the various vowels at a slow '3/4, largo' rhythm to produce an accentuated final, long relaxed phonation" (p. 317).

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Direct Quotes and Associated Page Numbers From Each Referenced Therapy Task

- Fex et al. (1994): "Sustained phonation with variations in loudness (accents) comprises a phrase produced by the therapist that is then imitated by the patient" (p. 164).

- Timing breath and voice onset
  - Kotby et al. (1991): ". . . optimal timing between pulmonary exhalation and onset of phonation . . ." (p. 317).
- Auditory cuing
  - Kotby et al. (1991): "For the fulfillment of the above goals, the patient is modifying the vocal function through self-auditory monitoring . . ." (p. 317).
- Optimal vocal effort
  - Casper and Murry (2000): "Easy voice production with an open-throat feeling is stressed . . ." (p. 994).
  - Kotby et al. (1991): ". . . optimal phonatory effort" (p. 317).
- Body posture
  - Casper and Murry (2000): "The patient develops a relaxed throat and upper thorax while acquiring the sensation of lower thoracic muscle activity as the accented breathing is produced" (p. 994).
  - Kotby et al. (1991): "Diaphragmatic breathing is trained in the sitting position except in a few rigid patients in whom the training starts in the supine position. It is important to assure relaxation of the upper chest and shoulders while transferring all respiratory efforts to the abdominal level. Further steps may be trained while the patient is sitting, standing, or even walking" (p. 317).
  - Fex et al. (1994): "The accent method focuses on developing a relaxed body position . . ." (p. 164).
- Breathy voicing
  - Kotby et al. (1991): "A breathy voice may be encouraged during the initial stages of the therapy program, particularly for cases of hyperfunctional dysphonia" (p. 317).