Should Singing Activities Be Included in Speech and Voice Therapy for Prepubertal Children?

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Summary

Customarily, speaking and singing have tended to be regarded as two completely separate sets of behaviors in clinical and educational settings. The treatment of speech and voice disorders has focused on the client's speaking ability, as this is perceived to be the main vocal behavior of concern. However, according to a broader voice-science perspective, given that the same vocal structure is used for speaking and singing, it may be possible to include singing in speech and voice therapy. In this article, a theoretical framework is proposed that indicates possible benefits from the inclusion of singing in such therapeutic settings. Based on a literature review, it is demonstrated theoretically why singing activities can potentially be exploited in the treatment of prepubertal children suffering from speech and voice disorders. Based on this theoretical framework, implications for further empirical research and practice are suggested.

Key Words: Speech and voice disorders; Children; Singing; Speech and voice therapy

Introduction

Nature of speech and voice disorders

Firstly, it is important to provide distinct definitions for speaking, singing, and voice. For the purpose of this paper, speaking is defined as the act of producing words with
appropriate intonation, volume, and tone of voice when communicating with others in
daily situations.\textsuperscript{1} Singing is defined as the act of making musical sounds with one's
voice in the form of a song or a tune.\textsuperscript{2} Voice is defined as the audible sound that is the
product of vibrating vocal folds and that is produced via the mouth when one is, for
instance, speaking or singing.\textsuperscript{[1] and [3]}

Speech disorders are characterized by disruptions in the flow of speech, for instance, in
the form of repeating the same word or substituting one sound with another.\textsuperscript{4} Voice
disorders, on the other hand, are characterized by some form of abnormality in different
vocal parameters, such as pitch of voice or the degree of perceived roughness.\textsuperscript{5}
Although customarily speech and voice disorders have been divided into two separate
categories, there have been claims that these disorders are interconnected.\textsuperscript{[6] and [7]}
Further evidence for this claim is that many speech and voice disorders appear to
originate from the same type of causal factors that need to be treated in order for the
client's vocal output to improve.\textsuperscript{3}

\textbf{Speech and voice disorders in children}

\textbf{Prevalence}

A significant number of children up to the age of 10 experience some form of a speech
or voice disorder, and increasing prevalence of such disorders has been reported during
recent decades.\textsuperscript{[4] and [8]} Nowadays, the prevalence is approximately 14\% in the
population of 10-year-olds,\textsuperscript{4} in comparison to 6\% in the 1960s.\textsuperscript{1} A variable minority are
also reported to suffer from a short- or long-term singing disorder.\textsuperscript{9} Although extremes
of any of these disorders (speech, voice, singing) are believed to be rare,\textsuperscript{10} the
prevalence of speech disorders has been difficult to determine in detail because a variety
of definitions have been proposed for them.\textsuperscript{11}

It would seem important to diagnose any vocal disability as early as possible because, if
such disorders are left untreated, they may evolve into more severe versions.\textsuperscript{12} This
may, consequently, have a significant impact on the sufferer's psychological well-being,
including his or her self-identity.\textsuperscript{[12] and [13]} Unfortunately, vocal functioning and its
disorders in children have been underresearched.\textsuperscript{14} In particular, effective treatment
strategies for children's speech and voice disorders have not been researched to a great
extent, in part because of a view that these disorders disappear with time and also because they are relatively difficult to treat because it is often difficult to identify the original causal factor(s) for the disorder.\textsuperscript{15}

**Childhood—a crucial period**

A large number of the essential characteristics of voice are established in childhood, such as the timbre of one's voice or pitch-range used for speaking.\textsuperscript{14} The voice mechanism in children is constantly changing as part of the maturational process,\textsuperscript{13} and\textsuperscript{13} with the vocal output changing simultaneously.\textsuperscript{9} Throughout one's life, environmental factors and life-experience shape one's vocal behaviors and products.\textsuperscript{13} In particular, the feedback received concerning the quality and appropriateness of vocal functioning may indirectly influence vocal products in a negative way and have a major impact on an individual's psychological well-being.\textsuperscript{4} For example, if a child is told that his or her voice sounds awful when he or she sings, the child may become afraid of singing and this may have a negative impact on his or her self-esteem.\textsuperscript{9} This implies that the role of a teacher or a therapist, as well as other significant individuals around the child, can contribute significantly to the way that the child uses his or her voice and relates to it.\textsuperscript{10}

**Causal factors for speech and voice disorders**

The quality of our voices, as well as our overall speaking and singing capabilities, are influenced by a number of factors, such as our genetics and living environment.\textsuperscript{16} Therefore, it is to be expected that the underlying causal factors for speech and voice disorders may have diverse origins.\textsuperscript{4, 8, 14} and\textsuperscript{16} Overall, the factors that influence vocal functioning can be divided into three categories, namely those whose origins are physiological, psychological, and/or sociological.\textsuperscript{3}

**Physiological and sociological origins of speech and voice disorders**

From the physiological perspective, our voices are influenced by our genetics, general health, and any pathological elements in the body.\textsuperscript{16} Particularly, the voice mechanism itself is influenced by such factors.\textsuperscript{17, 18} and\textsuperscript{19} For instance, when an individual has a common cold, the quality of his or her voice changes,\textsuperscript{20} or tension in a child's facial muscles may cause the vocal product to become distorted.\textsuperscript{21}
Voice function is further shaped by education, environment (such as family factors and one's living conditions), and life-experience.[20] and [22] For example, the number of family members or the way the parents speak may influence the way in which a child uses his or her voice,[4] or the feedback a child has received throughout its life in social situations may have had a significant modifying impact on the child's voice.[3]

**Psychological causal factors and their connections to one's physiology**

Complex neurological networks are engaged in the processing and production of any voiced sound.[23] and [24] These neural networks, which connect all the various physiological and anatomical elements of the body to each other and which are used for processing of sound, also connect the physiological and psychological sides of the individual to each other, forming a connection that has been identified as the bodymind.[25] and [26]

Pert[25] originally used the term bodymind. According to her, our bodies and minds are interconnected via neuropeptides and their receptors. Therefore, it is reasonable to talk about the bodymind rather than a separate body and a separate mind. For instance, it is in these neuropeptide connections throughout the body that the processing of emotions takes place.[25] Auditory stimuli (including music) are also processed by these neural connections, with all such stimuli greatly influencing us via an evoked emotional response that is recorded in the neurological networks.[27]

**The bodymind, psychological well-being, and sociological factors**

Evidence for such bodymind neurological interconnections is found from studies of children who do not appear to possess any form of a physical voice mechanism abnormality, but whose vocal products are distorted due to emotional factors (such as anxiety).[28] Negative psychological states are usually reflected as tension in the physiological behavior of the individual[29] that can, subsequently, cause his or her speaking and singing behaviors to become distorted.

Biography, factors related to the family, as well as general sociocultural factors educate and shape a child's vocal behaviors.[4] For instance, individuals from a lower socioeconomic status may have developed slightly different ways of using their voices in comparison to individuals from higher classes, because the way individuals close to a
child use their voices has a significant impact on how the child uses his or her voice. These factors are further connected to the child's physiological functioning. For example, once a child becomes accustomed to speak with a high-pitched voice as a result of learning to speak this way from family members, the way the child uses his or her voice mechanism changes. However, such changes may result in, for instance, excessive tension in the voice mechanism and, thus, in distorted voice qualities.

Collectively, the research evidence suggests that our vocal functioning is shaped by a number of factors, often alongside each other. Consequently, voice behavior and development could be regarded as a holistic entity, which may allow better diagnosis and treatment of the causal factors underlying the disorder, particularly if they have diverse origins.

**The bodymind and human-compatible learning**

The bodymind perspective is also related to a concept of human-compatible learning, according to which the greatest potential for the realization of human learning is achieved when such processes take place via both the body and the mind (ie, the bodymind). Memories, experiences, and knowledge are stored in the neural networks that connect the body to the mind, including knowledge of vocal use. For instance, more efficient learning takes place when a student is engaged in the concept being taught rather than listening to a teacher talking about it. This is because some form of emotional involvement that manifests itself in the bodymind takes place in such learning settings.

In addition, educators can have a great influence on how children's neural networks are shaped. It is also in these networks that the impact of considering speech and singing as two different sets of behaviors or considering them as an integrated whole is evidenced.

**The potential influence of singing on children's vocal functioning—potential inclusion of singing in speech and voice therapy settings**

Although the effect of music and singing in speech and voice therapy settings has been underresearched, there is a small number of studies that have indicated that singing may
be a beneficial addition to traditional speech and voice therapy techniques, as it may be helpful in improving the client's speaking in an indirect way (i.e., not focusing on speech behavior as such in the therapeutic setting but attempting to improve the child's speaking via alternative activities, such as singing) in addition to enhancing the quality of his or her vocal output. For instance, drumming with percussion instruments has been found to be helpful in relaxing the child; chanting has been found to have a similar effect. However, there appear to be no studies on the potential influence of singing on overall quality of vocal products, although theoretically it seems that singing could well be a beneficial addition to speech and voice therapy settings.

Below, theoretical arguments are formulated that demonstrate how one's singing and speaking behaviors are interrelated from both intraindividual and interindividual perspectives. The model on vocal behavior, proposed by the authors, also demonstrates how one's speaking and singing behaviors potentially influence the quality of one's voice in both speaking and singing.

**Intraindividual factors**

**Neural connections between speech, singing, and the voice**

The nervous system consists of neural networks throughout the body, including the brain. Overlaps between the neural processing systems dealing with speech and singing have been recorded in all neural networks, in particular in our brains, as demonstrated below.

**Linguistic elements, musical elements, and the brain**

Although major aspects of language and speech are primarily processed in the left hemisphere and features of music have a similar bias in processing toward the right hemisphere, it has been reported that music and language use several similar neurological features. Singing and speech also use shared cortical networks, and voice is processed bilaterally in a number of brain areas. Furthermore, the cerebellum is believed to be primarily evolved in speech processing, but it is also related to the processing of singing.
Language, music, and voice processing are seen to overlap in the brain because musical processing does not rely on a single neural location or pathway, but on sets of neural components that have a potential to specialize in music.\[24,37\] A greater amount of overlap between the processing of musical and linguistic stimuli may be observed in the pitch processing subsystem, since pitch plays a part in the comprehension of speech and in the comprehension of music.\[41,43\] Moreover, the prosodic features (the patterns of melody and rhythm) of speech and the melodies of music are processed in similar ways.\[37,41\] Prosody in speech is recognized in terms of its paralinguistic cues (such as pitch variations), which emphasize the syntax and the semantics of the utterance, while the communicative function of rhythm is significant in making speech meaningful.\[44,45\]

In most individuals, neither music nor language processing can be consigned to a single hemisphere,\[23,24,37,41\] and the relative extent to which each element is processed by each hemisphere (within an overall biasing mentioned at the start of this section) is likely to differ according to the life-experiences that have shaped the individual's neural networks.\[16,23,27,46\] Evidence for this has been found from studies with a number of brain-damaged patients, who, despite having all suffered damage to the same parts of the brain, still exhibit different capabilities with reference to their neural processing.\[46\] Additional evidence is found from studies comparing the brain functioning of musicians (skilled in a performance sense) to that of “non-musicians,”\[47\] with there being a greater amount of overlap in the processing of music and language in the former.

It should be noted that a particular amount of the elements that are only found in musical stimuli (such as melodies) is primarily processed by the right hemisphere,\[42,44\] while the other elements (such as pitch), which are also present in other auditory stimuli (such as in speech), are less specifically processed by a single hemisphere.\[24,38\] For example, pitch processing is needed both with musical and speech stimuli.

The processing of musical pitch takes place in the planum temporale of the right hemisphere.\[45\] More specifically, complex pitch processing takes place in the Heschl's gyrus of the right hemisphere, which is also associated with the analysis of the fundamental frequency of one's own voice when retrieving feedback for monitoring one's vocal product.\[45\] In addition, although different musical elements seem to be processed by different brain parts, the whole brain is activated in music perception and
performance, with the activation of a particular processing system being dependent on the stimulus component to which the brain is attuned. Such arguments provide further evidence on overlap in the neurological processes for music, speech, and voice.

Further evidence for the connections between speaking and singing is found in the fact that one's first musical and speaking experiences inside the womb deal with melodic contour to a great extent. Early experience determines one's perception of pitch variations both in speech and music. Infants recognize complex auditory stimuli primarily in terms of their relative contour, indicating the importance of the musical elements in the processing of both speaking and singing. This implies that children may be taught to listen to and imitate both spoken and sung passages and that, through a refinement in children's auditory skills (mainly through mastering the ability to perceive the emotional meaning of the passage), speech perception may also be enhanced. Moreover, speech and music (which both contain patterned and internally consistent sensory information) are combined in singing, implying that singing activities may facilitate one's speaking abilities by focusing on the patterned properties that music and speech share.

Rhythm processing and speech processing may also be closely related to each other, indicating that rhythmic activities in speech and voice therapy settings may be beneficial. However, the exact neural processes required for rhythm comprehension are still unknown. In addition, simpler rhythms are processed by the left prefrontal and parietal brain areas, while more complex rhythms are processed by the right prefrontal, premotor, and parietal regions. Furthermore, in vocal tasks, the anterior part of the right superior temporal lobe plays a significant part. This area is also involved in the processing of paralinguistic information (such as any musical elements) in the vocal input.

Vocal recognition is a highly complex auditory function, indicating that vocal imitation tasks require a number of different neural pathways. However, neural adaptation (ie, when one engages in a particular task a number of times, the neural networks of one's body may adapt and change permanently) to repetitive vocal input has been recorded in speech or voice disordered patients.
Emotions, the brain, and their connections to speech and voice disorders

The subcortical structures required for rhythm perception and emotional arousal may be closely related to one's musical and speaking abilities through the engagement of various brain areas. These brain processes have been developed according to the music present in the individual's culture and to the education she or she has received, since, in general, musical (including singing) education shapes our neural networks. Therefore, these areas may be responsible for one's disordered speech or voice.

Moreover, in individuals who suffer from speech and voice disorders, the causal factors for the disorder may influence the neurological processes. For instance, when the original causal factor is of psychological nature, negative emotions may inhibit the functioning of the neural pathways responsible for vocalization, resulting in disordered vocal output. For instance, when a child speaks with an extremely quiet voice due to a negative vocal identity, the neural pathways responsible for vocalization may adapt themselves so that the child is not able to produce voiced sounds in any other way, with the result being a rough voice quality. This indicates that the sufferer's vocal output may be enhanced by modifying his or her emotional state, potentially affecting positive change in his or her neural functioning, based on the fact that the neural pathways needed for vocalization and the pathways responsible for emotional processing overlap in the periaqueductal gray area.

The amygdala and the limbic system are responsible for processing emotions and also play a part in other physical functions (such as heart rate and respiration). Positive emotions are predominantly processed in the right hemisphere and negative ones in the left hemisphere, with there being multiple emotional systems in the brain that can be aroused by music. However, according to Peretz and Zatorre, emotional analysis may be mediated by cortical relay (ie, subcortically mediated affective responses), independent of limbic structures that have been believed to play a part in emotional processing.

Irrespective of the exact processing system for emotion, music and singing could potentially be positively used in speech and voice therapy settings by exploiting them in
an emotionally pleasing way. Additionally, temporary emotional states change along one's development, although core emotional states remain fairly stable, which, in turn, influences and alters one's neurological functions.

**Potential exploitation of music and singing in therapeutic settings**

The above argumentation provides support for the inclusion of singing in speech and voice therapy settings with prepubertal children. As demonstrated above, evidence is for the bodymind connections (ie, the connections between our physiology and psychological side) and for this entity to be highly sensitive to external influences (such as voiced sounds). Singing activities may, therefore, potentially affect positive change either in the child's psychological side or in the child's physiological side, which will have an enhancing effect on his or her speaking ability or voice quality. In addition, the evidenced integrated nature of the processing of musical (such as rhythm) and linguistic elements (such as the prosody in speech), as well as the processing of any auditory information, provides evidence for the potential inclusion of singing in speech and voice therapy settings.

It may be possible to exploit one aspect of vocal function (such as singing) to influence positive change in the other (such as speaking), based on their shared underlying neural processes. Since musical capacities are widely present in both hemispheres of the brain, therapeutic strategies focusing on melody (in addition to other musical elements) stimulate various areas of the brain that consist of a wide range of neural connections, potentially also stimulating the areas needed for speech production.

Furthermore, Thaut has argued that music can engage the brain in various ways, resulting in altered neural functioning (such as more integrated work between the left and right hemispheres). For example, singing activities may alter the brain functioning needed for speech production. An example of this is melodic intonation therapy, in which singing activities are exploited in order to gain positive development in a patient's speaking behavior. This evidence on the connections between music and language processing in the brain indicates that both of these processes make use of interhemispheric integration, and is potentially the basis for using singing activities in the treatment of speech and voice disorders in children (Figure 1).
Figure 1. The model demonstrates the elements that are primarily processed by the left hemisphere and the elements that are processed by the right hemisphere. The model also demonstrates which elements seem to rely on interhemispheric processing.

In addition, the voice mechanism adapts itself according to the desired vocal behavior. The functioning of the vocal mechanism in speaking is closely related to its functioning in singing, as the same mechanics are used for both vocal behaviors. However, the dynamics of speech and singing differ to some extent, with the most significant dynamic differences being found in vowel sounds. This indicates that one's cortical activity can potentially be trained by singing activities, which may result in improved vocal performance also when one is speaking.

In singing, the tension of the vocal folds plays an important role in terms of being relative to the pitch and the intensity of the vocal product, while being closely associated with the shaping of the vocal tract and the activity of the laryngeal muscles. In both speaking and singing, the individual's inner ear is stimulated by the incoming tactile and kinesthetic information, which facilitates neural pathways that are responsible for the fine motor movements that are required for modifying vocal products.

Furthermore, since the breathing pattern in singing differs from that in speaking, respiratory activity may be stimulated by singing activities. If the voice, for instance, lacks volume, the activity of the lungs and diaphragm, as well as other muscles needed for breathing, is likely to be functioning with relatively low movements, but their functions can be improved by applying the breathing patterns that one uses in singing to speaking. Singing may be used in voice therapy as a form of extended speaking, based on the notion that singing and speaking behaviors are connected via the breathing mechanism that they share.
In addition to singing and speaking being viewed as connected based on the same physiological structures that they share, singing activities may be beneficial in treating voice disorders since singing is primarily concerned with the quality of the voice. More specifically, physiological and anatomical neural networks are more likely to benefit from activities that enhance the individual's vocal behaviors, and the underlying vocal behaviors in speech (such as those related to the qualitative aspects of voice) could be influenced by activities focusing on the underlying vocal behaviors in singing. For instance, a child's singing abilities may potentially be enhanced by rhythmic and melodic speaking.

The bodymind connections and holistic treatment of speech and voice disorders

As mentioned earlier, our bodyminds process all auditory stimuli and they are responsible for producing desired behaviors (including speaking and singing behaviors). These bodymind connections can be the focus in the treatment of speech and voice disorders. Since all the elements of the physical body (including the immune, endocrine, and nervous systems) are affected by the individual's mental state, they are also reactive to the physical well-being of the individual and, thus, they further influence one's vocal functioning.

Since an individual's neural networks and bodymind connections are shaped by the sound environment he or she grows up in, musical (including singing) activities could potentially be used as a means to stimulate the individual's neural networks in order to gain a positive change in the vocal functioning through the influence that they have on the individual's bodymind. For instance, stress greatly influences the autonomic nervous system but these negative influences can be counteracted with the help of singing activities.

Singing and its psychological impact

Singing activities may be extremely beneficial in improving one's vocal output when the disorder originates from a psychological factor. Moreover, since both speech and singing are associated with emotions in one way or another, activities focusing on stimulating particular brain parts may influence both neurological and psychological functions of sufferers and indirectly improve their vocal functioning and vocal products.
Furthermore, individuals with disorders originating from a psychological factor can often sing easier than they can speak. This is due to the fact that the influence of singing over the bodymind normally enables the individual to relax, resulting in enhanced speaking competency. Singing activities may be even more beneficial than other musical activities due to our intimate relationship with our voices. Additionally, emotions may be viewed as a sequence of events, from which the significant ones are appraised and will subsequently cause reactions in the individual's body. For instance, some individuals avoid singing due to its potential to release emotions. The counteraction against responses to negative emotions may be the basis for using singing activities in speech and voice therapies.

Since music has a great deal of influence on the human nervous system, singing may be used as an agent that enables a child to relax. Relaxation factors are believed to be extremely significant in speech and voice therapies since excessive tension both in the body and in the mind can cause strong negative effects on respiration, phonation, and articulation. Once an individual is able to relax his or her voice mechanism and the rest of his or her body when engaged in one type of voice production (such as singing), he or she may be taught to elaborate the technique to another vocal behavior (such as speaking). This may potentially enhance the latter type of vocal behavior.

Different musical elements have different influences on the physical body and the psychological state of the individual (such as slower tempo most often being perceived as relaxing but staccato as energizing), and they may be exploited in therapeutic settings in order to obtain the desired effect on the bodymind and, indirectly, on the vocal product. Since emotional prosody is one of the most basic features of speech and since singing is regarded as performing an emotionally expressive function, the emotional side of musical elements and singing may be focused on when exploiting singing in therapeutic settings. For instance, as discussed above, rhythm is often regarded as one of the most influential and significant musical elements. In particular, with speech disorders, singing activities focusing on rhythm may be extremely beneficial in enhancing the individual's speech management and the vocal output in order for it to become more fluent. In addition, rhythm is an efficient memory tool.
Singing activities can be modified according to the individual's needs since singing activities may be exploited in therapeutic settings in several ways, depending on the original causal factor for the individual's disorder. For example, when personal relationships are causing distress to the individual, singing activities that take place in pairs may ease his or her problem. With some individuals, group singing activities may be beneficial due to the human tendency to social reinforce (ie, to learn from others how to respond to specific stimuli). In group settings, the sufferers can model the therapist or the teacher in order to improve their vocal behaviors. Major improvements may take place without particular notice, and children do not necessarily feel that they are undertaking therapy.

**Interindividual factors**

In addition to the intraindividual perspective, there are factors outside the individual that influence one's vocal products. Below, such factors are outlined and it is theoretically demonstrated how the voice seems to be a holistic entity from this perspective.

**Musical and vocal development**

From the developmental and sociological perspectives, speaking and singing behaviors are closely connected. A child's musical learning and development are defined by the musical environment he or she grows up in and, more specifically, by the musical action that is specific to his or her culture. Musical activities (including singing) are characteristics of communities, evidenced in individual cognitions and behaviors that can be recorded in social interactions. More specifically, the stimulation from the child's environment is essential for developing musical skill. Such skill is built on his or her innate abilities and tendencies, with the child learning to speak and sing according to the input he or she receives from other members of his or her culture. This implies that a model on vocal behavior development should be viewed with reference to the individual's culture.

The child's cultural experiences shape the development and the function of his or her anatomical and physiological structures that are required for the generation of vocal sound. In other words, all the different elements in one's voice mechanism are conditioned to produce voiced sound in accordance to the sociological feedback of one's
culture, based on which individuals from different cultures become accustomed to use their voice mechanisms in particular ways. Such experiences also shape the neuropsychobiological networks developed for the initiation and interpretation of sound\textsuperscript{[16]} and \textsuperscript{[27]}. Therefore, in some cultures (such as in Western countries), speaking and singing are learned and interpreted as separate entities. In some other cultures (such as in African cultures), they are interwoven to a greater extent.\textsuperscript{[16]} By the age of 5 or 6, children have usually learned to distinguish between singing and speaking.\textsuperscript{[69]} Therefore, it may be easier to educate children from a young age to regard all vocal behavior as interconnected rather than as separate.

**Early vocalization**

Further evidence for the connections between speaking and singing is found from studies concerning early vocalization, which have demonstrated that social surroundings inclusively determine our early vocalization sounds that may develop either into being similar to speaking or being similar to singing.\textsuperscript{[74]} More specifically, first cries, babbling, and vocal sounds all develop into speaking or singing, and it is the cultural influence (particularly the mother's vocalization) that divides the vocal behaviors into two separate categories.\textsuperscript{[3]} In all cultures, mothers speak to their children in a particular way (known as motherese), which consists of singing-like speech patterns\textsuperscript{[72]} that contain different rhythms, inflections, sequences, and intensities.\textsuperscript{[76]}

In one sense, therefore, children are exposed to singing from birth. It is only later on in life that their developing singing ability may diminish if it is not encouraged by the local culture.\textsuperscript{[27]} By the age of 1 or 2, children are able to sing spontaneously, and the habit of singing begins to develop.\textsuperscript{[48]} The early years of childhood may then be regarded as a significant time in an individual's life in terms of forming a firm ground for his or her subsequent vocal behaviors. This provides further evidence for the importance of treating speech and voice distortions early on in life if at all possible.

**Cultural traditions**

Cultures with oral music traditions maintain them by exercising singing in daily life, which educates the children to view speaking and singing as equally communicative behaviors.\textsuperscript{[27]} This early exposure to musical stimuli educates the child in a number of ways. For example, the child is more able to imitate sung pitches.\textsuperscript{[77]}
For the child, the encouragement to use his or her own voice in various ways is extremely important for learning to use the voice mechanism in an appropriate manner and for the vocal output to remain as “normal” as possible. Moreover, from a social perspective, it may be more beneficial to view singing and speech as a continuum rather than as separate categories since considerable overlap seems to occur between the components and the brain processes required for both of these behaviors. The categorization of vocal auditory input either as speech or as singing depends on the cultural environment and education.

From a sociological perspective, children can be educated to view both singing and speaking as expressive behaviors in everyday life. Through the use of singing activities, children may be made more aware of their vocal capabilities, and they may become more able to improve their distorted vocal behaviors by developing an ability to modify their vocal behaviors. This is due to the fact that singing behaviors are subject to change on a developmental continuum. On the other hand, the learning processes are constrained by the child's immature perceptual capabilities and by the nature of the material to be learned, which may be difficult for the child to comprehend. This implies that the singing activities need to be designed carefully in order for them to match the child's current abilities. The theorizing above on the sociological perspective of vocal behaviors indicates that all vocal behaviors (including speaking and singing) share the same starting-point and ontology, which may potentially be exploited in therapeutic settings (Figure 2).

Figure 2. The model demonstrates how the different factors that influence our vocal functioning and vocal products interact and influence each other. All the intra- and interindividual factors influence one another and shape the individual's singing and speaking competencies. The individual's speaking and singing competencies then...
influence the quality of his or her vocal output, both in speaking and singing. The model further demonstrates how the perceived quality of one's voice when speaking is influential to the quality of one's voice when singing, and vice versa. The research questions for further empirical research can be found in the yellow and blue boxes at the top of the model, as the theoretical argument has been that all vocal functioning and vocal products are interconnected. However, this needs to be tested empirically. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Implications for the speech and voice clinic

Some speech and voice therapists may feel that they are not qualified to use singing in their practice. However, one does not need to be a trained singer in order to be able to engage in singing activities with child clients. It is enough to follow a melodic line to some extent. Enthusiasm and encouragement are of greater importance. When working alone with children, the therapist does not need to feel intimidated by his or her singing abilities; it is more important to create a welcoming and comfortable atmosphere. Moreover, children usually enjoy singing and, once engaged in such an activity, may not feel that they are undergoing therapy. This may help in counteracting the negative psychological impact that therapy sessions may have on the child.

Through singing activities, the therapist may be able to make the children aware of their voice use and educate them in using their voices correctly. In addition, the therapist can educate the child to view speech and singing as connected rather than completely separate entities by engaging them in singing. This may be of significant subsequent help in preventing more severe voice disorders from arising since it may be the child's singing behavior that is causing his or her voice to be distorted. The therapist does not need extensive knowledge of singing in order to be able to do this. The main assets the therapist needs to have are good perceptual skills and attention to detail in order to be able to detect any vocal distortion in the child's voice when he or she sings and in order to detect if the child is forcing his or her voice when singing.
The potential use of singing activities in the treatment of children's speech and voice disorders is currently being tested empirically in an ongoing study. Further implications for the potential inclusion of singing in practical terms can be proposed once the empirical part of the study has been completed.

**Conclusions and implications for further research**

In this article, it has been demonstrated theoretically why singing activities may potentially be beneficial in treating children with speech and voice disorders. The branches of research concerning our vocal development,[13], [16], [22], [48] and [74], human biopsychological makeup,[23], [24], [43], [42], [52], [62], [66] and [69], and our cultural environment[3], [67], [73], [69], [76] and [77], demonstrate that there is a considerable amount of evidence on the connections between speech and singing behaviors.

The complex makeup of human physiology and its relations to our psychological side indicate that singing activities may influence the entire bodymind.[16], [31], [66] and [68]. Once these activities are used in the form of a holistic approach in a therapeutic or educational setting by focusing on the complex makeup of humans, vocal behaviors may be enhanced. However, there are considerable gaps found in the literature that concerns children's vocal functioning, vocal qualities, and therapeutic methods for speech and voice disorder treatment.

Furthermore, studies concerning the sociological side of vocal development support the idea of exploiting singing activities in the form of holistic strategies in therapeutic settings.[31], [52] and [53]. In addition, research concerning the neurological networks responsible for the processing of linguistic and musical stimuli,[16], [23], [24], [47] and [62] indicates that the connections between these processes may be exploited with the use of singing activities. The fact that some of the strategies emphasizing musical elements[1], [3] and [4] have already been used in therapeutic settings to some extent gives further support for the inclusion of singing activities in speech and voice therapy settings. However, a lack of scientifically tested evidence from the field prevents therapists and teachers from exploiting singing in therapeutic settings. Therefore, empirical research is needed in order to gain scientific support for the theoretical arguments and in order to demonstrate in the practical sense how singing can be used at the voice clinic. Such study is under way, and empirical evidence is currently being gathered in order to
investigate how the theoretical framework could potentially be applied to practice in speech and voice therapy clinics.

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