Music and Medicine
2(2) 85-88

DOI: 10.1177/1943862110365880
http://mmd.sagepub.com

Recovery of Fluent Speech Through a Musician's Use of Prelearned Song Repertoire: A Case Study

Concetta M. Tomaino, DA, MT-BC, LCAT

Abstract

Research in music and language has pointed to the many shared neural pathways in singing and speech (Patel 2003a, 2003b, 2003c; Schlaug, 2008); however, the use of prelearned songs as a tool to aid in the recovery of speech following stroke is not fully understood. Additionally, the differences in treatment of musicians versus non-musicians after brain injury need further investigation due to the potential differences in underlying neural networks (Gaser & Schlaug, 2003). A case study of a musicologist who lost his speech following a stroke and gradually recovered it through the systematic use of songs from his anthology of folk songs is presented in the context of contemporary neuroscience research in music language and the brain.

Keywords

music therapy, aphasia, musician, neuroscience, music and brain, rehabilitation

In April 1995, I met Mr. Smith upon his admission to our sub-acute rehabilitation program. Although he had recently suffered a stroke, this 80-year-old man was fully ambulatory, alert, pleasant, and eager to work toward recovery—his primary issue being loss of fluent speech. Because he had spent his life in music, recording and archiving folk songs, his family searched for a setting that could immerse him in his art as well as keep him mentally engaged. His daughter, sister, and friend accompanied him on the day of admission and provided additional information about his background and current work in archiving world music. It was obvious that his speech was severely impaired. He had long silent pauses when he attempted to speak, where his struggle to find the right word would cause frustration. His admitting hospital had prescribed several medications to reduce his restlessness and agitation—traits that the social worker, I, and others thought to be more from his frustration at his inability to communicate rather than from a behavioral problem. We also wondered if such medication would inhibit the potential for neural recovery. With some careful team planning, his medications were greatly reduced and he was placed on speech therapy and daily (5 times/week) music therapy.

During our first music therapy session, a full assessment was performed to test intact music abilities. He was able to tap back simple rhythmic patterns—a test that demonstrates that both rhythmic perception as well as motor ability (skills essential for speech) were intact. His perception of melody was intact in that he recognized songs as I sang them to him; however, his ability to sing in pitch was greatly impaired with almost no tone, although the inflection or prosody seemed intact. He could not sing any of the lyrics to "Happy Birthday" except for mimicking "hap" and then continuing only with a rhythmic "da da da da da da." I also sang "Down by the Riverside," cueing him to follow the rhythm and mouthing the lyrics, but he still missed all but the rhythm.

After 4 weeks, he was already showing recovery. His singing had improved in melodic contour, pitch, and his ability to recall longer melodies. His lyric retrieval was still impaired, although now he was singing the opening words to the refrain of a few folk songs and intermittently singing the correct lyrics at the beginning and end of the verses.

To keep him mentally engaged and motivated, I gave him "homework"—to take one of the songs from his anthology and try to memorize the lyrics and then sing them without reading the lines from his song book. His ability to read aloud seemed to be easier than recalling even very familiar lyrics from memory. He was still very anxious about his condition and his prospect for full recovery but was very motivated.

The beginning of the 5th week, he arrived to the music therapy studio a little early, eager to tell me that he "had a few . . . songs . . . for me," and then sang, from memory, "Down in the Valley" and "Blind Man" and part of another song. Mr. Smith sang the first verse of each in good voice, tone, and control and

Institute for Music and Neurologic Function, Bronx, NY, USA

Corresponding Author:
Concetta M. Tomaino, Institute for Music and Neurologic Function, 612 Allerton Avenue, Bronx, NY 10467.
Email: ctomaino@bethabe.org

with the correct lyrics. He was very pleased and stated that he had worked on these for many hours and could not recall them without the practice. During the session, he stated that he couldn't remember the word for what had happened to him (stroke). He then sang many songs from his book. The first few were sung with much feeling and hardly any word errors. He then sang several more and started having some problems with recalling the tunes and made some errors. He wanted to give up, but I encouraged him to stop and relax for a second and try again, which he did with more success. After he sang each song, we would engage in simple conversation. I would ask questions about the songs, but his speech was still impaired and word retrieval was better immediately after singing each song and then would show impairment the more he tried to express himself verbally. This made me question whether or not the singing was "priming" his word retrieval as he had better word recall immediately after singing than he did prior to singing.

By the beginning of August (4 months after his admission) and shortly before his discharge home, my notes showed that he was singing with more expressivity. He was taking artistic pauses within the song—demonstration that he was no longer carefully thinking about the lyrics but rather freely singing them with complete recall and flow. His speech had also improved greatly. Speech therapy noted that his phrases were at 80% for word retrieval and fluency. I noted that his speech was slow and deliberate but more accurate.

The work with Mr. Smith led me to ask many questions about the overlap of singing and speech and especially if the musician's brain could better recover if overlearned skills could be applied in the therapeutic context to stimulate preserved abilities—in this particular case, the possibility of applying a lifetime of singing and, consequently, overlearned lyrics as a tool to stimulate word retrieval and speech fluency.

At the time of this case study, there was little information on the shared networks of singing and speech. In fact, most neurologists still explained singing as a separate skill from speech, having observed persons with left brain strokes in Broca's region to be able to sing although they could not speak. However, I was finding that if such patients could be engaged in singing overlearned songs, on a daily basis, they did recover speech at a rate above the 50% chance of spontaneous recovery.

Studies within cognitive neuroscience are now dispelling previous notions of independent processes for music and language. Patel, Gibson, Ratner, Besson, and Holcomb (1998), as a result of a study investigating linguistic and musical syntactic processing in musically educated adults, argued against the previous notion of the language-specificity of the P600 (ERP—typically associated with the processing of grammatical anomalies or incongruities) and suggested that language and music may share some important aspects of neural specificity in cognitive processing in the brain. Likewise, a study using magnetoencephalography (MEG; Maess, Koelsch, Gunter, & Friderici, 2001) revealed that the Broca's area is not only involved in syntactic analysis during auditory language comprehension but also responsible for an analysis of incoming harmonic sequences. Authors of this study suggested that the

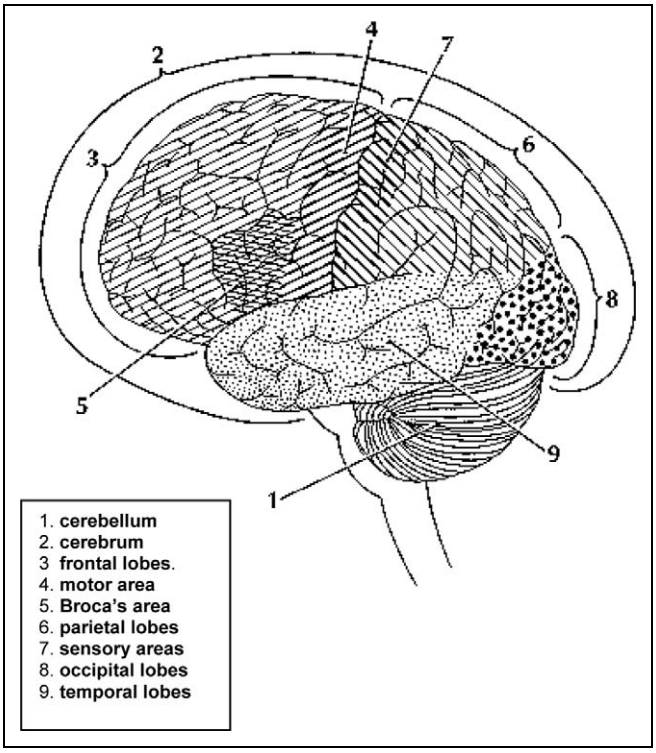

Figure 1. Left hemispheric regions involved in language. Used with permission from the National Institute of Neurological Disorder and Stroke.

Broca's area thus may process syntactic information that is less language-specific than previously believed. In addition, Besson and Schon (2001) used fMRI to investigate the hemispheric lateralization of affective prosody of language in comparison with the melodic component of music and showed a bilateral activation for both. This finding supports the indication made by an earlier behavioral study (Patel, Peretz, Tramo, & Raymonde, 1998) in which two "amusic" patients with bilateral brain damage were asked to perform tasks composed of prosodic discrimination and musical discrimination and showed a level of performance that was similar across the two modalities. Authors in the latter study suggested shared neural resources for language prosody and music from the results.

Figure 1 shows some of the interactions of various left hemispheric regions involved in language, including auditory perception and motor areas.

Current research in music and language has pointed to the many shared neural pathways in singing and speech. The effect of Melodic Intonation Therapy (MIT, a technique developed and studied by Sparks, Helm, and Albert in 1974) on neural changes after stroke has been studied in PET scans (Berlin et al., 1996) and in fMRI studies by Gottried Schlaug (2008) and his team at Harvard. Schlaug, Marchina, and Norton (2009) have shown, using diffusion tensor imaging (DTI), that intensive MIT (75–80 daily therapy sessions) for people with left side stroke (lesions in Broca's area) may lead to changes in white matter tracts and volume in the right hemisphere arcuate fasciculus (AF), a major

fiber tract that reciprocally connects to auditory and motor processing areas (superior temporal lobe and premotor regions/posterior inferior frontal gyrus). Schlaug's research suggests that intense MIT leads to remodeling of the right AF and may provide an explanation for the sustained effects that were observed in the six participants in his study.

Even though prelearned songs have been used by music therapists as a tool to aid in the recovery of speech, the process by which this affects clinical outcomes is not readily understood. Also, the concept of using prelearned songs as a priming agent for word retrieval needs further investigation. Straube, Schulz, Geipel, Mentzel, and Miltner (2008) have looked specifically at this in their recent study that investigated the role of singing during repetition of word phrases in a patient severely affected with non-fluent aphasia who had an almost complete lesion of the left hemisphere. The patient showed a pronounced increase in the number of correctly reproduced words during singing as compared to speaking excerpts of familiar lyrics. They showed that this dissociation between singing and speaking was not seen for novel song lyrics, regardless of whether these were coupled with an unfamiliar, a familiar, or a spontaneously generated melody during the singing conditions. They propose that singing might help word phrase production in at least some cases of severe expressive aphasia but question whether the strong association of melody and text within long-term memory is responsible for this effect.

The case of Mr. Smith raises another question: Is the potential for recovery of speech following a stroke or traumatic brain injury greater in musicians (singers) versus non-musicians given the potential for more networks pairing melody and words than in the normal population? This needs further investigation. Gabriella Musacchia, Mikko Sams, Erika Skoe, and Nina Kraus at Northwestern University in collaboration with Helsinki University have begun to look at these differences. In one study, Musacchia et al. (2007) show that musical training modifies cortical organization within subcortical sensory structures and generalize to processing of speech. One of their results indicated that musicians had earlier and larger brainstem responses than non-musician controls to both speech and music stimuli presented in auditory and audiovisual conditions.

The above studies point to the fact that there are many shared neural networks for both singing and speech and that musicians may process music and language differently from non-musicians. Given these findings, a rationale for using prelearned lyrics to prime or aid in word retrieval in the context of speech therapy for persons with aphasia would be indicated and especially in those with musical training. We do know that both singing and speech have a temporal element, involve time and structure, require temporal planning, and have other parallels to language such as stress, inflection, pauses—all of which provide meaning.

Both require auditory discrimination and discourse intonation, that is, the ordering of pitched sounds. These are early aspects of language development (Moro, 2000). Also, the musical contours of singing are similar to the contours of prosody (Loewy, 2004).

Tempo, pitch, and contour provide context to convey meaning, evoke emotions, and form associations. The more the music and words are encoded to multiple processes, the stronger the recall of each will be.

Singing involves repetition (both melodic and verbal). Repetition is required for any learning to take place—and more so for ''relearning'' to take place—as Schlaug's MIT studies showed, that is, intensive daily MIT led to measurable changes in fibers and volume in a non-dominant area of the brain. Within the therapeutic context, the repetition allows for increased chances of predicting and retrieving words in the process of singing. Songs are effective because the melodic contour is similar to prosodic speech, and there is a strong associative component that aids in memory retrieval and imagery.

In a clinical trial analysis of music therapy techniques for persons with non-fluent aphasia (Kim & Tomaino, 2008; Tomaino, 2002, 2009), it was frequently observed that the rhythmic flow of a patient's singing was relatively intact despite his or her severely impaired normal speech rhythm. The rhythmic flow of singing was also correlated with articulation accuracy for song words. To enhance the rhythmic flow of singing, it was crucial to adjust song tempo to the patient's ability to successfully coordinate vocal musculature to the timed sequences of the song phrases. For example, tempo variation, in accordance with the frequency of notes or phrases (even within a song, if necessary), was found helpful in producing more accurate rhythm and word articulation in singing. Consistent progress in rhythm and word articulation in singing was correlated with better outcomes in other areas of musically assisted speech exercises. This observation is related to the findings of Cohen and Masses (1993), from which the authors suggested singing and rhythmic interventions as effective therapeutic techniques to improve the rate of speech and verbal intelligibility for persons with neurogenic communication disorders.

In the context of this case study, the following techniques were key in the rehabilitation process:

1. Familiar lyrics were sung repeatedly until the patient had achieved close to 100% success in singing complete lyrics. The reason for this is to stimulate recovery of words that are easier to retrieve (i.e., lyrics of songs). Improvement in recovery of these words seems to correlate with improvement in object naming tasks and other verbal skills.
2. Singing was accompanied with tapping the rhythm. This self-cueing of the phrase structure not only reinforces the phrase structure but stimulates the corresponding motor elements of speech.
3. Lyrics were cued with gaps for the patient to fill in missing words. This facilitates and stimulates word retrieval skills.
4. Once lyrics were correctly sung, the lyrics were spoken to a rhythm with no melody. This removes the dependency on melodic cueing.
5. Finally, word retrieval and conversational speech were encouraged without music or rhythmic cues.

In conclusion, the use of prelearned songs as a therapeutic tool for recovery of speech is indicated for persons with aphasia and other impairments of speech. There is also strong evidence that musicians, because of enriched neural systems, may benefit more from music therapy approaches than from traditional speech therapy approaches only.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the authorship and/or publication of this article.

Financial Disclosure/Funding

The author(s) received no financial support for the research and/or authorship of this article.

References

Berlin, P., Van Eeeckhout, P., Zilbovicius, M., Remy, P., Francois, C., Guillaume, S., ... Samson, Y. (1996). Recovery from nonfluent aphasia after melodic intonation therapy: A PET study. *Neurology*, *47*(6), 1504-1511.

Besson, M., & Schon, D. (2001). Comparison between language and music. *Annals of the New York Academy of Sciences*, *930*, 232-258.

Cohen, N., & Masses, R. (1993). The application of singing and rhythmic instruction as a therapeutic intervention for persons with neurogenic communication disorders. *Journal of Music Therapy*, *30*, 81-89.

Gaser, C., & Schlaug, G. (2003). Brain structures differ between musicians and non-musicians. *The Journal of Neuroscience*, *23*(27), 9240-9245.

Kim, M., & Tomaino, C. M. (2008). Protocol evaluation for effective music therapy for persons with nonfluent aphasia. *Topics in Stroke Rehabilitation*, *15*(6), 555-569.

Loewy, J. (2004). Integrating music, language and the voice in music therapy. *Voices, 4*(1). Retrieved February 25, 2010, from http://www.voices.no/mainissues/mi40004000140.html

Maess, B., Koelsch, S., Gunter, T. C., & Friderici, A. D. (2001). Musical syntax is processed in Broca's area: An MEG study. *Nature Neuroscience*, *4*(5), 540-545.

Moro, A. (2000). *Dynamic antisymmetry.* Cambridge, MA: MIT Press.

Musacchia, G., Sams, M., Skoe, E., & Kraus, N. (2007). Musicians have enhanced subcortical auditory and audiovisual processing of speech and music. *Proceedings of the National Academy of Science*, *104*(40), 15894-15898.

Patel, A. D. (2003a). A new approach to the cognitive neuroscience of melody. In I. Peretz & R. Zatorre (Eds.), *The cognitive neuroscience of music* (pp. 325-345). Oxford, UK: Oxford University Press.

Patel, A. D. (2003b). Language, music, syntax and the brain. *Nature Neuroscience*, *6*(7), 674-681.

Patel, A. D. (2003c). Rhythm in language and music. *Annals of the New York Academy of Sciences*, *999*(1), 140-143.

Patel, A. D., Gibson, E., Ratner, J., Besson, M., & Holcomb, P. (1998). Processing syntactic relations in language and music: An event-related potential study. *The Journal of Cognitive Neuroscience*, *10*(6), 717-733.

Patel, A. D., Peretz, I., Tramo, M., & Raymonde, L. (1998). Processing prosodic and musical patterns: A neuropsychological investigation. *Brain and Language*, *61*, 123-144.

Schlaug, G. (2008). From singing to speaking: Why singing may lead to recovery of expressive language function in patients with Broca's aphasia. *Music Perception*, *25*(4), 315-323.

Schlaug, G., Marchina, S., & Norton, A. (2009). Evidence for plasticity in white-matter tracts of patients with chronic Broca's aphasia undergoing intense intonation-based speech therapy. *Annals of the New York Academy of Sciences*, *1169*, 385-394.

Sparks, R., Helm, N., & Albert, M. (1974). Aphasia rehabilitation resulting from melodic intonation therapy. *Cortex*, *10*(4), 303-316.

Straube, T., Schulz, A., Geipel, K., Mentzel, H.-J., & Miltner, W. (2008). Dissociation between singing and speaking in expressive aphasia: The role of song familiarity. *Neuropsychologia*, *46*(5), 1505-1512.

Tomaino, C. (2002, winter). How music can reach the silenced brain. *Cerebrum*, 4(1), 22–33.

Tomaino, C. M. (2009). Clinical application of music therapy in neurological rehabilitation. In R. Haas & V. Brandes (Eds.), *Music that works* (pp. 211-220). Austria: SpringerWienNewYork.

Bio

Concetta M. Tomaino, DA, MT-BC, LCAT, is the executive director and co-founder of the Institute for Music and Neurologic Function and senior VP for music therapy services at Beth Abraham Family of Health Services.