The Power of Music: A Critical Analysis of Melodic Intonation Therapy

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Abstract

This paper examines the efficacy of Melodic Intonation Therapy (MIT), a speech therapy commonly used for patients suffering from Broca's aphasia or another kind of injury that affects the language and speech production areas of the brain. The areas of the brain involved in speech and language comprehension will be laid out, as will the consequences of damage to those areas. Since MIT relies on music, the physiological effects on music on the body and brain will be explained in detail to give the reader additional background information to help clarify discussed studies. Additionally, other aspects of MIT will be explored including cross-modularity of the brain and which specific piece of Melodic Intonation Therapy is most helpful to patients. Following the presentation of multiple studies to support all information, I will suggest ways to improve the therapy itself and additional palliative care that could alleviate patient symptoms or improve the likelihood of speech therapies making a significant difference.

Introduction

Charles Darwin developed his beliefs about the human adaptations of music and language from his observation that many species of birds rely on "the charms of their song," as a means of courtship (Kivy, 1959, p. 43). He further suggested that due to the increased vocal use by males in mammalian species considered evolutionarily close to humans, primitive man must have somehow relied on the beauty of his voice in pursuit of a mate. Kivy (1959) notes that both Darwin and German composer Richard Wagner believed music to be the source of language - that is to say, language evolved from musical beginnings. Darwin and Wagner's mutual credo that music preceded language stood in direct opposition with an 1857 essay, "The Origin and Function of Music," written by Herbert Spencer, an English scientist of multiple disciplines.

Spencer pointed to five factors of speech: volume (loudness), timbre, pitch, intonation, and rate of speech. He observed that "in emotional speech, the increased emotional energy tends to increase loudness, increase sonority, raise pitch, widen intervals, and produce a greater variety of sounds," (Kivy, 1959, p. 45). Spencer argued that characteristics of emotional speech tend to transform the speech into something much more similar to what most would consider music. This led him to the conclusion that vocal music is an extension of language that developed to allow further emotional expression. Darwin had little criticism for Spencer's methods and results, but simply believed the opposite - that language had evolved and become specialized to express that which cannot be expressed through music, leaving music behind as an emotionally stirring remnant. An important aspect of both music and speech that both men did not take into account, however, is rhythm. In the century and a half since Darwin's time, we have begun to understand the cognitive and physiological effects of music: thus far, we have discovered an intrinsic relationship between speech, music, and rhythm and used that knowledge to develop therapies. Based on the numerous positive health benefits of music, I believe music itself to be form of palliative care, which is the lens through which this paper will explore the physiological effects of music; history of its use in speech therapy for the past forty years, Melodic Intonation Therapy (MIT) in specific; and how that use could be adjusted to better suit patient needs.

The Brain and Injury

Melodic Intonation Therapy was first developed in 1973 at the Boston Veterans Association Hospital by Sparks, Helm, and Albert. The three worked to help those with non-fluent aphasias, most specifically Broca's aphasia, to recover. Our only means of interacting with one another and the world in which we live is through sensory input and output. Diverse and direct communication is an important aspect of what distinguishes humans from other animals and allows us to create society as we know it. Both language and music are an indispensable part of our culture; we have spent centuries creating art, literature, and music to express, excite, and push limits. Communication of all kinds is a lynchpin in all societies and cultures, whether it be direct speaking or more emotionally abstract musical expression. We find these facets of our humanity so important that the exploratory Voyager spacecraft's golden record contains ninety minutes worth of various world musics (including Bach, Beethoven, and Stravinsky); greetings in fifty-five languages, both ancient and modern; and 116 images of natural scenes, pages of books, cities, construction, a few planets, and many diverse depictions of human anatomy.

Broca's aphasia is a non-fluent aphasia that may result when damage is sustained to the left inferior frontal gyrus, whether from ischemic[1] or hemorrhagic[2] stroke, traumatic brain injury, or some other cause. Non-fluent aphasias are characterized by problems with cognition of language and disruption of the pathways that allow for production of speech. Damage to Wernicke's area, located in a fissure between the temporal and parietal lobes (see figure 1 on next page), affects speech comprehension and can result in fluent aphasia. This is the primary auditory cortex, the area where auditory stimuli first reach the cerebral cortex before the frequencies are processed into speech (Schacter, Gilbert, & Wegner, 2010). The patient retains the ability to produce speech with normal tone at a natural rate with proper syntax and grammar, but cannot articulate meaningful sentences. Not only is speech comprehension affected, but also

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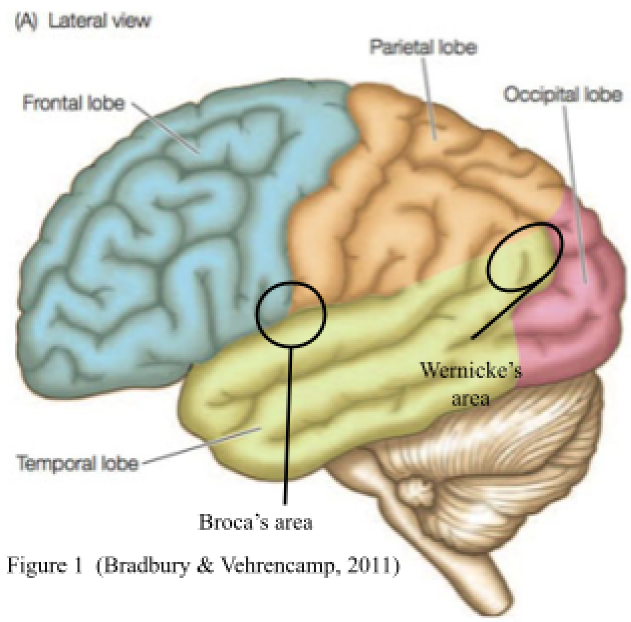
[1] Ischemic stroke results from an obstruction of some kind forming within a main artery or fine blood vessel in the brain and is very common.
[2] Hemorrhagic stroke results from a ruptured blood vessel.

the ability to understand writing. Most of these comprehension deficits do not come from the damage to Wernicke's area alone: Kolb and Wishaw (2003) propose many of the symptoms people with fluent aphasias face are a result of damage to the medial temporal lobe. In addition to any damage sustained to the primary auditory cortex itself, there is interference in the connections between the parietal, occipital, and remainder of the temporal lobe.



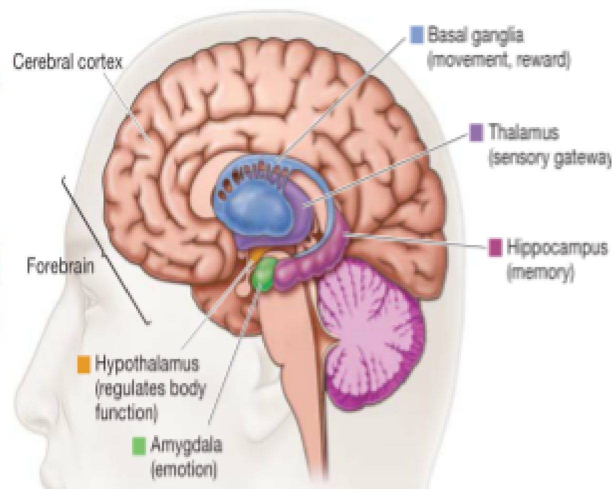


Figure 1 (Bradbury & Vehrencamp, 2011) (Gazzinga, Heatherton, & Halpern, 2011)

Sparks, Helm, and Albert theorized that, "increased use of the right hemisphere dominance for the melodic aspect of speech increases the role of that hemisphere in inter-hemispheric control of language, possibly diminishing the language dominance of the damaged left hemisphere," (Marshal & Holtzapple, 1976, p. 115). The doctors did not assume the MIT would be successful with all types of aphasia or in all patients, but noted that patients with Broca's aphasia would find it most beneficial. Damage to the left hemisphere of the brain causes such devastation to communication abilities, because it contains the language processing and production center (for right-handed people[3]).

The theory behind Melodic Intonation Therapy relies on the neuroplasticity of the brain - that is to say the natural ability of the brain to alter its neural pathways and connections to make up for lost function. Neuroplasticity is simply how the brain changes in response to environment, differing behavior, or damage (Pascual-Leone et. al., 2011). Angiogenesis, neurogenesis, and synaptic plasticity comprise much of what drives the neuroplasticity that occurs following brain injury. Angiogenesis refers to the reformation of capillaries in and around the damaged area, increasing collateral circulation, restoring adequate blood supply, and removing necrotic tissue or cells. This is especially crucial following a stroke, because it creates new pathways for blood to enter the damaged area of the brain. The next step in restored function is neurogenesis, which is the regeneration of new neurons from neural stem cells. Normally this is a neonatal process, but neural stem cells are self-renewing and continue to produce throughout adulthood. Neurogenesis "is controlled by intrinsic genetic mechanisms and growth factors, but ambiental[4] factors are important," (Krupinski, Arboix, and Font, 2010, p. 238). Finally synaptic plasticity generates new dendrites and synapses that attempt to reroute the neural pathways (Krupinski et. al, 2010). Melodic Intonation Therapy is based on this process: by creating and maintaining cross-hemispheric pathways, linguistic function is supposed to reroute to the right hemisphere and take the strain off of the damaged left hemisphere areas, especially the left inferior frontal gyrus.

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[3] For purely left-handed individuals, the main centers of linguistic processing and production are in the right hemisphere - this paper focuses on studies with right-handedness control.

[4] This pertains to living environment and quality of life.

Music, the Body, and the Brain

The physiological effects of music can be shocking or addictive - so much so that music has been compared to a drug in and of itself. Oxytocin acts as a neurotransmitter in the brain and plays a large role in pair bonding by increasing trust and reducing fear. Some animal studies suggest that the presence of oxytocin can inhibit tolerance development and aid in the reduction of withdrawal symptoms from addictive drugs like opiates, stimulants, or alcohol (Kovács, Sarnyai, & Szabó, 1998). Singing has been shown to increase levels of both immunoglobulin A, which boosts the immune system, and oxytocin, which can promote socialization - this trend is especially present in group singing and even more so during a performance (Chanda & Levitin, 2013). Though prominent cognitive scientist Steven Pinker (1997) purports that music is nothing more than auditory cheesecake, something we've crafted and sustained solely for pleasure, its measured therapeutic benefits suggest otherwise.

Dopamine is a neurotransmitter released during pleasurable activities such as sex and recreational drug use, it forms a positive reinforcement mechanism in the area of the brain that affects motivation and behavior. Further research suggests that dopamine does not necessarily function solely as a pleasure chemical, but can regulate motivation and goal-oriented behavior related to musical reward[5] and opioid neurotransmission (Chanda & Levitin, 2013). Listening, or even the anticipation of listening to music one finds pleasurable increases the dopamine levels in the brain by 6-9% (Zatorre & Salimpoor, 2011). Dopamine has also been shown to stimulate neurogenesis in adults, which could potentially increase rate of recovery following brain injury (Höglinger & Borta, 2007).

[5] This differs between people. It could be singing, playing an instrument, simply listening to music one enjoys, or experiencing musical frisson (chills).

Dopamine release most often results from tangible stimuli such as eating or sleeping yet music, an intangible stimuli, can still arouse the same “feelings of euphoria and craving,” in the striatum, a component of the basal ganglia, which are located at the base of the forebrain within the temporal lobes of each hemisphere and closely connected to the hypothalamus, cerebral cortex, and brainstem (Zatorre & Salimpoor, 2011, p. 257). Many different areas comprise the basal ganglia, the largest and most important being the striatum - it receives input from most brain areas but can only signal to other areas of the basal ganglia that are involved in voluntary and involuntary control of bodily actions. Another part of the basal ganglia, the substantia nigra, socalled due to the dark coloration resulting from a high concentration dopaminergic neurons, plays a large role in reward and addiction because half of its use is to supply the striatum with the dopamine that assists in keeping the basal ganglia functional (Fix, 2008).

Music can act as a stress regulator by initiating reflexive brainstem responses (Juslin & Västfjäll, 2008). The tempo of music can cause an increase or decrease in the listener’s heart rate as it changes to match the tempo. Music can also act as a regulator for other parts of the autonomic nervous system (ANS), including respiration rate and blood pressure (Chanda & Levitin, 2013). The ANS comprises the parasympathetic nervous system (PNS), sympathetic nervous system (SNS), and enteric nervous system (ENS), which governs the gastrointestinal system and is therefore musically non-notable. The PNS takes care of our instincts to eat, sleep, and reproduce. The most interesting effect music has on the ANS is within the SNS, which controls what is colloquially known as the “fight or flight” response. The physiological effects of music on the autonomic nervous system are best explained by theories of survival: stimulating music is usually loud and has short, repeating motifs while calming music has a slow tempo and mimics natural sounds. Anything that arouses the sympathetic nervous system has most likely been an indication of danger historically, while decreased SNS arousal results from indications of a safe environment. "Simple musical properties, such as tempo, may therefore affect central neurotransmission underlying cardiovascular and respiratory control, motor function, and potentially even higher order cognitive functions, such as the setting of attentional filters," (Chanda & Levitin, 2013, p. 185).

Menon and Levitin published a study in 2005 that explores why and how music provokes emotional and physical response through the mesolimbic pathways in the brain. Following a study showing that musical frisson and changes in heart rate related to music can be blocked by the opioid antagonist, Naloxone, Menon and Levitin became interested in the relationship between opioid transmission pathways associated with reward and music (Goldstein, 1980). Opioid transmission in the nucleus accumbens (a component of the basal ganglia) was shown to be associated with a release of dopamine from the ventral tegmental area (VTA), an area that is very difficult to distinguish from the substantia nigra (Kelley & Berridge, 2002). The 2005 study used fMRI to examine the brains of thirteen right-handed non-musicians while they listened to alternating 23-second samples of standard Classical music repertoire[6] and short, scrambled excerpts from those pieces. Menon and Levitin hypothesized that the nucleus accumbens would be activated very strongly while participants listened to the Classical pieces and that this would correlate with activation in the hypothalamus, an area of the brain "known to control autonomic and physiological response to emotional stimuli," (p. 176). Their hypothesis proved correct - there was significant activation in predicted areas, but the scans also revealed bilateral activation

[6] All chosen excerpts were relatively homogenous and characterized by major key and moderate tempo.

in Broca's area and its right hemisphere homolog; anterior cingulate cortex, which plays a role in regulation of autonomic functions; cerebellar vermis, which is associated with recognizing the relative position of one's body and coordination of movement; and the brainstem, which sits below the limbic system and relays signals throughout the body.

Menon and Levitin's 2005 study showed interaction between affective and autonomic brain systems and allowed for informed speculations about the involvement of the mesolimbic pathways in the physical or emotional response to music. Dopamine released from the ventral tegmental area seems to mediate interaction of the nucleus accumbens with the hypothalamus and insular cortex, which are extremely important in autonomic, somatic, and emotional functionality. Cepeda et. al (2006) report that listening to music can reduce the postoperative need for sedatives or opiate drugs to manage pain, which may be attributed to the capacity of music to create a relaxing environment by engaging these dopaminergic pathways. Menon and Levitan's results suggest that the nucleus accumbens is invoked, even when there is no immediate reward, supporting the theory that "[music] rewards arise from the interaction between mesolimbic reward circuitry and cortical networks involved in perceptual analysis and valuation," (Zatorre & Salimpoor, 2011, p. 257).

Cross-Modularity of Music and Language

Melodic Intonation Therapy assumes inter-hemispheric control of language relies on cross-modal sensory interactions - that is the idea that information from one sensory channel can influence interpretation of information from other sensory channels (Vines & Krumhansl, 2006). In 1993, Davidson instructed musicians to perform inexpressively, with normal expression, and finally in an overly expressive manner for recordings. Study participants were presented with only a sound recording, a video recording, or a recording with both audio and video. Davidson found that participants were best able to distinguish between the levels of expressiveness when shown only a video recording, but that those who only heard audio recordings showed markedly decreased accuracy in their ability to distinguish expressiveness. This evidence led Davidson to the conclusion that visual stimuli is more indicative of a performer's expressive intention than auditory only stimuli. Vines and Krumhansl (2006) wanted to explore the cross-modality of emotional content and musical structure, tested as continuous judgements in tension and phrasing, respectively.

All music performance involves both auditory and motor memory, and bodily movements tend to act as cues that help the musician remember their piece (Levitin, McAdams, & Adams, 2002). Vines and Krumhansl (2006) chose Stravinsky's second piece for solo clarinet because it lacks an underlying pulse, therefore preventing performers from syncing up their movements with a consistent beat: this allows for the subtle movements and gestures made by performers in response to structural or emotional aspects of the piece to be more apparent (Wanderley, 2002). Recordings of two professional clarinetists playing the piece for the 2002 Wanderley study were used. As in Davidson's study, participants were shown either video (VO), audio (AO), or an audio-visual recording (AV) and asked to judge tension and phrasing of each performer on an electronic sliding scale that recorded button position every 100 ms.

Each performer had a very different style of expression: Performer R was more calm, controlled, and his movement flowed throughout the piece while Performer W moved much more dynamically, including stepping back and forth. The increased movement of Performer W accounts for the higher level of tension perceived by participants. Combined results of this study reveal that the relationship between auditory and visual stimuli differ somewhat drastically for each of the examined aspects. Tension (emotional content) was conveyed very differently to participants who only viewed a performance than to those who heard it. In contrast, phrasing was conveyed similarly to those with either audio or visual input (Vines & Krumhansl, 2006). Figures 2 and 3 on the next page show functional fitted means of each participant group's results for tension and phrasing, respectively. The vertical lines in the figures mark major phrase boundaries.

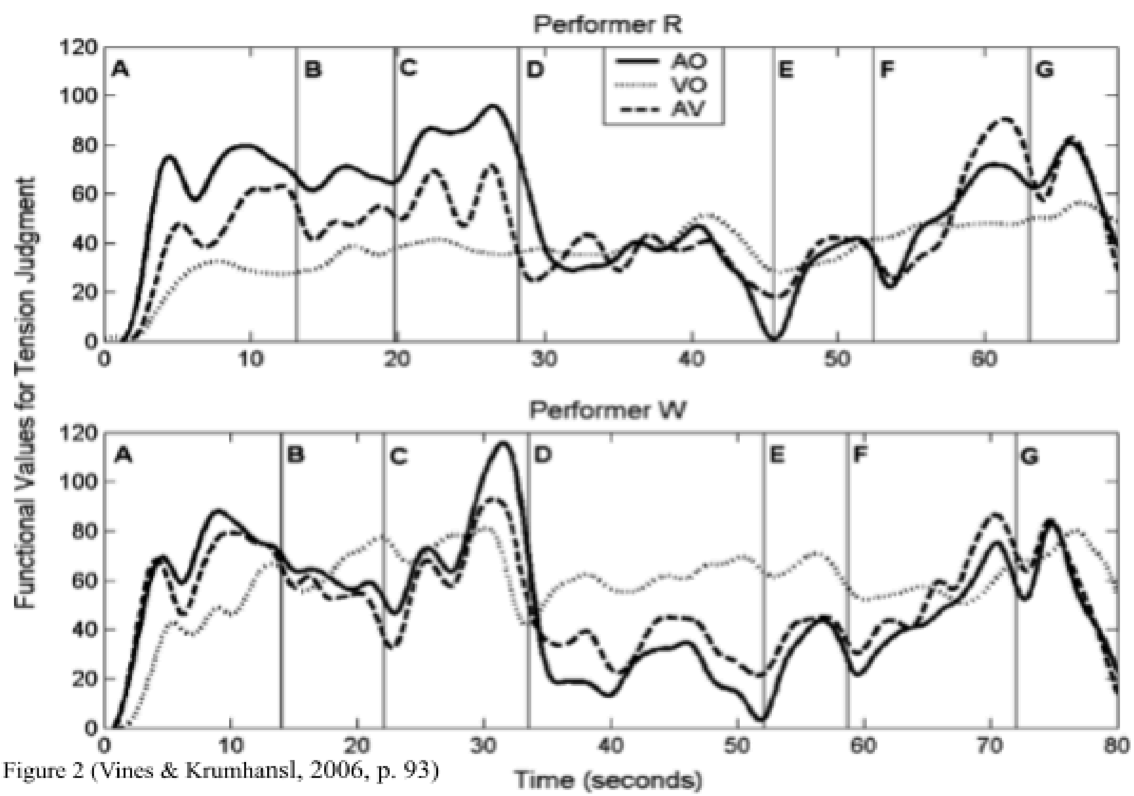

Figure 2 (Vines & Krumhansl, 2006, p. 93)

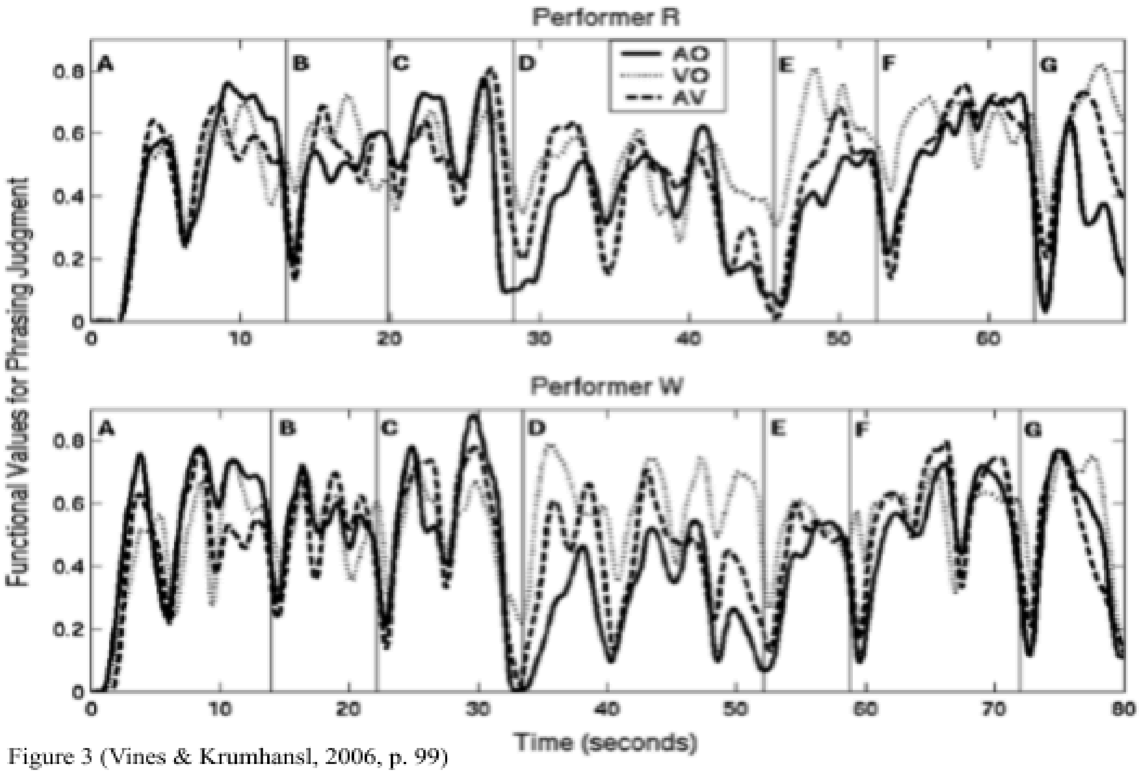

Figure 3 (Vines & Krumhansl, 2006, p. 99)

These results suggest that the level of tension, or kind of emotional content, differs from person to person and is dependent on many more factors. The similarity between groups assessing phrasing could be indicative of a culturally ingrained musical syntax that also engages visual pathways, or go back to Davidson's theory that visual stimuli convey level of expression more accurately, though here it pertains to phrasing (1993). I believe that the audio only group understood phrasing through cognitive ability to process musical syntax, but the visual only group understood phrasing through the performer's movement.

Effects of Melodic Intonation Therapy

Patients undergoing Melodic Intonation Therapy are asked to sing simple phrases while tapping the rhythm of the statement. MIT depends upon the melodic pattern to mimic the rhythm, inflection, and stress of normal speech. In theory, this helps neurogenesis or rerouting of neural pathways because the right hemisphere is engaged through singing. Sparks et. al noted in 1974 that "patients who profit from MIT seem to evolve to good examples[7] of Broca's aphasia -- four to five word sentences which are meaningful and substantive but dysarthric and agrammatical," (p. 5). After working with eight adults suffering from Broca's aphasia Sparks, Helm, and Albert determined a higher success rate with patients who met the following criteria: "good auditory comprehension, facility for self correction, markedly limited verbal output, reasonably good attention span, and good emotional stability," (Marshal & Holtzapple, 1976, p. 115).

It is difficult to dissect which aspect of Melodic Intonation Therapy is most beneficial, or if positive results come from a combination of factors; there has generally been a lack of patients with whom a study could be formed because they lack similar damage and symptoms. Belin's 1996 study using CBF (cerebral blood flow) and PET (positron emission tomography) scans looked at seven right-handed patients who had suffered the identical kind of stroke, experienced persistent non-fluent aphasia even with multiple efforts to restore speech through more common speech therapies, and all previously been through a French equivalent of MIT, TMR (Thérapie Mélodique et Rythmique). Five of the participants experienced global aphasia[8], while only two experienced Broca's aphasia. Participants were first scanned while listening to and being asked to repeat a simple word and again scanned while using TMR to repeat words. The first experiment revealed abnormal activation in areas of the right hemisphere homologous to the language areas but deactivation in both Broca's and Wernicke's areas. Belin and his associates

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[7] These patients had reached a level of communication that was considered exemplary given their diagnoses.

[8] Global aphasia results from damage to every part of the language centers in the left hemisphere or is an immediate consequence of large middle cerebral artery injury, but will often evolve into Broca's aphasia.

observed that the second experiment, where participants employed TMR in their response, showed re-activation in Broca's area and deactivation of the right superior temporal gyrus, which is the right-hemisphere homolog of Wernicke's area related to the cognition of music. The study concluded that MIT most likely had some effect on the re-activation of Broca's area and surrounding tissue, but the abnormal activity in the right hemisphere could be related to the persistence of the participants' aphasia. This second conclusion suggested to the researchers that abnormal activation patterns may not necessarily be indicative of a brain regaining function or recovering (Belin et. al, 1996, p. 1510). The activation of the right hemisphere could also be a result of the non-formulaic speech used in this study (Kotz, 2013).

Most investigate elements of Melodic Intonation Therapy in an attempt to determine the efficacy or therapeutic implication of singing structured phrases versus rhythmically speaking those phrases or tapping. Upon realizing that the role of rhythm and automaticity of formulaic phrases in MIT had not yet been properly studied, a team of researchers at the Max Planck Institute for Human Cognitive and Brain Sciences located in Germany have come out with multiple studies. Geyer's 2011 study was designed around seventeen right-handed participants with non-fluent aphasia to assess relative importance of melody and rhythm. All participants had been diagnosed with Broca's or global aphasia following an ischemic stroke in the left middle cerebral artery or hemorrhage of the basal ganglia, all had undergone speech therapies that did not include singing, and no participant had any musical experience or training. All but three of the participants had lesions in their left basal ganglia, one participant had a lesion only in their

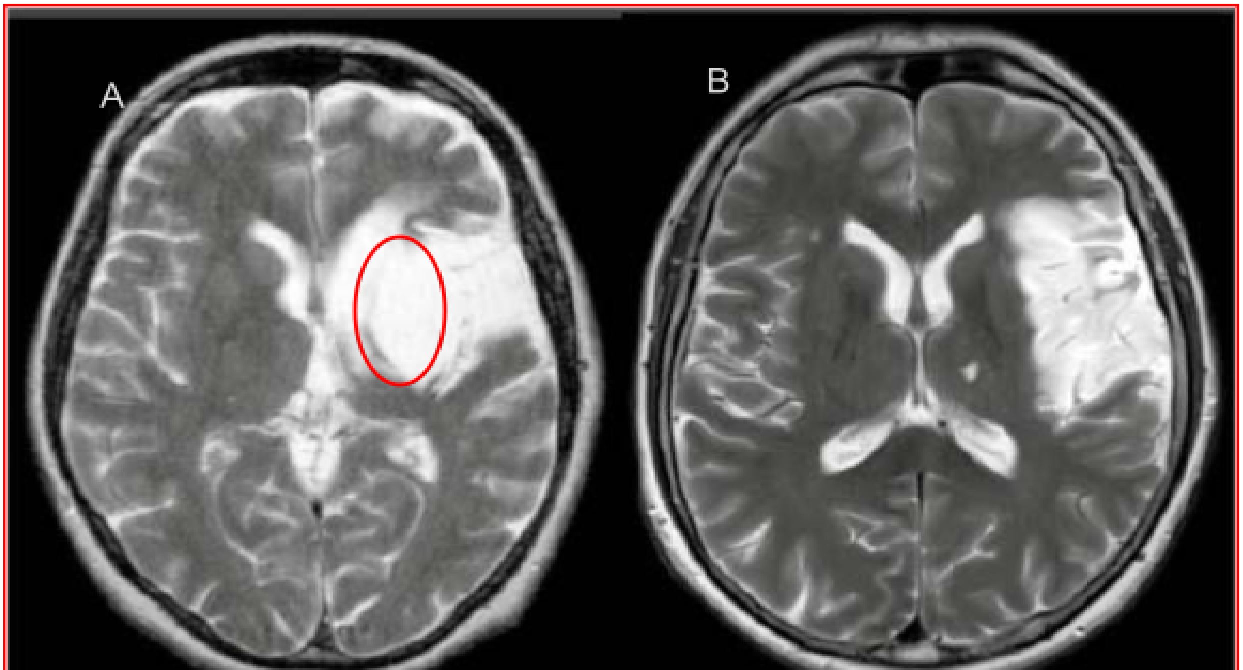

Figure 4 (Geyer, 2011, p. 3087)

right basal ganglia, and two participants displayed lesions in both sides. Figure 4, located above, shows an MRI scan that compares damage sustained following stroke in the middle left cerebral artery (located in the left medial temporal lobe). Patient A shows visible damage to the left basal ganglia (area circled in red). Patient B shows no lesions in their basal ganglia.

Geyer first looked at original, formulaic, and non-formulaic lyrics. To examine original lyrics, participants were played four bars of a simple, common German song[9] and asked to hum the remainder, they were then asked to speak the song lyrics freely without music. The results showed that every participant could produce the notes of the melody correctly and 87% of the lyric syllables were produced when participants were asked to speak freely. Formulaic lyrics were developed from common phrases which followed one another in a logical order, as would occur in an average conversation; non-formulaic lyrics were created by piecing together

[9] The song was chosen based on its familiarity to 35 control participants.

syntactically correct phrases, but ones that were not predictable, much like poetry. In both cases the lyrics were synced up with the original melody.

The research team hypothesized that the formulaic lyrics would have a higher word transition frequency than the non-formulaic lyrics due to the semi-automatic nature with which most can conduct a brief and simple conversation, but were surprised to find that there was no statistically significant difference in the word transition frequency between the two categories. Word transition frequency serves as a marker for automaticity within a spoken language: the likelihood of a word appearing depends on the preceding word, so common formulaic phrases were expected to have high word transition frequency. All patients had lesions in the basal ganglia, which are involved with voluntary and involuntary movement, and the similarity in word transition frequency points to the possibility that these lesions blocked signals for automatic phrases and replies, while non-formulaic speech was simply more difficult to produce voluntarily.

Further analysis in this portion of the study required calculations of articulation quality. This was calculated as the percentage of correct syllables produced with each lyric type, where a fully correct syllables were worth one point, syllables with either incorrect vowel or consonant were worth half a point, and syllables with errors in both vowel and consonant received no points. No significant correlation appeared between pitch accuracy and quality of articulation, even when participants with right hemisphere lesions, which could affect their musical cognition, were included. This suggests that intact cognitive music function does not have an effect on pitch or correct syllabic placement. These participants were provided with sheets of music for each lyric type, but were not allowed to tap to the rhythm, as that would engage their sensorimotor systems; this was a study solely to isolate the value of singing without the involvement of rhythmic influences in non-fluent aphasics (Geyer, 2011).

Next, three experiments were performed for each lyric type: the first where the participant speaks along with a pre-recorded voice accompanied by percussion beats in stressed common time, the second where they sing[10] along with the pre-recorded voice in the key that best suits their vocal range, and the third experiment to act as a control. The control experiment created an arrhythmic recording where the the 4/4 time signature was changed to 3/4 and the speech sample moved up by one eighth note. Results showed that across original, formulaic, and non-formulaic lyrics, rhythmically spoken lyrics consistently showed a higher percentage of correctly produced syllables than singing. Geyer's team found the nine participants with the larger lesions (LL) in their basal ganglia produced the correct syllables about 43% of the time with the arrhythmic speech, compared to the 68% of correctly produced syllables from the eight other participants with much smaller lesions (SL). Similarly, the nine LL participants produced correct syllables 47% of the time with rhythmic speech, while the eight SL participants produced correct syllables 67% of the time. With only melodic intonation, the participants with larger lesions correctly produced syllables 42% of the time, which is one percentage point lower than with arrhythmic speech. The eight participants with SL produced the correct syllable 67% of the time using melodic intonation - consistent with their rhythmic speech.

These results show that the more damage to the basal ganglia, the greater the benefit of rhythmic speech over melodic intonation, though all results show rhythmic speech to be more helpful than melodic intonation for the participant. Additionally, insignificant difference in

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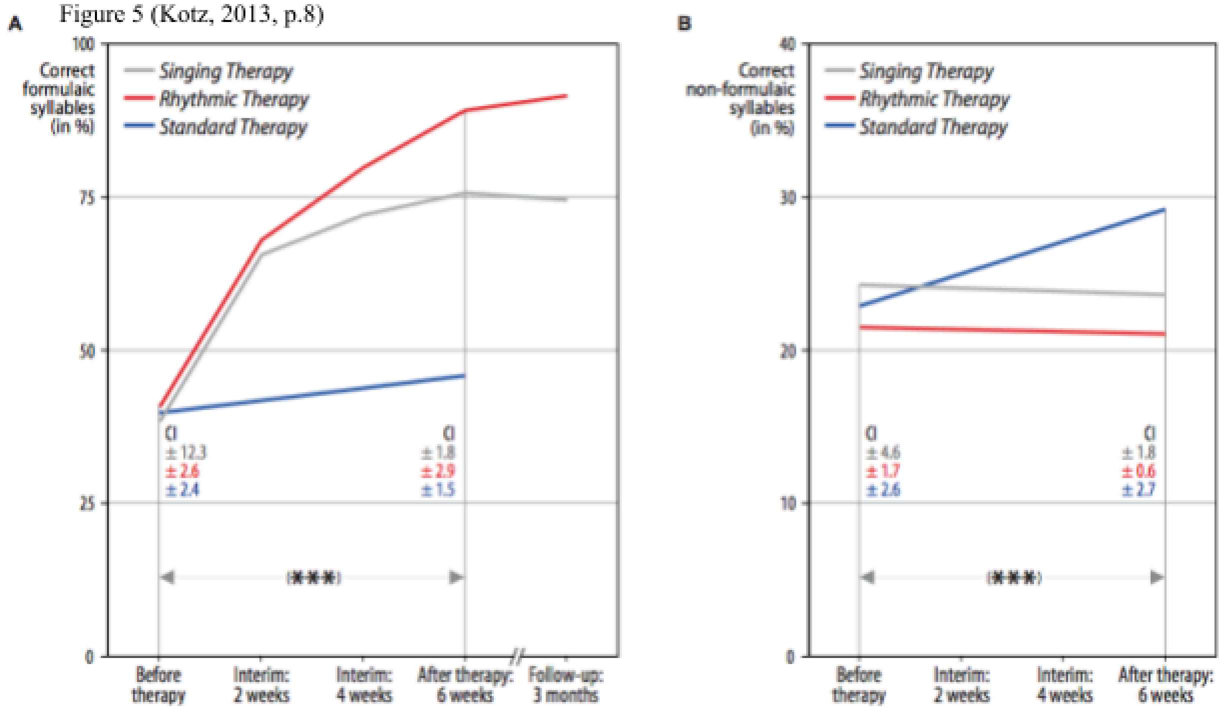
[10] The melody was that of the common German song used earlier in the study.

correct syllable production in formulaic and non-formulaic song and speech suggest that the autonomic nervous system is depressed by lesions in the left basal ganglia, which affects speech that would be automatic and that which would be more consciously verbalized. This result clashes with past studies that have suggested formulaic speech may be processed in the right cortex and basal ganglia (Speedie et. al, 1993). Geyer's findings coupled with the less helpful melodic intonation aspect reveal that activation and involvement of the sensorimotor system stimulates the basal ganglia, producing therapeutic results. He sums up his results using an earlier study done by the same team - conducted research suggests that the "basal ganglia mediates rhythmic segmentation in speech perception and production," (2011, p. 3083).

Alternate Approaches to Patient Rehabilitation

The Max Planck Institute published a study in 2013 that provided the first evidence that singing and rhythmic speech could be similarly effective in the treatment of non-fluent aphasias (Kotz). Working from Geyer's 2011 study, Kotz created a study that isolated each individual factor associated with Melodic Intonation Theory where type of speech was also taken into account (formulaic vs. non-formulaic). Fifteen right-handed participants who suffered from ischemic stroke to the middle cerebral artery were split into 3 groups according to treatment type. Those in singing therapy sung formulaic lyrics to familiar melodies; those in rhythmic therapy spoke the same formulaic lyrics as the singing group set to rhythms mimicking the natural prosody of speech; and those in standard speech therapy did not work with singing, rhythm, or formulaic phrases. Participants were evaluated regularly using methods similar to Geyer in 2011, where they were provided sheets with formulaic and non-formulaic lyrics to be sung and spoken along with recordings. Each evaluation began with the speaking portion so no association between lyrics and melody influenced the spoken samples. The participants had to repeat each section of the evaluation four times. Additionally, they were not permitted to tap in order to prevent engagement of the sensorimotor system. Quality of articulation was calculated and logged following each session. The results of each group were averaged to create the two charts that comprise Figure 5, located below. Chart A shows articulation quality of formulaic speech while Chart B shows articulation quality of non-formulaic speech.

Figure 5 (Kotz, 2013, p.8)



Rhythmic therapy is the most effective for regaining and retaining formulaic speech capabilities, but the least effective with regard to non-formulaic speech. Only participants in the standard therapy group improved their non-formulaic speech. These results validate the hypothesis that non-formulaic and formulaic speech rely on different neural pathways, though the extent to which the mechanisms differ remains unclear. Kotz also notes that further testing is needed to act as a control for the rhythmic aspect of formulaic speech.

The results of Kotz' study challenge the fundamental principle behind Melodic Intonation Therapy - patients do not regain language abilities through codominance between the undamaged hemisphere and the damaged language controlling hemisphere (2013). The efficacy of Melodic Intonation Therapy could be improved by adjusting methods for the particular kind of brain injury a patient has suffered. It seems like Sparks, Helm, and Albert were thinking small when they stated that the best possible likely outcome of Melodic Intonation Therapy was independent production of short, simple, but agrammatical sentences characterized by difficulty in articulation (1974).

Conclusion

The combination of multiple studies discussed here brings me to the conclusion that brain lesions that affect the autonomic nervous system, whether through damage to the left hemisphere or the basal ganglia should be treated with rhythmic speech therapy to stimulate their sensorimotor system in an attempt to facilitate cross-modularity and increased functionality of formulaic neural pathways. Patients would also participate in standard speech therapy to increase their quality of articulation for non-formulaic statements. These dual therapies would occur separately from pure music therapy where patients would participate in group singing activities or merely be encouraged to sing along to their favorite songs at home. Music can be classified as a form of palliative care, in and of itself, because it relieves pain and stress through dopaminergic reward pathways discussed throughout the paper. The physiological effects of music would increase dopamine production that could assist in neurogenesis and mood elevation.

Additionally, group singing could help improve mental state of the patients who elected to participate, as oxytocin would make them feel more focused and connected with one another. Imagine being able to connect with others who shared and understood your struggle to communicate or connect verbally; music as we conceive of it communicates emotion, but there are so many uses and positive physiological effects. All of these musical aspects can help improve mental stability and attention span, which directly resonates with two criteria of what makes an ideal Melodic Intonation Therapy candidate. Though Sparks, Helm, and Albert's theory that the melodic aspect of speech in MIT would increase the inter-hemispheric control of language may not be correct, that does not mean their therapy is not a good starting point for further improving the rehabilitation options for those with non-fluent aphasias. Much in the same way that Darwin and Spencer had differing views on the same facts, because they approached music and language from opposing angles, the pioneers of Melodic Intonation Theory had the right idea. Sparks, Helm, and Albert were so focused on the areas of the brain associated with language and music, they neglected to approach their theory from other angles, explore neural pathways, and distinguish between the cognitive creation of music with the other structures that allow for its production.

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