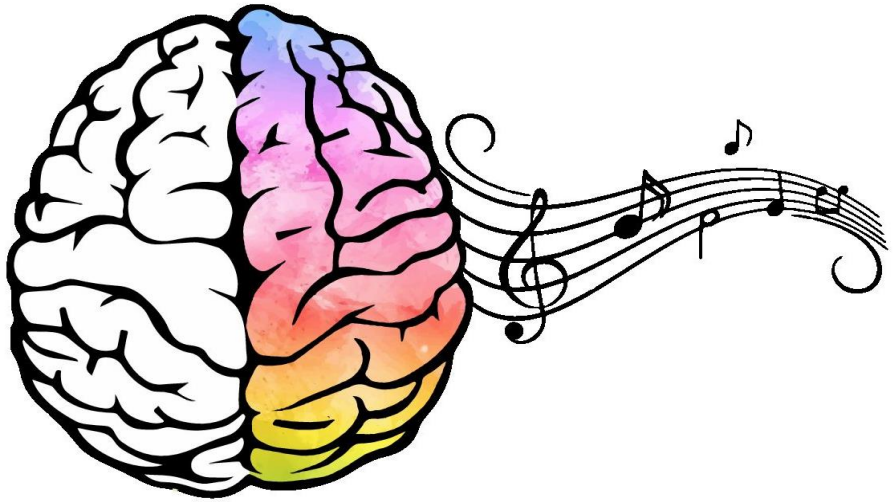
The Effects of Music On Language Disorders



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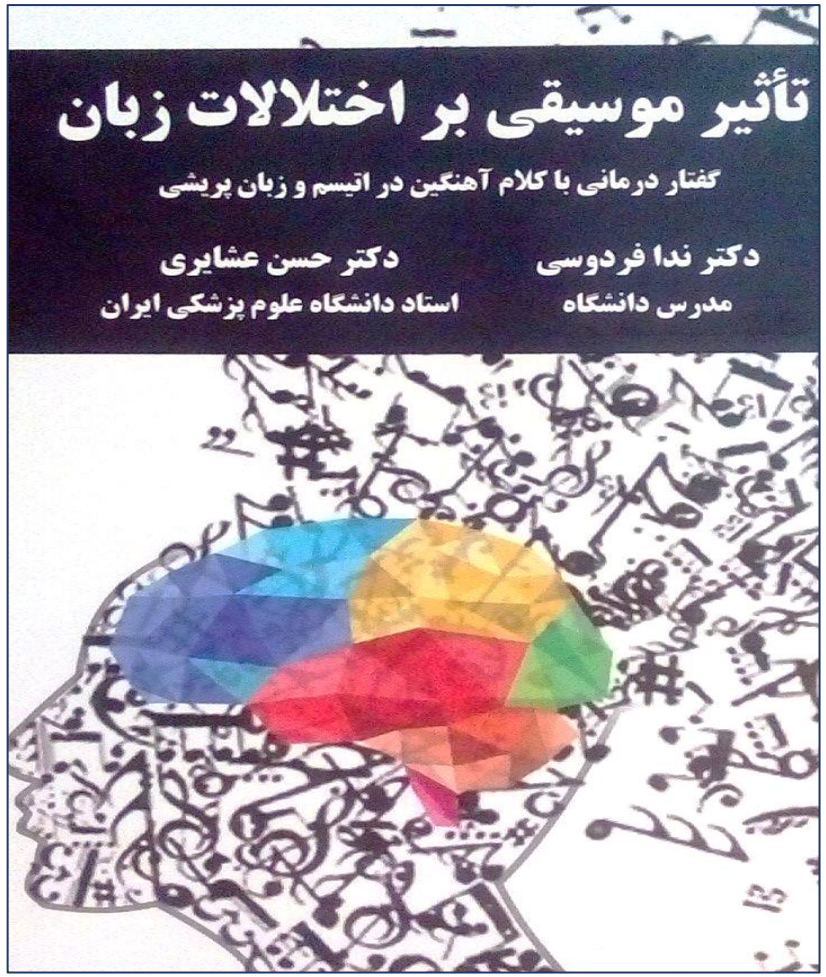
Melodic Intonation Therapy (MIT)

(Sparks, Helm-Estabrooks, Albert; 1973)



A structured aphasia therapy program using the melodic aspects of language (prosody);
Intonation
rhythm
stress
to improve language production.

The Effects of Music on Brain

- Music listening ➡ Enhanced emotional and cognitive functioning

(Chan et al.,2009).

- Active music ➡ Strong coupling of perception and action

(Playing or singing)

Fronto-temporoparietal network (FPN);

Sensory, Motor, Mirror Neuron System

Plastic changes in the brain.

(Gaser & Schlaug, 2003)

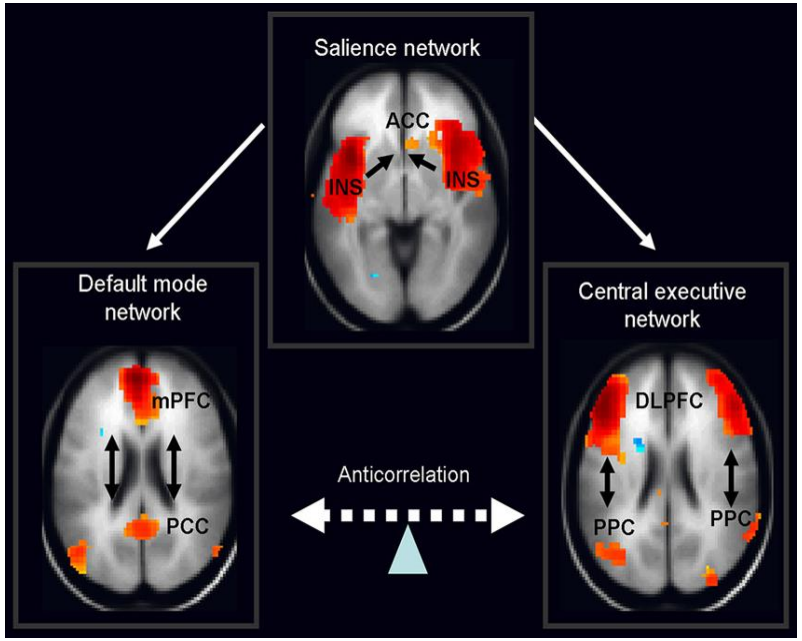
Frontoparietal network (FPN)
Central Executive Network

- **Dorsolateral prefrontal cortex (DLPFC)**
- **posterior parietal cortex (PCC)**

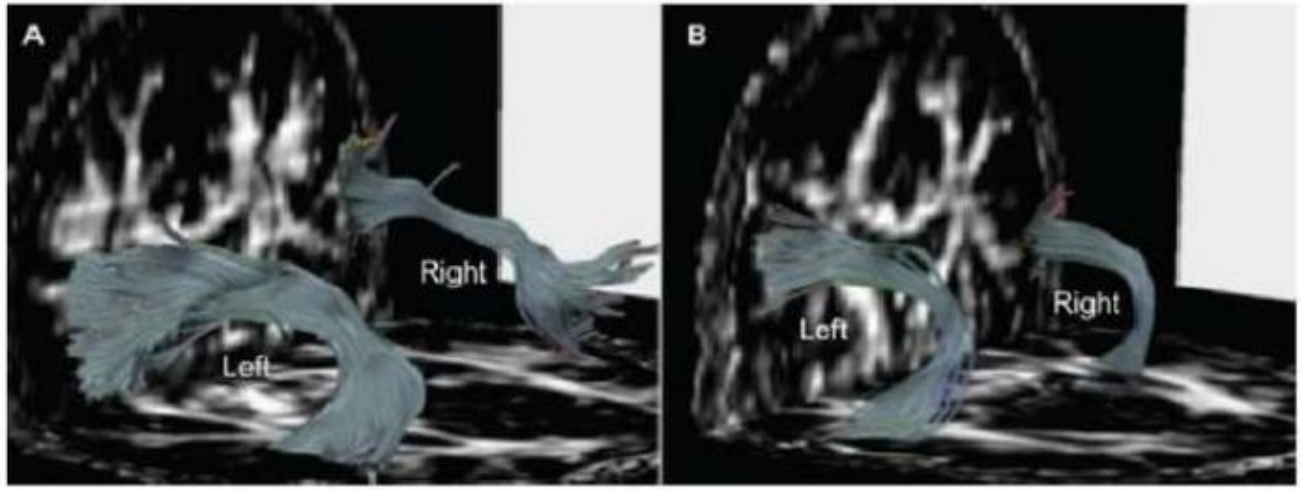
- It is involved in Executive Function;
- Sustained attention
- Problem-solving
- Working Memory

- **Triple Network**:
- The FPN
- Salience network
- default mode network (DMN).

➢ The salience network facilitates switching between the FPN and DMN

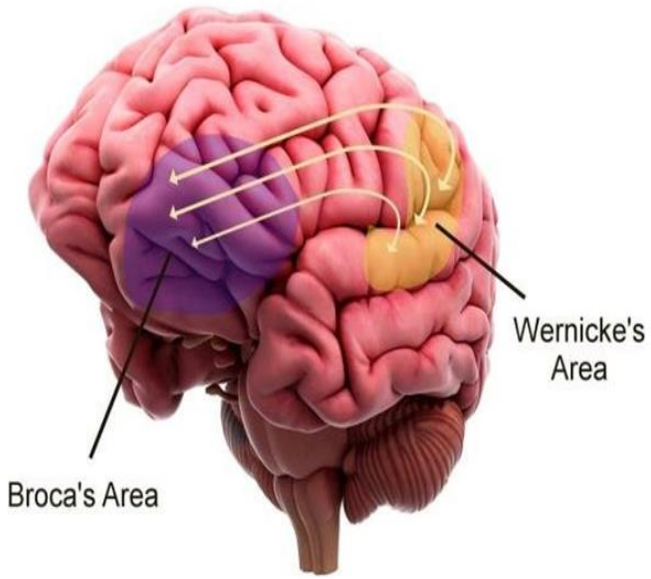


The Effects of Music on Brain



A) Musician
Arcuate Fasciculs (AF)

B) Non-musician
Arcuate Fasciculs (AF)



Researchgate.net

Music & Singing

- Music making (playing an instrument or singing) is a multimodal activity that involves the integration of **auditory** and **sensorimotor processes.**

- Singing: the act of producing musical sounds with the voice.

- Singing engages an auditory-motor feedback loop in the brain **more intensely** than other music making activities such as instrumental playing (Kleber et al., 2009).

Singing and Brain

- Singing is a universal form of musical expression that is as natural as speaking.
- The ability to sing in humans is evident from infancy, and does not depend on formal vocal training but can be enhanced by training.

The Origin of Language & Music

- In Charles Darwin's vision of the origins of language, early humans had already developed musical ability prior to language and were using it "to charm each other."

Evolutionary Neurobiology of Vocalizing

- Vocalizing in vertebrates; fish, birds and mammals, and even primates, originate from the same compartment in the developing hindbrain.

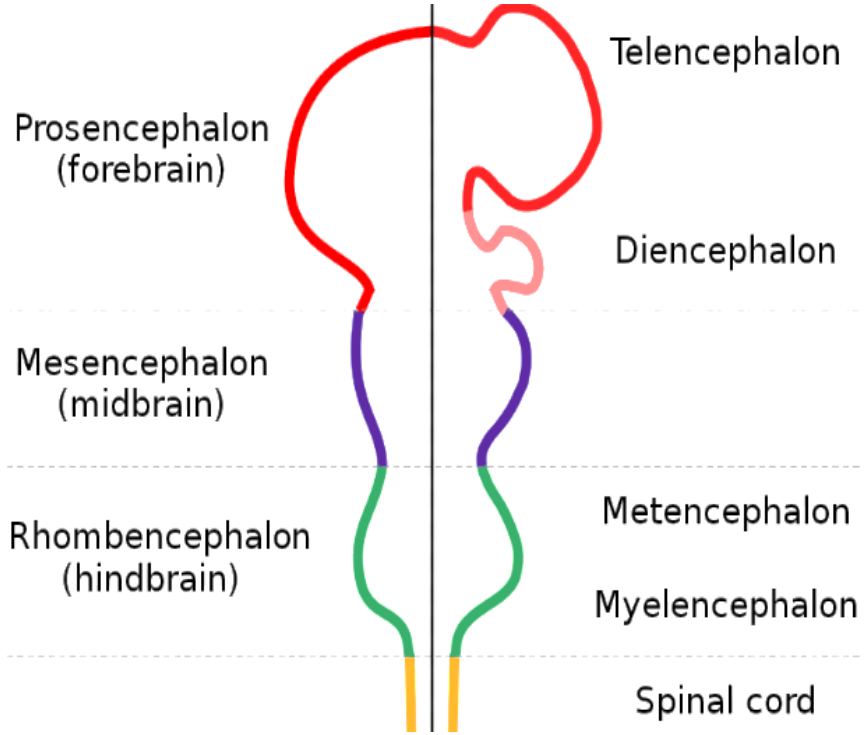
- The ability to produce sound and simple vocal patterning (a hum versus a grunt, for example) appears to be in an ancient part of the brain that we share with all vertebrates, including fish, frogs, birds and other mammals. But that isn’t human language (Reptilian brain).

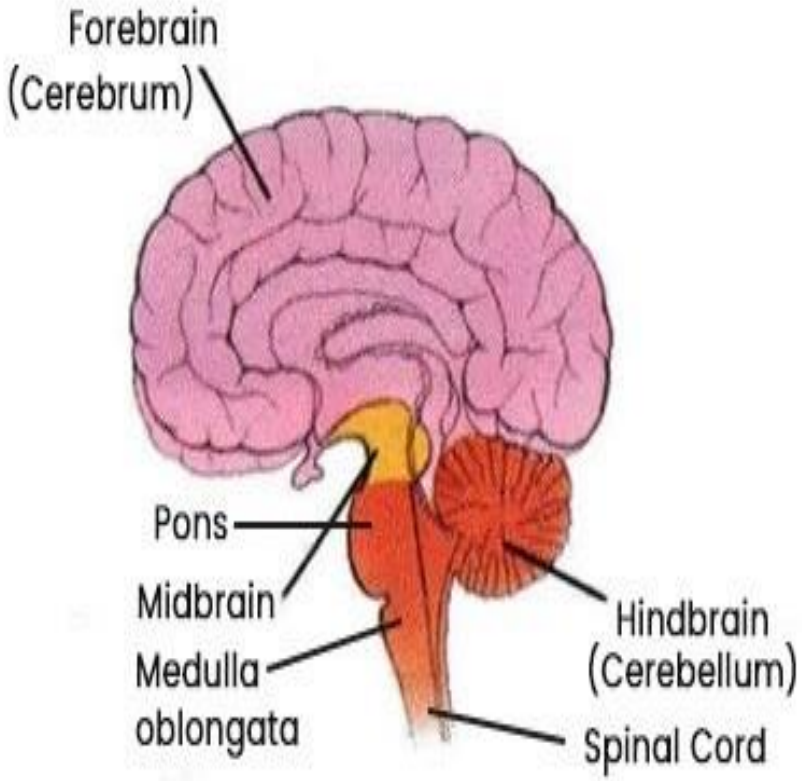
- Midshipman fish

(Bass et al.,2008)

Hindbrain

It includes the medulla, pons, and cerebellum.

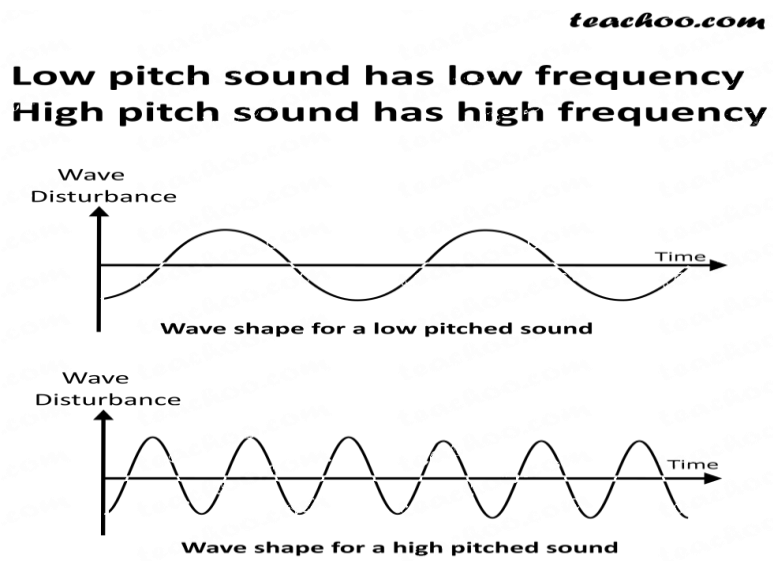


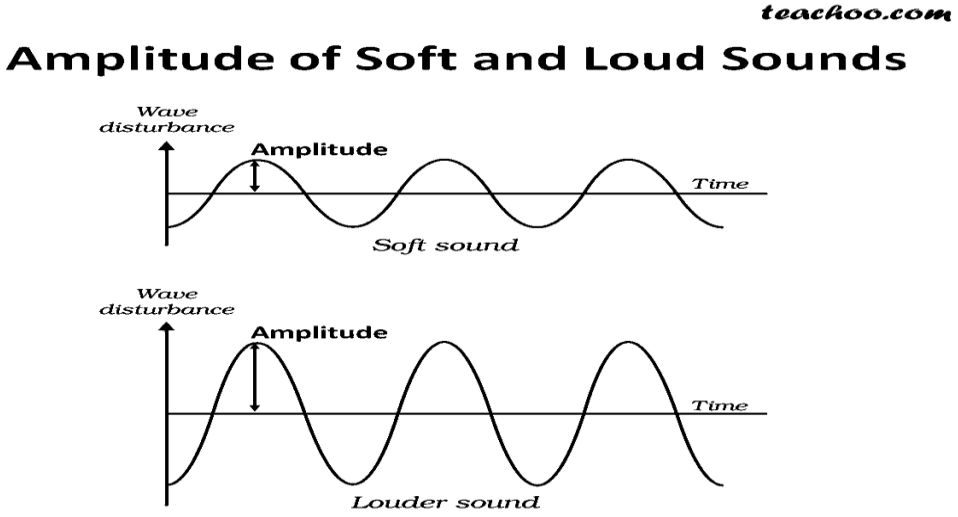


Prosody (Supra-segmental Features)

Prosody; Melodic aspect of language

Pitch (Frequency)
Loudness (Intensity)
Length (Duration)
Rhythm





Pitch changes in sentence	Intonation
Pitch changes in word	Tone
Pitch changes in syllable	Stress

Development of Prosody

- As early as 4 days after birth infants ➡ distinguish the prosody of their native language from other languages.

- **The prosodic characteristics of a language**

➢ the first phonetic features acquired by a child.

➢ the last to be lost either through **aphasia** or during the acquisition of another language or dialect.

(Hirst & Cristo,1988)

Therapeutic effects of singing.

Behavioral similarities between singing and speaking.

Respiration, phonation, articulation, and resonance.

Singing Treatment in:

- **Stuttering**
- **Parkinson's disease**
- **Acquired brain lesions (aphasia)**
- **Autism**

Singing & Speech in aphasia

Stroke or other brain injuries (trauma) ➡ Aphasia

Loss of ability to produce and/or comprehend language.

24-52% of acute stroke patients have some form of aphasia within 7 days of their stroke;

12% have significant aphasia at 6 months after stroke.

(Wade, Hewer, David, & Enderby, 1986).

Types of Aphasia

Nonfluent Aphasias

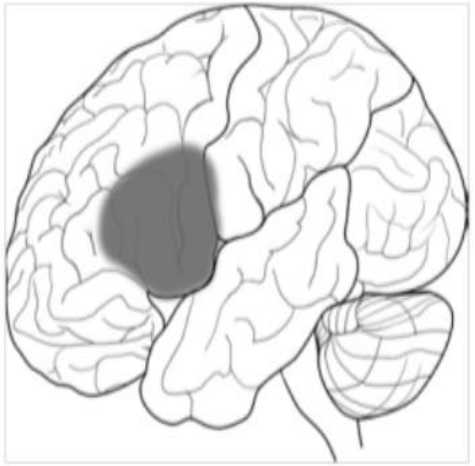
1. Global Aphasia
2. Mixed Transcortical Aphasia
3. Broca's Aphasia
4. Transcortical Motor Aphasia

Fluent Aphasias

1. Wernicke's Aphasia
2. Transcortical Sensory Aphasia
3. Conduction Aphasia
4. Anomic Aphasia

Broca's Aphasia

- **Fluency**: almost a complete lack of coherent speech to slow halting speech with few content words and few verbs or adjectives.
- **Comprehension**: Comprehension of single words, short phrases, and reading intact. The more grammatically complex, the more impairments
- **Repetition, Naming, Writing**: Impaired



Wernicke's Aphasia

- **Fluency**: Speech is fluent, but unintelligible. Speech output is effortless, rapid, and sentence length is normal, but content is unintelligible
- **Comprehension**: Impaired - typically have trouble answering yes/no questions and following one-step commands
- **Repetition and Naming**: Impaired
- **Writing**: Letters are being written, but content is unintelligible

Treatment

- Depends on a variety of factors:
  - Age
  - Type of aphasia
  - Cause of aphasia
  - Position and size of brain lesion

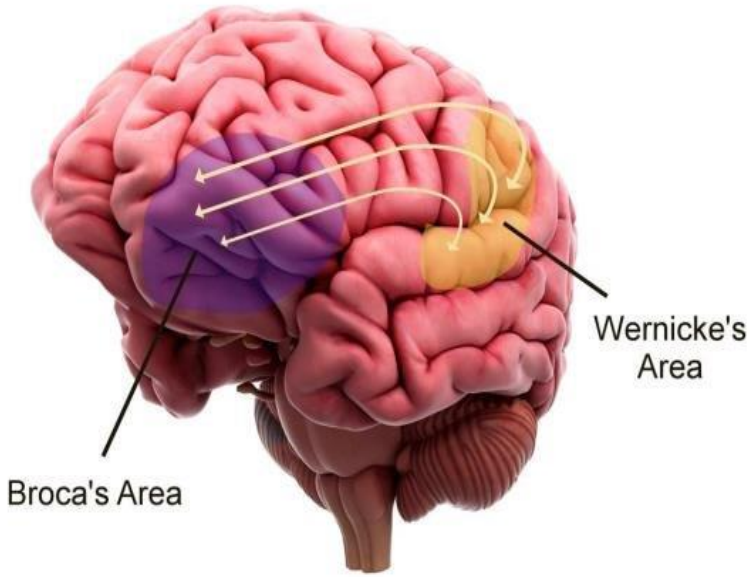
Treatment

- Speech and language Therapy (most common)
- **Melodic Intonation Therapy (MIT)**
  - Melodic intonation of words
  - Rhythmic tapping of each syllable using the left hand while phrases are repeated
- Art Therapy
- Visual Speech Perception Therapy – associating pictures with words
- Family Counseling
- Medications to improve blood flow in the brain

The linguistic profile of the patient

- The level of impairment in auditory language comprehension;
  - Broca's aphasia Vs. Wernicke's

- The neuroanatomical correlates of lesion;
  - Size
  - Location



Melodic Intonation Therapy (MIT)

- Patients with severe Broca's aphasia can produce well-articulated words while singing, but not during speech.

- **Melodic Intonation Therapy:**

➢ Exaggerated prosody of the phrase,

➢ Stress, rhythm, intonation pattern,

➢ A melodic pattern of 3 or 4 notes.

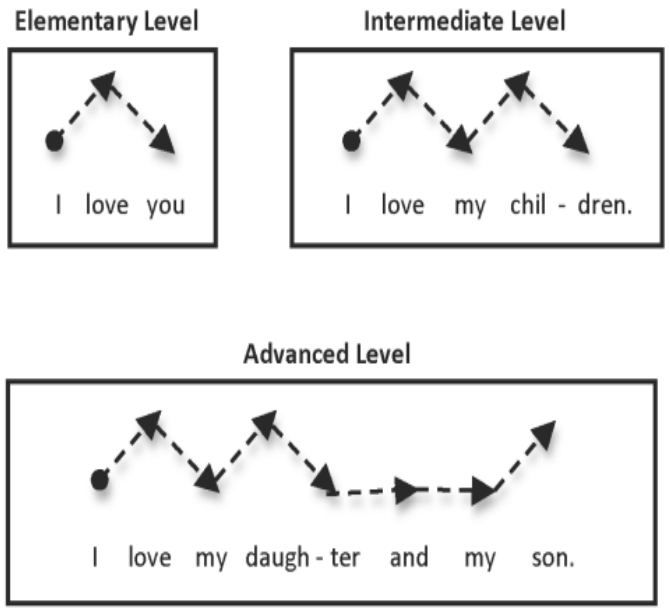
➢ While rhythmically tapping the patient's hand

- From intoning (singing) simple, 2–3 syllable phrases,
- to speaking 5+ syll. phrases
- across 3 levels of treatment.
- Each level consists of 20 high-probability words (e.g., "Water")
- or social phrases (e.g., "I love you.") presented with visual cues.

(Norton et al,. 2009)

Rhythmic-Melodic Pattern in MIT

- Phrases are intoned on just 2 pitches, “melodies” are determined by the phrases’ natural prosody.
- Stressed syllables are sung on the higher of the 2 pitches.
- Unaccented syllables on the lower pitch.
- The patient’s left hand is tapped 1x/syllable



Adapted from: Helm-Estabrooks, N., Nicholas, M., & Morgan, A. (1989). *Melodic Intonation Therapy program.* Austin, TX: PRO-ED.

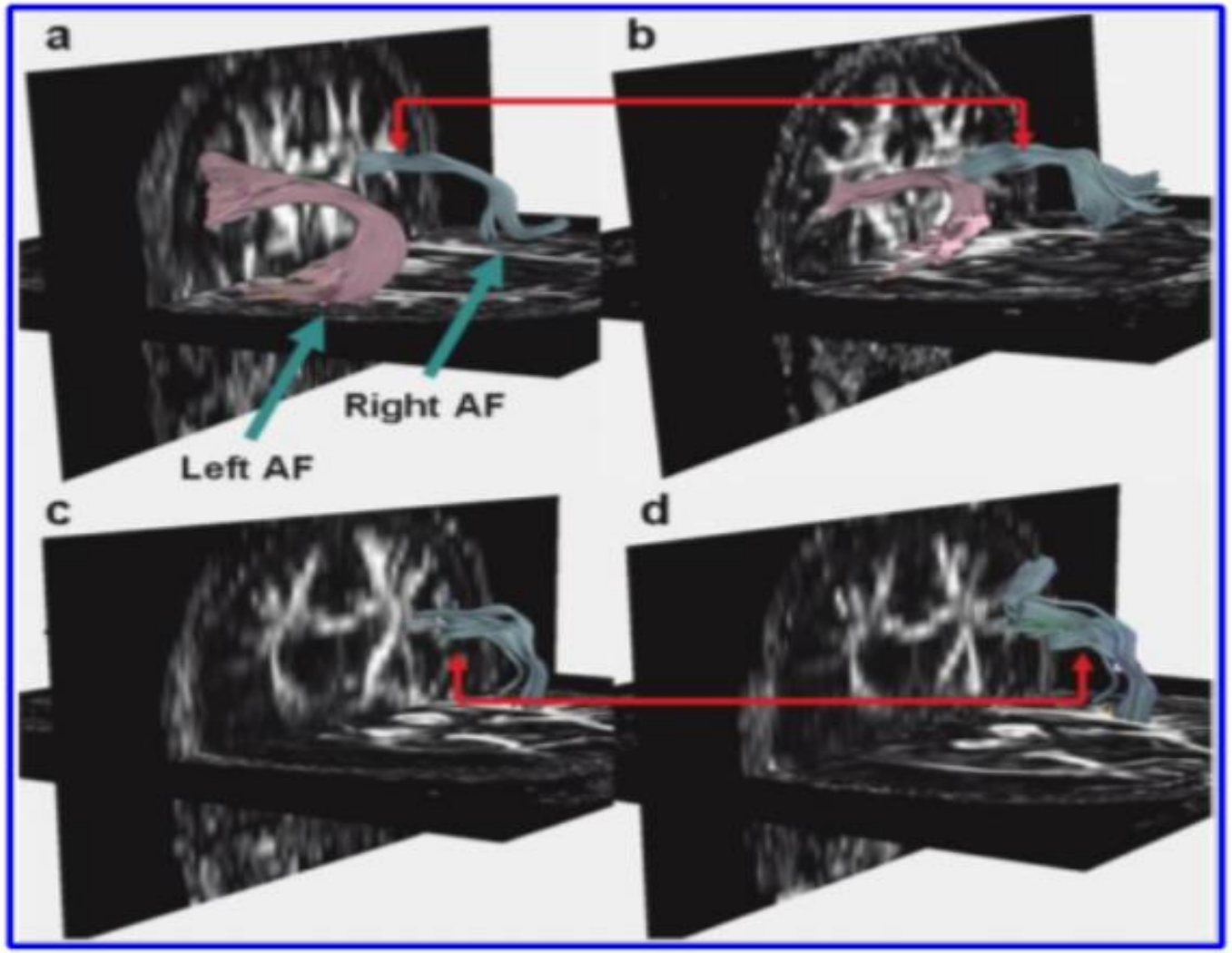
Figure 2. MIT: Melodic Phrase Construction

MIT & Brain

- Left hand tapping and intoning engage homologous language regions in the right hemisphere.
- Melody (Pitch) processing in right hemisphere
- Rhythm processing in left hemisphere
- Top-down Processing
- Neuroplasticity in right & left hemisphere

Healthy non-musician

Healthy professional singer



Patient with chronic non-fluent aphasia before MIT

Patient with chronic non-fluent aphasia after MIT

FIGURE 1. The arcuate fasciculus (AF) fiber bundles of: a healthy nonmusician (a); a healthy professional singer (b); a patient with Broca's aphasia before (c) and after (d) intensive melodic intonation therapy. This patient has no left AF due to his left hemispheric stroke.

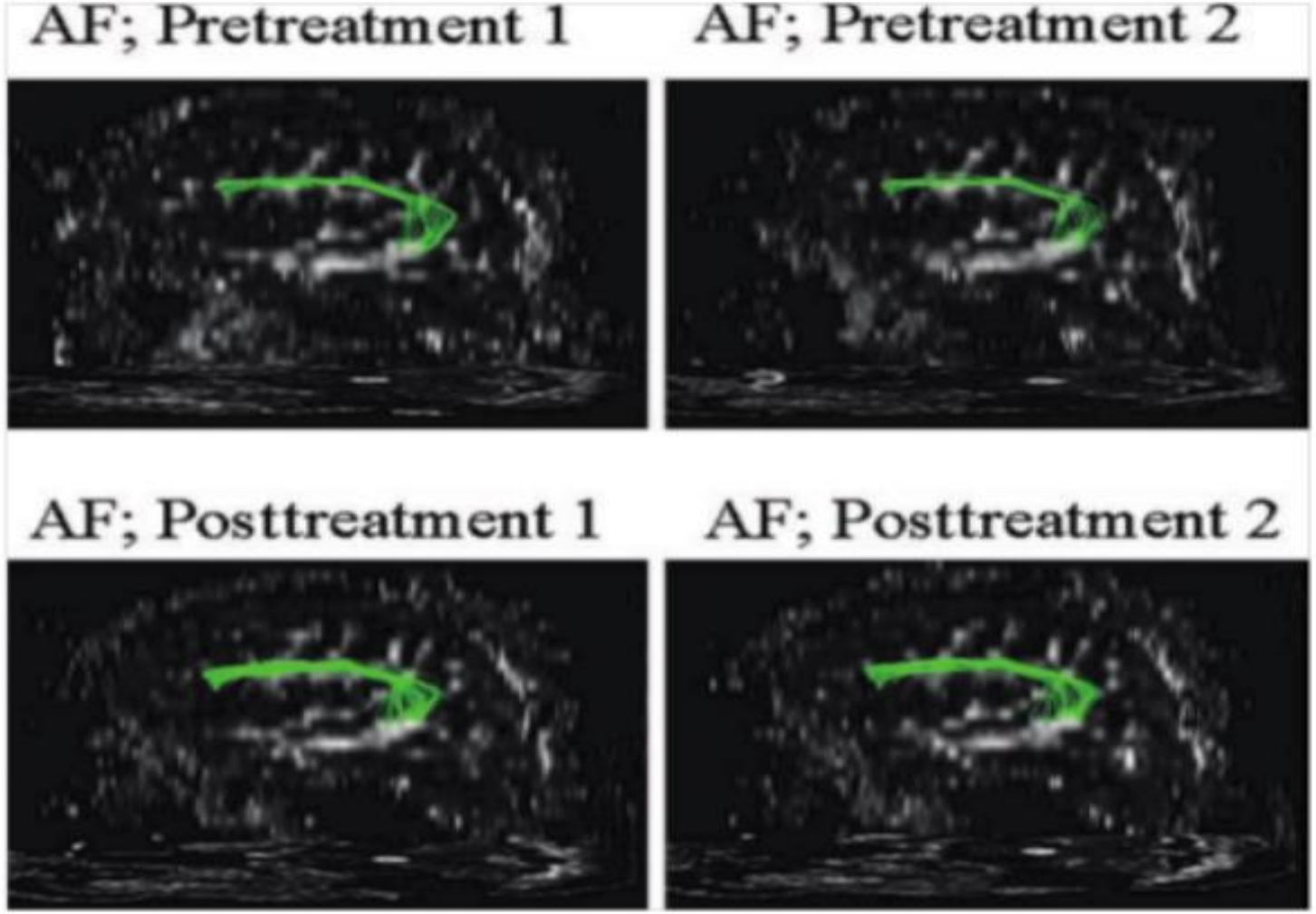
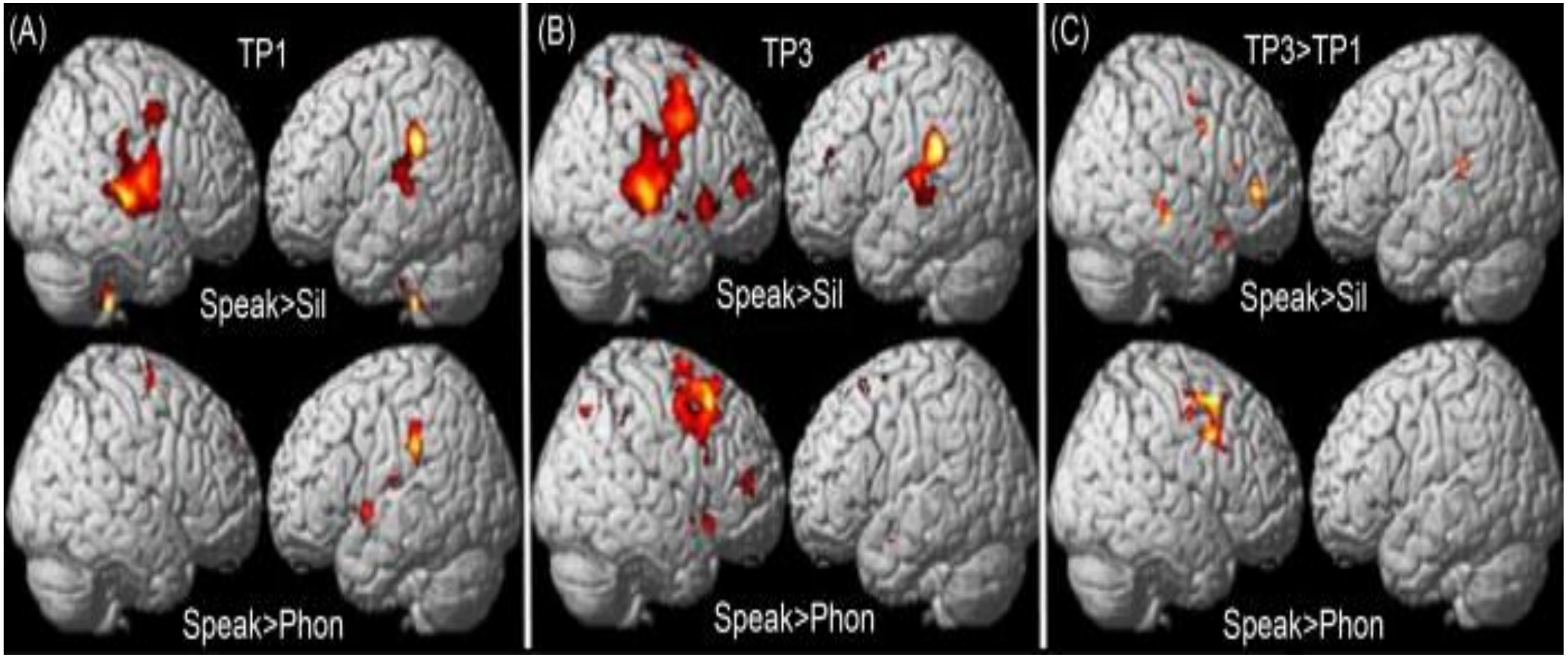


Figure 2. Right AF in one patient with two scans before therapy and two scans after 75 sessions of melodic intonation therapy. The scan-to-scan variability is minimal before therapy and a clear difference in the number of fibers and fiber volume can be seen in comparing the AF before and after therapy. (In color in *Annals* online.)



A) Before MIT

B) after MIT

C) Before & After MIT

Speaking- Silence / Speaking-phonation

Table 1: MIT Effectiveness

Study	Year of Publication	n	MPO* Mean (range)	Design	Outcome Measures	Main Findings
Sparks et al[10]	1974	8	>6	Case series	Subtests verbal expression standard aphasia test	Characteristics of good and poor responders: implications for MIT candidacy
Marshall and Holtzapple[18]	1976	4	9.0 (4–27)	Case series*	Standard aphasia test	3 patients improvement directly after MIT. 1 patient no improvement after MIT, but improvement on follow-up
Goldfarb and Bader[19]	1979	1	60	Case	Production of trained phrases	Improvement in trained phrases
Naeser and Helm-Estabrooks[20]	1985	8	12.6 (1–51)	Retrospective	Standard aphasia test	Characteristics of good and poor responders: implications for MIT candidacy
Popovici and Mihăilescu[21]	1992	80	<6	Group with control group	Repetition, naming, and comprehension	MIT patients: significantly higher improvement on all verbal output tasks. On the comprehension tasks, more patients in the MIT group improved, but this did not reach statistical significance
Springer et al[22]	1993	12	20.3 (3–69)	Cross-over	Production of trained and untrained items	Greater immediate improvement after linguistic treatment than after MIT. Best performance obtained when MIT precedes linguistic therapy
Belin et al[23]	1996	7	18.9 (4–35)	Case series and neuroimaging	Standard aphasia test	Improvement on language outcome measures. During MIT: decreased RH activation
Carlomagno et al[24]	1997	2	7.5 (7–8)	Case series	Repetition and naming tests	Improvement
Baker[25]	2000	2	5.5 (3–8)	Case series*	Production of trained words and phrases	Improvement in trained items
Bonakdapour et al[26]	2003	7	35.4 (14–57)	Single group	Subtests standard aphasia test; CIUs in connected speech	Significant improvement on all outcome measures. Generalization to spontaneous speech
Wilson et al[27]	2006	1	46	Case	Production of trained and untrained items in MIT repetition versus normative repetition	No difference between MIT repetition and normative repetition directly after therapy. Long-term effect: MIT significantly better than normative repetition
Schlaug et al[28]	2008	2	12.5 (12–13)	Case-control and neuroimaging	Picture naming; CIUs in connected speech	MIT patient greater improvement than the control patient. Generalization to spontaneous speech; RH activation associated with MIT success
Schlaug et al[29]	2009	6	>12	Case series and neuroimaging	Picture naming; CIUs in connected speech	Significant improvement in speech outcome measures. Generalization to spontaneous speech; RH activation associated with MIT success
Hough[30]	2010	1	48	Case*	Production of trained and untrained phrases; standard aphasia test; quality of life questionnaire; proxy questionnaire on communication	Improvement in trained and untrained phrases, also on follow-up; increased communicative effectiveness and communicative independence

Persian MIT & Aphasia

7 patients with Broca's aphasia (3 control- 4 MIT)
Right-handed
Persian speaking
36 sessions (12 weeks)
T1- T2
Farsi Aphasia Test (Nilipour, 1993)
Free conversations
Verbal language
Mean Length of Utterance (MLU)
Speech rate
Listening Comprehension
Reading Comprehension
Writing

(Ferdosi, Ashayeri, Nilipour, 2006)

Autism & Singing

- Autism is characterized by impairments in expressive language and communication, with some affected individuals completely lacking functional speech (Tager-Flusberg, 1997).

- Individuals with autism have superior auditory processing abilities and often exhibit strong interests in learning and making music (Trevarthen et al., 1996).

Melodic Intonation Therapy in Autism

- MIT involving intoned questions and statements (Miller & Toca, 1979).
- Using pitch matching and singing to encourage vocalizations, which eventually led to the articulation of words (Hoelzley, 1993).
- Auditory-motor mapping training (AMMT), this intervention involves three main components—singing, motor activity, and imitation—that engage a presumed dysfunctional human mirror neuron system that is believed to underlie some of the communication deficits in autism (Wan et al., 2010).
- **The Effects of MIT in Persian autistic male children (Ferdosi, Ashayeri, Rovshan, Modarresi, 2012,2013).**
- **The Effects of MIT in Persian autistic female children (Iravani, Ferdosi, Ghorbani,2017).**
- **The Effects of MIT on executive function in Persian autistic children (Rajabi, Ferdosi, Ghorbani,2018).**

Persian MIT & Autism

- 13 autistic male children
- 7-10-year
- MLU
- Echolalia
- Speech rate
- Verb count
- Acoustic Features (Praat software): Frequency
  Intensity

Stuttering & Singing

- Stuttering is a largely developmental condition that affects the fluency of speech.
- Repetition of words or parts of words,
- prolongations of speech sounds,

➡ Disruptions in the normal flow of speech.

Singing (90%) ➡ Duration of phonation ↑ ➡ Frequency of stuttering ↓

(Davidow et al., 2009)

Parkinson's Disease

- 80% of patients with Parkinson's disease have voice and speech problems (Ramig, Fox, & Sapir, 2008).
- Loudness & Pitch ➡ Emotions of speech ⬇
- Phonation time ⬇
- glottal closure ⬇
- respiratory function
- Breathy voice
- Vocal resonance ⬇
- Difficulty initiating speech
- Abnormal speech rate and rhythm
- Short rushes of speech: Inappropriate pauses and hesitations.

Parkinson's Disease & Singing

- A) Vocal warm-ups
- Singing
- with an emphasis on phonation and breathing.
- After 12-14 sessions, patients with Parkinson's disease showed significant increases in speech intelligibility and vocal intensity.
- B) Group choral singing
- Singing chants with a piano accompaniment, to enhance auditory rhythmic stimulation. The protocol also involved a series of prosodic, respiratory, and laryngeal exercises.
- After 13 sessions of singing, patients with Parkinson's disease showed improvements in vowel phonation and reading (Benedetto et al. (2008).


Thank You!