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Research Article

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Exploring Speech Disorders: Cultural Contexts, Therapeutic Practices, and Holistic Approaches

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ABSTRACT

Purpose: Therapeutic interventions for speech pathologies have evolved with underlying neuroanatomical basis and types of interventions.

Methods: Our research involved interviews of experts and therapists in examining influences on speech pathologies and therapeutic potential of music-based interventions.

Results: Our findings highlight the role of linguistic, neuroanatomical, and psychosocial factors in speech fluency and recovery, including language used during treatment, patient's native language, and multilingualism. Bilingualism resulted in greater fluency in a second language due to reduced emotional pressure or exposure to different phonemes and phonetic structures. The distinction between neurogenic and developmental stuttering emphasizes the need for tailored therapy, with neurogenic cases benefiting from neuroplasticity-driven interventions. Psychosocial factors, including anxiety and bullying, commonly exacerbate speech difficulties, reinforcing values of cognitive-behavioral approaches. The efficacy of traditional clinical interventions was ameliorated by holistic approaches. Thus, music therapy emerged as a promising intervention, particularly for individuals with autism spectrum disorder (ASD) and neurogenic speech disorders. Techniques such as rhythmic queueing and melodic intonation therapy were reported to improve speech fluency by strategic brain region engagement, enhancing speech-motor coordination.

Conclusion: Our findings suggest that holistic approaches can optimize treatment outcomes. Future research should explore the long-term efficacy of these methods and their optimized application.

Keywords: Speech Therapy, Language, Biliguism, Holistic, Culture, Interviews

Introduction

There are precise distinctions between the neuroanatomical aspects of speech and language, due to the striking plasticity derived from learning diverse inputs, which result in diverse clinical outcomes [1]. Multiple factors, such as genetics, psychology or environment, play a role in affecting the speech system in people, leading to complex speech disorders [2]. Such disorders affect an individual's ability to produce coherent and fluent speech, resulting in disfluent/unclear vocabulary, syntax, morphology, semantics or a combination of these aspects. These disorders can be organic or acquired psychogenic (functional) in nature; organic speech disorders have a known cause, such as neurological, motor, anatomical or sensory impairment [3,4]. Speech and language processing rely on a distributed neural network that includes cortical regions such as Broca's and Wernicke's areas, the arcuate fasciculus, supramarginal and angular gyri, and auditory cortices, while music therapy additionally engages limbic and paralimbic regions including the amygdala, hippocampus, cingulate cortex, prefrontal cortex, and nucleus accumbens, thereby influencing emotional, cognitive, and motivational circuits relevant for speech rehabilitation (Figure 1 and 2) [2,5-7].

Fluency speech disorder of stuttering is characterised by the disrupted rate of speech, prolongation of sounds, difficulty in initiating speaking, use of filler words and repetitions. It affects

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approximately 1% of the global population, with a higher prevalence in children (about 5%), most of whom recover naturally, and a persistence rate of about 1% in adults. Males are 3 to 4 times more likely to stutter than females, and the condition often begins between the ages of 2 and 6 years, typically during early language development [8,9]. Stuttering manifests with additional comorbid conditions stemming from psychosocial factors that can complicate both diagnosis and treatment for an individual, impacting their overall health [10]. Psychological factors such as anxiety, depression, temperament, heritable factors and social factors such as differential treatment at school/workplace, childhood bullying and stereotyping, along with insufficient professional help, are certain aspects that have been shown to contribute to the coexistence of stuttering and its psychological comorbidities. There have been a few reports on the role of language and the use of languages in the therapy of stuttering [11]. Differences in language proficiency between the therapist and the patient can be attributed to listening skills and associated psychosocial and genetic factors.

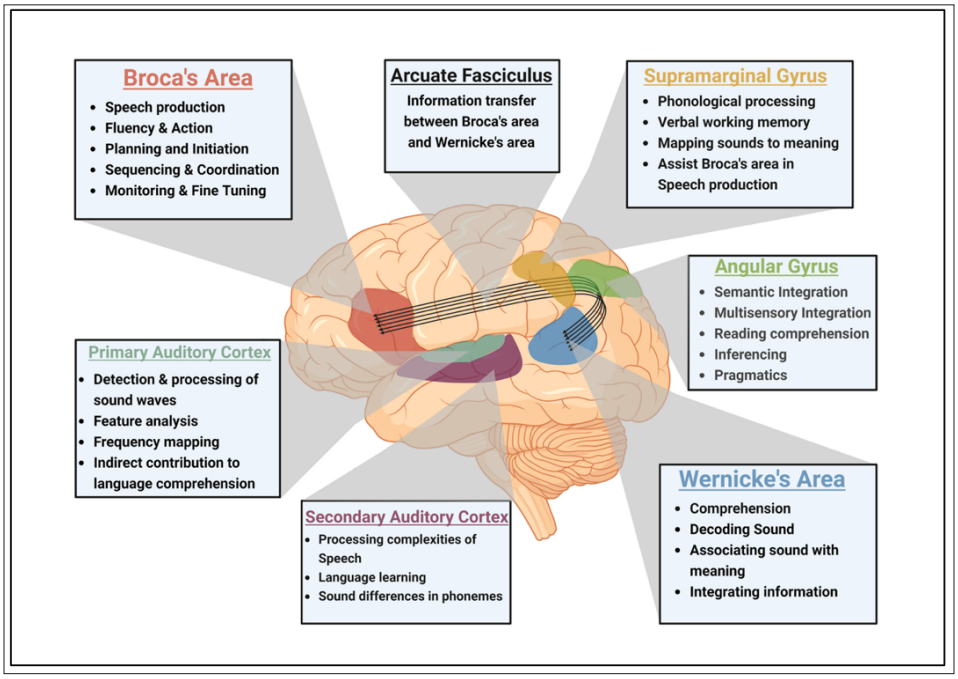


Figure 1: Cortical and Subcortical Regions Involved in Speech and Language Processing

These schematic highlights key brain areas relevant to speech and language. Broca's area (speech production, fluency, sequencing), Wernicke's area (comprehension and decoding sound), the arcuate fasciculus (information transfer between Broca's and Wernicke's areas), the supramarginal gyrus (phonological processing and working memory), the angular gyrus (semantic and multisensory integration), and the auditory cortices (sound detection, phoneme discrimination, language learning) are shown. These regions collectively support articulation, comprehension, phonological processing, and integration of multisensory information essential for speech. Figure adapted from [2].

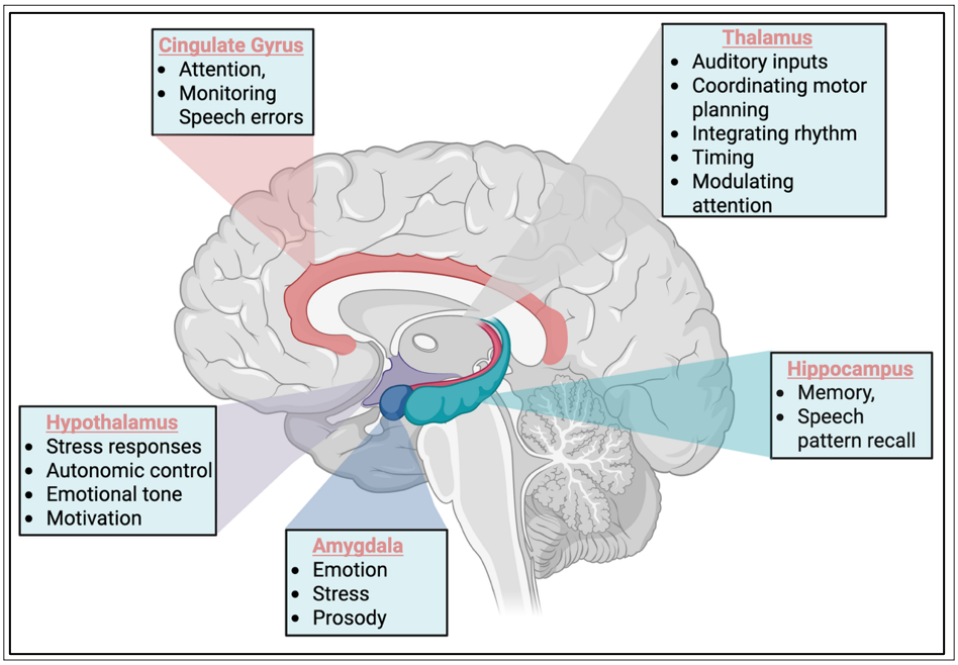


Figure 2: Limbic System Involvement in Music Therapy and Speech Rehabilitation

This medial brain diagram highlights limbic and associated regions influenced by music therapy. The amygdala modulates stress and calms anxiety-driven stuttering, the hippocampus supports memory for speech patterns, and the cingulate cortex regulates attention and error monitoring. The prefrontal cortex improves emotional self-regulation, while the nucleus accumbens contributes to reward and motivation. Together, these regions demonstrate how music therapy influences emotional, cognitive, and motivational circuits to support speech rehabilitation. (Image created using BioRender)

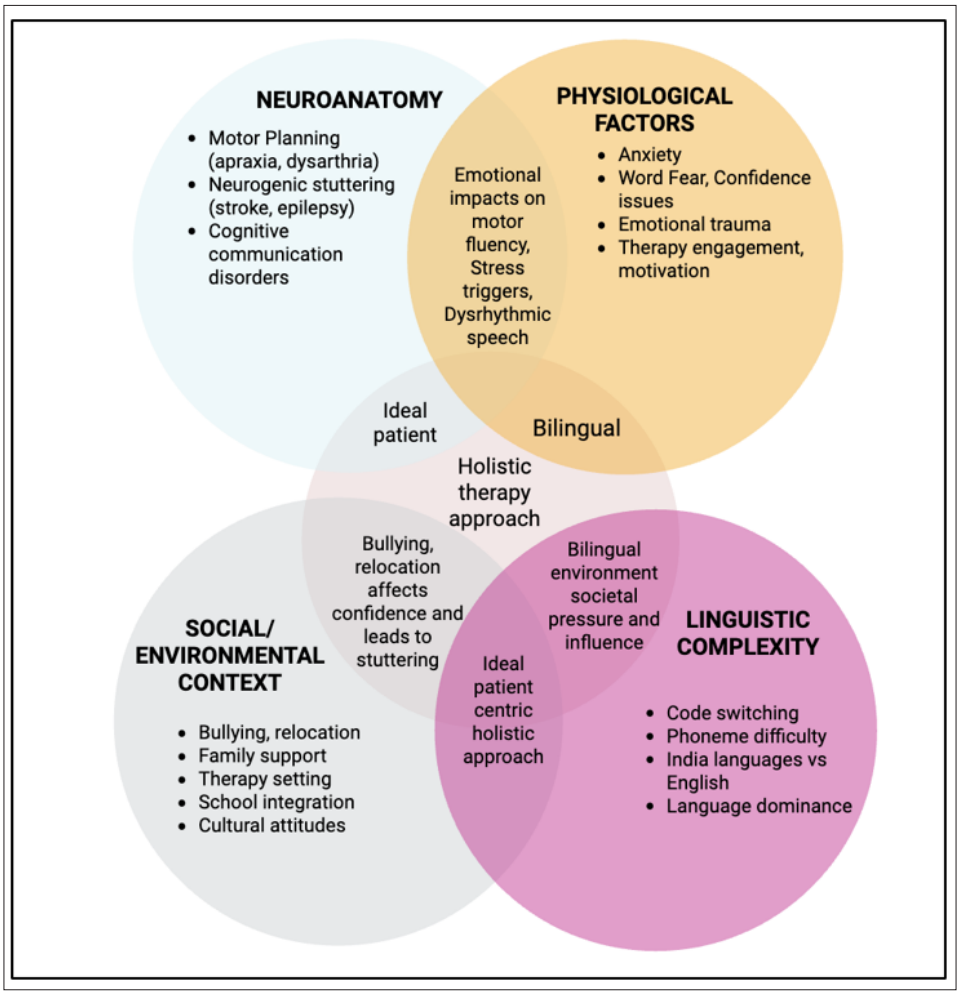


Figure 3: Interconnected Factors in Speech Therapy for Multilingual and Neurogenic Disorders

This Venn diagram illustrates the interplay of four key domains influencing speech therapy outcomes: neuroanatomy, psychological factors, social/environmental context, and linguistic complexity. Each circle represents a category of influence, with overlapping areas denoting shared or interacting effects. The central intersection highlights the ideal patient-centered, holistic therapy approach that integrates neurological, emotional, social, and linguistic considerations. This model reflects insights from interviewed therapists who emphasized individualized treatment, cultural and language context, and the impact of stress and environmental factors on speech fluency. (Image created using BioRender).

In this study, we performed an exploratory analysis of interviews with speech therapists to understand how bilingualism and stuttering interact. Bilingualism is defined as the everyday use of more than one language [12]. There is no singular definition of how to measure bilingualism. Proposed possibilities to quantify or categorise it include: similar proficiency levels to a native speaker in one's second language, attaining a minimum proficiency in one of the four linguistic skills: understanding, speaking, reading and writing, usage of multiple languages daily without necessarily mastering them [13]. Through this study, we aim to understand the nuances of speech therapy for patients with speech and language disorders through first-hand interviews with 8 professionals in the field of speech pathology and language, which included speech therapists and speech experts situated globally. Our particular focus was on the themes of individualised approach, the role of bilingualism and music therapy in adaptation to treatment.

Materials And Methods

The purpose of this study is to comparatively examine the effectiveness of traditional and non-traditional approaches of therapists in treating speech disorders and the presence or absence of certain themes mentioned earlier, characteristic to the two types of treatment. In addition to the purpose stated above, the study also aims to explore how these therapies impact three domains of speech rehabilitation: language functioning, co-occurring (comorbid) conditions, and the social aspects of communication.

The participants in the study are practicing speech and music therapists from India, the UK and the USA. They were recruited through word of mouth and social media platforms. The therapists answer questions regarding their patients who have been diagnosed with speech disorders. Only anonymized data from the therapists was used in the research study.

The study used a semi-structured interview format for data collection. The questions were designed to address each of the three above-mentioned domains. The same set of questions was asked of all the therapists. The questions used in the interview are as follows:

1. Please introduce the work you do as a speech therapist.
2. In your opinion, has the language spoken by the patient influenced the speech disorder and speech recovery?
3. Do you see patients with any of these speech disorders?

a. stuttering, stammering
b. phonological disorders
c. Other (please describe)

4. Is your patient's monolingual, bilingual or multilingual?

a. What percentage of patients
b. Please list the languages they speak

5. Have you noticed any differences in the speech disorders of your patients' symptoms based on the language you are speaking?
6. Can you provide any details (if any) on environmental or societal factors that may have contributed to your patient's speech disorder? (e.g., bullying, anxiety, stress)
7. What kinds of interventions and therapies have you used for the treatment of stuttering?
8. What kinds of co-morbidities (mental and physical) have you observed in patients you are treating with stuttering?
9. Do you use music therapy for the treatment of your patients? Are there specific groups of patients who can benefit more from this type of therapy?

Ethics Approval

The de-identified demographic data of the patients were obtained from therapists. The data was anecdotal and not representative of the population. There was no direct contact established with any patient receiving treatment from the therapists. The ethics committee of ARISA Foundation, Pune, India, has approved the study.

Results

Participant Demographics and Professional Backgrounds

Eight professionals were interviewed for this study, including speech therapists, speech experts, music therapists, and a spiritual practitioner engaged in voice-based healing practices. Their expertise spans clinical, neurological, educational, and alternative therapy settings. These professionals work with a range of speech disorders, including developmental conditions such as stuttering, phonological disorders, apraxia, and neurodevelopmental disorders like autism spectrum disorder (ASD), as well as neurogenic disorders resulting from stroke, epilepsy, Parkinson's disease, and traumatic brain injuries. Some of the therapists also noted working with patients experiencing co-morbid psychological and cognitive conditions, including Down syndrome, schizophrenia, and anxiety-related disorders. The professionals varied in their therapeutic approaches, with some incorporating structured neuroanatomical methods and others integrating music or spiritual elements into therapy. All therapists agreed that treatment must be individualized, addressing each patient's unique psychological, social, and environmental context.

Languages Spoken by Patients

The majority of patients treated by the therapists were bilingual or multilingual. Common language combinations included Hindi-English, Marathi-English, Tamil-English, and Bengali-English. Several therapists reported that patients tend to prefer the language that feels cognitively and emotionally easier to articulate, even when it is not their native tongue. Children, especially, often develop fluency in English when exposed to English-language media, even if their home language differs. Language therapy is generally conducted in the language most comfortable for the patient, though in some cases, bilingual therapy is used to support fluency across multiple languages. Therapists observed that patients frequently use code-switching, a self-management strategy often used by people who stutter to induce fluency and to bypass difficult phonemes or words they associate with discomfort [14,15]. Some noted that Indian languages are often more phonologically complex than English, posing a greater challenge for individuals with speech disorders.

Environmental and Social Influences

Therapists emphasized the significant impact of environmental and psychosocial factors on speech fluency. Anxiety, stress, bullying, and important life changes such as relocation or changes in school were often associated with the onset or worsening of stuttering. In contrast, a calm and accepting environment, coupled with strong family support, has been found to facilitate better outcomes, especially in children. In paediatric speech therapy, children were not asked direct questions about their difficulties. Instead, assessment was conducted primarily through observation during activities involving books, toys, and games. Several therapists also reported that children with ASD or speech delays benefited from the use of visual aids, body language cues, and alternative communication devices.

Thematic Analysis of Interview Responses

Analysis of the interview responses revealed three key themes that spanned the range of therapeutic approaches: multilingualism and speech disorders, the role of music and rhythm in therapy, and holistic patient-centered approaches.

Multilingualism emerged as a critical factor influencing both the manifestation of speech disorders and their treatment. Therapists observed that speech fluency often varied depending on the language spoken, with patients sometimes stuttering in one language while remaining fluent in another. Factors influencing this included phonetic complexity, emotional associations with specific languages, and cognitive effort. Some patients showed a tendency to switch languages during speech to avoid difficult phonemes or anxiety-inducing vocabulary. In some cases, bilingual individuals demonstrated "word fear" in one language while compensating fluently in another. Most therapists agreed that linguistic context plays a key role in tailoring speech therapy to the patient's comfort and fluency needs.

The role of music and rhythm in speech therapy was reported by therapists with training in or exposure to music-based interventions. Techniques described included rhythmic exercises based on tabla patterns, Sanskrit chanting, melodic intonation therapy, and choral reading. One music therapist described mother-child singing sessions that led to rapid improvements in speech production among non-verbal children with ASD. Others used rhythm and melody to support articulation and fluency. Emotional engagement through music was seen to boost confidence and reduce anxiety-related speech disruptions. While not all therapists formally practiced music therapy, some acknowledged its use as a relaxation technique to support the therapeutic process.

Holistic approaches to speech therapy were also emphasized across several interviews. These included practices that considered the patient's psychological, emotional, and physiological states. Mindfulness and breathwork techniques such as star breathing and five-finger breathing were used to manage stress and support stuttering therapy. Star breathing is a conscious breath control technique in which one imagines repetitively tracing a star, inhaling while tracing away from the star's centre and exhaling while tracing inwards [16]. Five-finger breathing uses the same idea, physically tracing one's hand with fingers of the other hand, instead of imagining tracing a star. Some therapists integrated visual cues and structured interactive tools to help children with speech organization and reduce verbal cluttering. Others highlighted the importance of teaching parents how to model appropriate speech behaviour and create supportive communication environments. One practitioner, with a background in spiritual healing, emphasized the integration of breath, posture, and resonance, suggesting that the voice serves as a bridge between the physical and emotional aspects of oneself.

Table 1 provides a consolidated summary of the professional backgrounds, therapeutic approaches, patient populations, and key insights from each of the eight therapists. The table illustrates the diversity in both methodology and perspective, from highly structured neurogenic and developmental models to culturally informed music-based and spiritually grounded practices.

Table 1: Summary of Perspectives and Therapeutic Approaches Shared by Speech Therapists, Music Therapists, And Speech Experts, Highlighting Their Expertise, Key Insights, And Strengths in Addressing Speech and Language Disorders

Speech Therapists and Experts	Expertise & Approach	Key Insights	Strengths
Subject 1(Music Therapist)	Uses Hindustani classical music therapy (tabla bols, ragas, shlokas) for speech disorders.	- Stuttering may reduce when patients focus on it.	- Rhythm-based therapy for fluency improvement.
		- Multilingual patients may struggle with specific phonemes.	- Connects phonetics with fluency.
		- Stress and anxiety worsen speech disorders.	
Subject 2 (Music Teacher, Spiritual Guru)	Holistic approach linking voice (body) and swar (soul).	- Speech fluency is better in the morning when the body is relaxed.	- Integrates breathing, sound therapy, and emotional healing.
		- Breathing, posture, and resonance impact speech.	
		- Musical instruments (e.g., drums, zanz) regulate emotions.	
Subject 3 (Speech Therapist)	Structured clinical approach in hospital settings, usually for elderly patients	- Motor speech disorders require timing, rhythm, and emotional engagement.	- Uses Venn diagram framework (neuroanatomy, genetics, psychology, social factors).
		- Dysrhythmic blockages in ASD/ Down syndrome patients affect fluency.	- Uses Venn diagram framework (neuroanatomy, genetics, psychology, social factors).
		-PTSD and other traumatic experiences affect speech disorder and ability to recover	
		-research into MIT and alternative therapy is innovative and may be more efficient	
Subject 4 (Neurogenic Speech Disorders Specialist)	Neurogenic speech therapy expert (stroke, epilepsy, Parkinson's, cognitive-communication disorders).	- Differentiates developmental vs. neurogenic stuttering.	- Expertise in neurological speech disorders.
		- Uses bilingual therapy tailored to patient comfort.	- Uses OASIS & ICF frameworks for speech assessment.
		- Evaluates psychological & emotional impacts of speech disorders.	

Subject 5 (Music Therapist)	30+ years of experience in Carnatic music therapy for speech disorders, autism, and cerebral palsy.	- Mother-child singing therapy significantly improves speech in ASD children.	- Strong results in ASD and non-verbal children.
		- Rhythm therapy (mridangam bol) aids fluency.	- Prefers in-person therapy over recordings.
		- A calm and accepting environment is key to speech recovery.	
Subject 6 (School-Based Pediatric Speech Therapist)	Works with ASD & neurodevelopmental disorders, specializing in multilingual speech therapy.	- Bilingual & multilingual children choose the easiest language to speak.	- Strong focus on multilingual therapy.
		- Indian languages are phonetically complex, making English easier for some patients.	- Uses alternative communication devices for non-verbal ASD patients.
		- Uses mindfulness, breathing exercises, and visual aids for fluency improvement.	
Subject 7 (Speech Therapist)	Practical, patient-centered therapy techniques for stuttering & speech impairments.	- Speech therapy is tailored to individual needs.	- Real-world therapy approach.
		- Stuttering frequency varies by language.	- Focuses on stress-related speech impairments.
		- Patients may relapse if they stop using therapy techniques.	
		- Stress (e.g., moving cities) triggers stuttering.	
Subject 8 (Speech Expert)	Performs research on speech and language patterns and mechanisms across species as a study of evolution	- Connection between birds, chimpanzees, and humans found in terms of speech pathways and forms of communication	- Proposes explanations for efficacy of newer and holistic methods (song, dance) of treatment for speech disorder - Study of speech systems and the brain from genetic (FOXP2, heat shock protein, SRG2), neuroscience (nuances in neural circuitry), and psychological (social learning) perspective enhances the depth of knowledge
		- Activation of parts of brain responsible for music, rhythm, dance could improve speech fluency and affect disorder intensity	
		- Neural circuitry has a major effect on the speech and language abilities of a particular species	
		- Speech probably evolved from motor control systems	

Key Takeaways

The interviews revealed that speech disorders are multifactorial and deeply influenced by individual, linguistic, environmental, and neurological variables. Bilingualism and multilingualism introduce both complexity and opportunity in therapy design. Music-based and rhythm-supported interventions are increasingly recognized as effective for improving fluency, especially among children and individuals with anxiety-related speech issues. Finally, a holistic, individualized, and culturally responsive approach remains central to effective speech therapy across all age groups.

Methodological Strengths and Limitations

This qualitative study employed semi-structured interviews to gather in-depth insights from a diverse group of eight professionals engaged in speech therapy and related practices. The methodology enabled the collection of rich, narrative data, revealing nuanced perspectives on multilingualism, music-based interventions, and holistic therapeutic approaches.

One of the key strengths of this methodology lies in its diversity of perspectives. By including not only licensed speech therapists but also music therapists, a speech researcher and a spiritual voice practitioner, the study captures a broad spectrum of therapeutic strategies, from evidence-based clinical practices to culturally embedded, non-traditional methods. This inclusivity enhances the ecological validity of the findings, particularly in multicultural and multilingual contexts where conventional speech therapy may not fully address individual needs. Another strength is the contextual depth provided by the interview format. Therapists shared specific observations, challenges, and adaptive strategies based on their real-world experiences. This allowed for the emergence of meaningful themes—such as the psychological impact of stress on fluency, and the role of rhythm and musicality in language development—that may not be captured in standardized survey-based studies.

However, the methodology also presents certain limitations. The sample size is small and may not be representative of the broader population of speech-language pathologists and therapists. While the qualitative nature of the data yields depth, it limits the generalizability of the findings. Moreover, as some participants practice outside conventional clinical frameworks (e.g., music teachers, spiritual practitioners), their approaches may lack empirical validation, and their inclusion may introduce variability in interpretive rigor. There is also the potential for interviewer and response bias, particularly given the open-ended and interpretive nature of qualitative interviews. Therapists may have emphasized unique or successful aspects of their practice while underreporting challenges or failures. Additionally, the absence of patient perspectives restricts the findings to therapist observations, leaving out how these approaches are perceived or experienced by patients themselves.

Despite these limitations, the methodology successfully surfaces critical themes that warrant further exploration and quantitative validation. The study offers valuable insights into how speech therapy can be adapted in culturally diverse, linguistically complex, and emotionally sensitive contexts.

Discussion

The results of our survey highlight the multifaceted nature of speech disorders and the various factors influencing speech recovery. The responses from speech therapists emphasize the significance of linguistic, neuroanatomical, psychological, and social influences on speech disorders [2]. Additionally, the use of music therapy as an adjunct treatment has demonstrated potential benefits, particularly in younger patients and those with autism spectrum disorder (ASD).

Speech, Stuttering, Linguality, and Therapy

The role of language in speech disorders is complex, with bilingualism and multilingualism playing both a facilitating and a challenging role in fluency [17]. Our findings corroborate previous research suggesting that bilingual individuals may stutter more in one language than another due to differences in phonetic complexity, cognitive load, and emotional associations with a language [11]. Therapists reported that some patients exhibited greater fluency in their second language, possibly due to reduced emotional pressure or a lesser fear of judgment. These observations align with studies indicating that bilingualism does not directly cause speech disorders but may influence their manifestation [12]. Additionally, therapists noted that therapy approaches incorporating a patient's dominant language and cultural context led to better engagement and outcomes.

A distinction was observed between developmental and neurogenic stuttering. Developmental stuttering, commonly observed in childhood, may persist into adulthood due to psychological and social reinforcement of speech anxiety [2]. Neurogenic stuttering, resulting from neurological impairments such as stroke or epilepsy, presents different therapeutic challenges [18]. Unlike developmental stuttering, neurogenic stuttering does not show adaptation effects, such as fluency improvements with repeated word exposure [19]. This distinction underscores the importance of a tailored therapeutic approach depending on the etiology of the speech disorder. The survey responses further emphasized that successful therapy for neurogenic stuttering often integrates speech-motor exercises with neuroplasticity-driven interventions.

Anxiety, stress, and environmental factors were commonly reported as exacerbating speech disorders. Many therapists observed that children who experienced bullying or social isolation exhibited worsened speech fluency, consistent with research indicating that negative social interactions contribute to speech anxiety and avoidance behaviors [20]. Supportive environments, particularly within families and schools, were identified as crucial for speech improvement. Notably, therapists highlighted the importance of parental modeling and intervention, which aligns with previous studies advocating for family-centered speech therapy [21]. Several respondents also emphasized the role of cognitive-behavioral therapy (CBT) in addressing anxiety-driven speech avoidance patterns.

Music Therapy in Speech Rehabilitation

Music therapy has been a promising intervention for speech disorders [22]. Several therapists reported using rhythm-based exercises, melodic intonation therapy, and mother-child singing interventions to improve speech fluency. The benefits of rhythmic cueing for speech fluency have been well-documented, particularly in patients with neurogenic speech disorders and ASD [23]. Therapists observed that structured rhythmic exercises helped patients regulate their speech timing and improve articulation. Additionally, music therapy's ability to engage multiple brain regions supports its application in speech rehabilitation. Specifically, music therapy activates Broca's and Wernicke's areas, the arcuate fasciculus, auditory cortices, the supplementary motor area, cerebellum, and limbic regions such as the amygdala and prefrontal cortex, collectively enhancing fluency, timing, comprehension, and emotional regulation in speech rehabilitation [24]. Our findings suggest that incorporating personalized musical elements, such as a patient's preferred songs or culturally familiar rhythms, can enhance engagement and therapeutic success.

Clinical Implications and Future Directions

The findings from this study underscore the necessity of a personalized approach to speech therapy. Given the complex interplay of language, neuroanatomy, and psychological factors, therapy must be tailored to each patient's specific needs (Figure 3). Future research should focus on longitudinal studies to assess the efficacy of bilingual speech therapy and music-based interventions over extended periods. Furthermore, integrating digital tools and artificial intelligence in speech therapy could enhance treatment outcomes by providing real-time feedback and personalized training modules [25]. Virtual reality (VR) and augmented reality (AR) applications may also serve as promising tools for immersive and engaging speech therapy interventions. Furthermore, novel approaches to brain implants can also enable interventional therapies for correcting speech disorders [26,27]. In summary, the survey provides insights into the diverse methodologies employed by speech therapists worldwide. The recognition of bilingual influences, psychological factors, and music

therapy as integral components of speech therapy reinforces the need for an interdisciplinary approach in treating speech disorders. By expanding access to innovative and culturally sensitive therapeutic techniques, clinicians can better support individuals with speech disorders in achieving long-term communicative success.

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- Proposes explanations for efficacy of newer and holistic methods (song, dance) of treatment for speech disorder

- Study of speech systems and the brain from genetic (FOXP2, heat shock protein, SRG2), neuroscience (nuances in neural circuitry), and psychological (social learning) perspective enhances the depth of knowledge

References

1. Rogalsky C, Basilakos A, Rorden C, Pillay S, Keator L, et al. The Neuroanatomy of Speech Processing: A Large-scale Lesion Study. Journal of Cognitive Neuroscience, 2022. 34: 1355–1375.
2. Jaishankar D, Raghuram T, Raju BK, Swarna D, Parekh S, et al. A Biopsychosocial Overview of Speech Disorders: Neuroanatomical, Genetic, and Environmental Insights. Biomedicines. 2025. 13: 239.
3. Baars BJ, Gage NM. Cognition, brain, and consciousness: Introduction to cognitive neuroscience (2nd ed). Elsevier/ Academic Press. 2010.
4. Duffy JR. Functional speech disorders: Clinical manifestations, diagnosis, and management. Handb Clin Neurol. 2016. 139: 379-388.
5. Fujii M, Maesawa S, Ishiai S, Iwami K, Futamura M, et al. Neural Basis of Language: An Overview of An Evolving Model. Neurol Med Chir (Tokyo). 2016. 56: 379-386.
6. Raglio A. A novel music-based therapeutic approach: The Therapeutic Music Listening. Frontiers in Human Neuroscience. 2023. 17: 1204593.
7. Ramaswamy M, Philip JL, Priya V, Priyadarshini S, Ramasamy M, et al. Therapeutic use of music in neurological disorders: A concise narrative review. Heliyon. 2024. 10: 35564.
8. Engelen MM, Franken MCJP, Stipdonk LW, Horton SE, Jackson VE, et al. The Association Between Stuttering Burden and Psychosocial Aspects of Life in Adults. Journal of Speech, Language, and Hearing Research: JSLHR. 2024. 67: 1385-1399.
9. Walsh EE, Frenck RW, Falsey AR, Kitchin N, Absalon J, et al. Safety and Immunogenicity of Two RNA-Based Covid-19 Vaccine Candidates. N Engl J Med. 2020. 383: 2439-2450.
10. Perez HR, Stoeckle JH. Stuttering: Clinical and research update. Canadian Family Physician Medecin De Famille Canadien. 2016. 62: 479-484.
11. Brundage SB, Ratner NB. Linguistic aspects of stuttering: Research updates on the language-fluency interface. Topics in Language Disorders. 2022. 42: 5-23.
12. Spitzer M. Bilingual benefits in education and health. Trends in Neuroscience and Education. 2016. 5: 67-76.
13. Daller MH. The measurement of bilingual proficiency: Introduction. International Journal of Bilingualism. 2011. 15: 123-127.
14. Manivannan V, Maruthy S. Code-switching and Code-mixing: A gap in the Stuttering Literature. Research Review International Journal of Multidisciplinary, 2024. 9: 10-23.
15. Medina AM, Pereira T, Muñoz D, Palacios G, Perez V. Fluency Strategies of Spanish–English Bilinguals Who Stutter: A Thematic Analysis. Perspectives of the ASHA Special Interest Groups. 2019. 4: 1062-1073.
16. Yilmaz EB, Dikmen SNT, Yüksel A. Medication Adherence and Functioning in Individuals With Bipolar Disorder Type I. Journal of Psychosocial Nursing and Mental Health Services. 2025. 63: 25-33.
17. Goral M, Conner PS. Language Disorders in Multilingual and Multicultural Populations. Annual Review of Applied Linguistics. 2013. 33: 128-161.
18. Junuzovic Zunic L, Sinanovic O, Majic B. Neurogenic Stuttering: Etiology, Symptomatology, and Treatment. Medical Archives (Sarajevo, Bosnia and Herzegovina). 2021. 75: 456-461.
19. Van Borsel J, Taillieu C. Neurogenic stuttering versus developmental stuttering: An observer judgement study. Journal of Communication Disorders. 2001. 34: 385-395.
20. Iverach L, O'Brian S, Jones M, Block S, Lincoln M, et al. Prevalence of anxiety disorders among adults seeking speech therapy for stuttering. Journal of Anxiety Disorders. 2009. 23: 928-934.
21. Glogowska M, Campbell R. Investigating parental views of involvement in pre-school speech and language therapy. International Journal of Language & Communication Disorders. 2000. 35: 391-405.
22. Koshimori Y, Akkunje PS, Tjiandri E, Kowaleski JB, Thaut MH. Music-based interventions for nonfluent aphasia: A systematic review of randomized control trials. Annals of the New York Academy of Sciences. 2025. 1549: 92-111.
23. Fujii S, Wan CY. The Role of Rhythm in Speech and Language Rehabilitation: The SEP Hypothesis. Frontiers in Human Neuroscience. 2014. 8: 777.
24. T Zaatar M, Alhakim K, Enayeh M, Tamer R. The transformative power of music: Insights into neuroplasticity, health, and disease. Brain, Behavior, & Immunity – Health. 2024. 35: 100716.
25. Deka C, Shrivastava A, Abraham AK, Nautiyal S, Chauhan P. AI-Based Automated Speech Therapy Tools for persons with Speech Sound Disorders: A Systematic Literature Review. In Review. 2024.
26. Kunz EM, Abramovich Krasa B, Kamdar F, Avansino DT, Hahn N, et al. Inner speech in motor cortex and implications for speech neuroprostheses. Cell. 2025. 188: 4658-4673.e17.

27. Littlejohn KT, Cho CJ, Liu JR, Silva AB, Yu B, et al. A streaming brain-to-voice neuroprosthesis to restore naturalistic communication. Nature Neuroscience. 2025. 28: 902-912.

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