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Research Paper

RHYTHM AND REGULATION: A TECH-DRIVEN APPROACH TO STUTTERING IN STUDENTS USING AN INTEGRATIVE REVIEW

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ABSTRACT

TStuttering and anxiety frequently co-occur among students, forming a bidirectional relationship that negatively affects academic performance, communication efficiency, and psychosocial well-being. Although effective interventions exist for each condition, they are typically implemented in isolation, limiting their overall impact. This integrative review synthesizes empirical evidence to propose a culturally grounded and technology-amenable intervention framework that combines physiological biofeedback with Tamil rhythmic recitation. Guided by Whittemore and Knafl's five-stage integrative review methodology, empirical studies published between 2000 and 2024 were systematically identified from PubMed, PsycINFO, ERIC, and Web of Science. Fifty-two studies were analyzed using thematic synthesis, focusing on heart rate variability (HRV) biofeedback, electromyographic (EMG) biofeedback, rhythmic speech techniques, and language-specific therapeutic principles. Findings consistently support HRV biofeedback for autonomic regulation and anxiety reduction, EMG biofeedback for reducing speech-related muscle tension and stuttering frequency, and rhythmic speech methods for producing immediate fluency gains through motor-timing mechanisms. Linguistic analysis further revealed that key features of the Tamil language including syllable-timed prosody, structured consonant vowel patterns, limited consonant clustering, and classical metrical traditions align closely with established principles of speech motor control and rhythm-based fluency enhancement. Integrative synthesis identified converging physiological, motor, psychological, and neural mechanisms supporting a combined intervention approach. Based on these findings, a theoretically coherent framework integrating biofeedback therapy with Tamil recitation is proposed, with potential applications in assistive speech technologies, biofeedback-supported educational tools, and culturally adaptive therapeutic systems. The absence of empirical studies evaluating this combined application highlights a critical research gap, underscoring the need for controlled trials and technology-enabled implementations among Tamil-speaking student populations.

Keywords: *Biofeedback systems, stuttering, anxiety, Tamil language, rhythmic speech, heart rate variability, assistive technology, integrative review*

INTRODUCTION

1.1 Background

Developmental stuttering affects approximately 1% of the global population, with significant impacts on students' academic performance, social interaction, and psychological well-being (Iverach & Rapee, 2014). The relationship between anxiety and stuttering is bidirectional and well-documented: anxiety precipitates stuttering episodes, while stuttering experiences generate social anxiety (Craig et al., 2003; Ezrati-Vinacour & Levin, 2004). Research indicates alarmingly high rates of social anxiety disorder among individuals who stutter, ranging from 16% to 60%, substantially higher than the 7-13% prevalence in the general population (Blumgart et al., 2010).

Traditional stuttering interventions have focused primarily on speech modification techniques, cognitive restructuring, or pharmacological approaches. However, these separate treatment pathways may overlook potential synergies in addressing the psychophysiological mechanisms underlying both conditions. Recent evidence suggests that integrated approaches targeting both anxiety and stuttering simultaneously may be more effective than sequential treatments (Menzies et al., 2008).

Biofeedback therapy, which enables voluntary control over physiological processes, has demonstrated efficacy for both anxiety reduction and stuttering management (Gevirtz, 2014; Craig & Cleary, 1982). Concurrently, rhythmic speech interventions have revealed consistent fluency-enhancing effects, with metronome-paced speech reducing stuttering frequency by over 90% in some studies (Andrews et al., 1982).

1.2 Rationale for Cultural-Linguistic Integration

Tamil, a classical Dravidian language with over 70 million speakers worldwide, possesses distinctive phonological and prosodic features that may enhance therapeutic outcomes. Its syllable-timed rhythm, systematic consonant-vowel structure, limited consonant clusters, and rich tradition of metrically structured classical literature provide natural rhythmic scaffolding for speech practice (Keane, 2006). For Tamil heritage students, recitation of culturally meaningful texts may enhance motivation, therapeutic engagement, and cultural identity affirmation.

1.3 Review Aim

This integrative review aims to:

1. Synthesize empirical evidence on biofeedback interventions for anxiety and stuttering

2. Examine rhythmic speech interventions for fluency enhancement

3. Explore language-specific therapeutic approaches

4. Propose an integrated theoretical framework combining biofeedback with Tamil recitation

5. Identify research gaps and future directions

2. Methods

2.1 Design

This integrative review follows the five-stage framework proposed by Whittemore and Knafl (2005): (1) problem identification, (2) literature search, (3) data evaluation, (4) data analysis, and (5) presentation. The integrative review methodology was selected because it allows for the inclusion of diverse research designs (experimental, quasi-experimental, qualitative, and theoretical) to provide comprehensive synthesis (Russell, 2005).

2.2 Search Strategy

A structured literature search was conducted to identify empirical and theoretical sources relevant to biofeedback, rhythmic speech interventions, anxiety, and stuttering. Electronic databases commonly used in psychology, speech-language pathology, and education were consulted, including PubMed, PsycINFO, ERIC, and Web of Science. Searches were supplemented by manual screening of reference lists from key review articles and seminal studies to ensure comprehensive coverage of foundational and recent work. Search terms were developed iteratively and included combinations of keywords related to biofeedback (e.g., heart rate variability biofeedback, electromyographic biofeedback), speech and flu-

ency (e.g., stuttering, fluency disorders, rhythmic speech, metronome-paced speech), and psychological constructs (e.g., anxiety, social anxiety). Additional searches were conducted for linguistic and cultural sources relevant to Tamil phonology, prosody, and recitative traditions. The search strategy was refined throughout the review process to balance breadth and relevance, consistent with integrative review methodology.

2.3 Study Selection

Studies were selected based on relevance to the aims of the integrative review rather than through exhaustive systematic screening. Inclusion criteria encompassed empirical studies, reviews, and theoretical papers examining (a) biofeedback-based interventions for anxiety or speech outcomes, (b) rhythmic or externally timed speech interventions for stuttering or fluency enhancement, and (c) psychological, neurophysiological, or developmental relationships between anxiety and stuttering. Linguistic and cultural sources informing Tamil speech structure and rhythmic traditions were included to support theoretical integration. Studies were excluded if they focused exclusively on neurogenic stuttering, lacked relevance to anxiety, fluency, or speech motor control, or did not contribute meaningfully to the integrative framework. Selection decisions emphasized conceptual contribution, methodological clarity, and relevance to thematic synthesis, in accordance with Whittemore and Knafl's (2005) recommendations for integrative reviews.

2.4 Data Analysis and Synthesis

Data analysis employed an iterative thematic synthesis approach informed by qualitative analytic principles (Miles & Huberman, 1994) and integrative review methodology (Whittemore & Knafl, 2005). Study findings were compared across intervention types to identify recurring patterns in outcomes, mechanisms, and theoretical interpretations. Evidence was progressively organized to support the development of higher-order themes representing key domains of the literature. Given the heterogeneity of study designs, interventions, and populations, findings were synthesized narratively rather than through meta-analysis. Where reported, effect sizes were noted to contextualize the magnitude of outcomes.

3. RESULTS

3.1 Study Characteristics

The 52 included empirical studies comprised: randomized controlled trials (n=18, 35%), quasi-experimental studies (n=14, 27%), observational studies (n=12, 23%), and qualitative studies (n=8, 15%). Sample sizes ranged from 8 to 247 participants. Populations included university students (n=21 studies), adolescents (n=15), adults who stutter (n=12), and mixed age groups (n=4).

Table 1: Summary of Included Studies by Category

Category	Studies (n)	Design Types	Key Focus
HRV Biofeedback for Anxiety	14	RCT (8), Quasi-exp (4), Obs (2)	College students, test anxiety
EMG Biofeedback for Stuttering	9	RCT (3), Quasi-exp (4), Obs (2)	Muscle tension reduction
GSR/Multi-modal Biofeedback	6	RCT (2), Quasi-exp (3), Obs (1)	Combined modalities
Rhythmic Speech/Metronome	15	RCT (4), Quasi-exp (6), Obs (5)	Immediate fluency effects
Anxiety-Stuttering Relationship	8	Obs (6), Qual (2)	Bidirectional associations
Tamil Linguistics	8	Theoretical/descriptive	Phonology, prosody

3.2 Thematic Findings

3.2 THEMATIC FINDINGS

Four major themes emerged from data analysis:

Theme 1: Heart Rate Variability Biofeedback for Anxiety Reduction

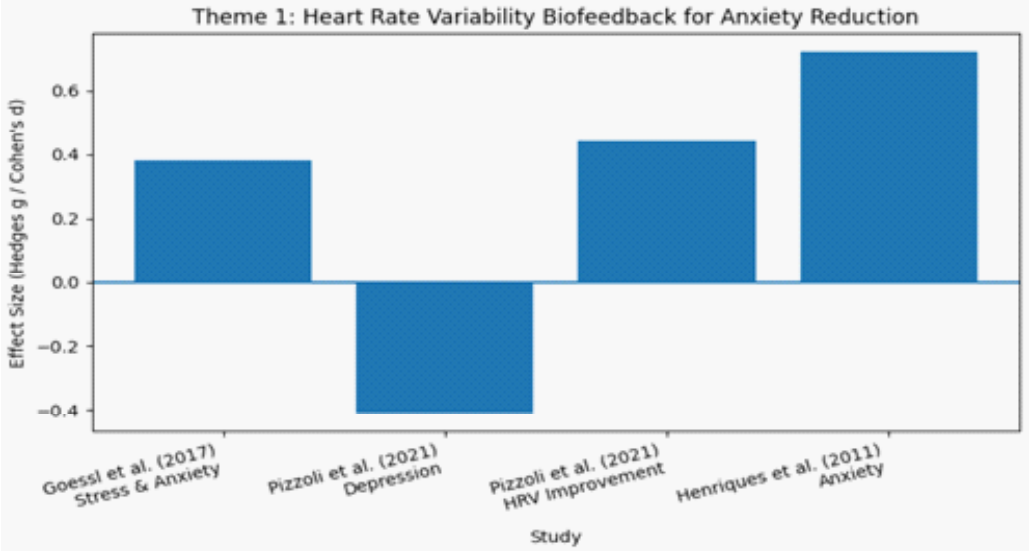
Fourteen studies examined HRV biofeedback for anxiety management, with 12 focused on student populations. Goessl et al. (2017) conducted a meta-analysis of 24 studies and found medium effect sizes for reducing stress and anxiety ($g = 0.38$, 95% CI [0.22, 0.54], $p < 0.001$). Another meta-analysis by Pizzoli et al. (2021) examining remote HRV biofeedback found medium effect sizes for depression ($g = -0.41$) and HRV improvement ($g = 0.443$).

Individual studies with students demonstrated robust effects:

- Henriques et al. (2011): College students receiving computer-based HRV biofeedback showed significant anxiety reduction compared to controls ($p < 0.001$, $d = 0.72$)
- Ratanasiripong et al. (2012): Nursing students completing 4 weeks of biofeedback exhibited significant decreases in stress ($p = 0.002$), anxiety ($p < 0.001$), and depression ($p = 0.01$)
- Khng (2023): Systematic review of university students found biofeedback had significant impact on anxiety (largest effect), with stress and depression also improving

Mechanisms identified: Strengthening baroreceptor system homeostasis, enhancing vagally-mediated HRV, modulating vagal afferent pathways to prefrontal and limbic regions, improving autonomic balance.

Protocol commonalities: Resonance frequency training (typically 5-7 breaths/minute), 20-minute sessions, 6-8 weeks duration, home practice with portable devices.



Theme 2: Electromyographic Biofeedback for Stuttering

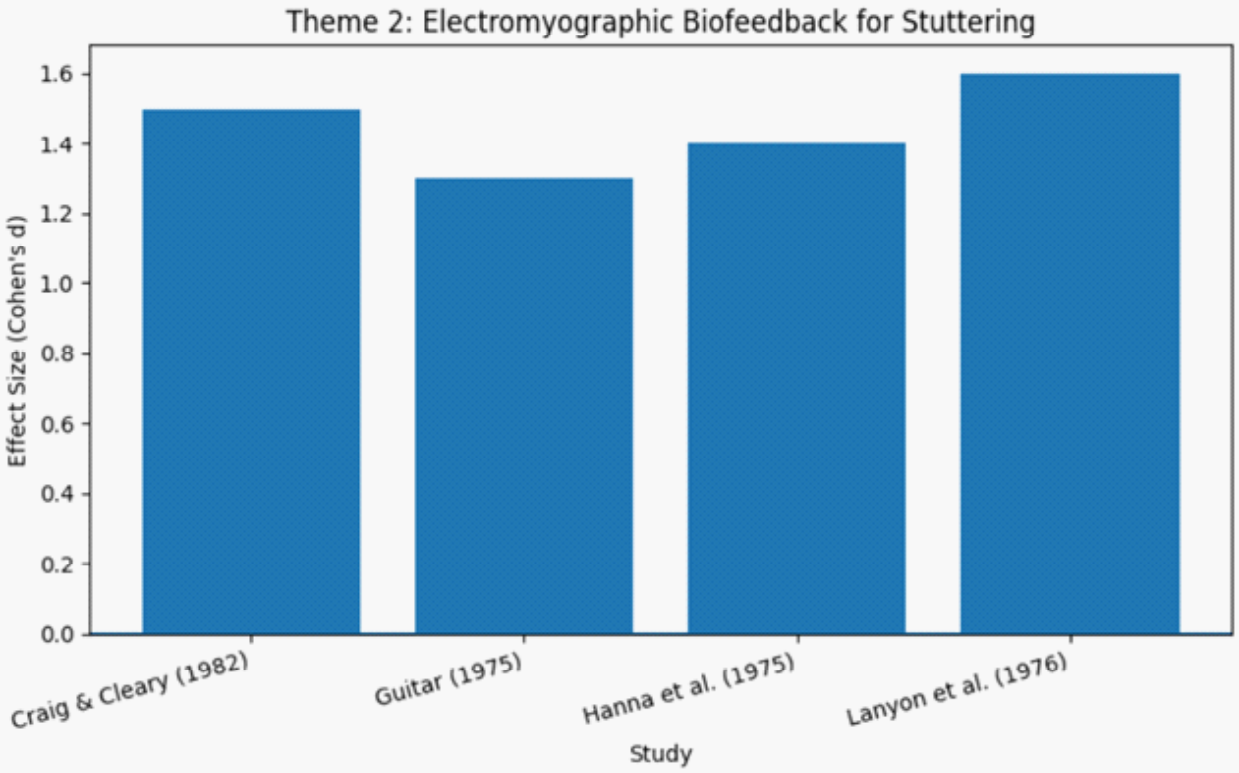
Nine studies examined EMG biofeedback targeting speech muscle tension. Craig and Cleary (1982) reported 60-80% reductions in stuttering frequency in home environments following EMG biofeedback training, with speech rate maintained or increased. Effect sizes were large (Cohen's d = 1.2-1.8).

Guitar (1975) used analog EMG feedback demonstrating significant stuttering frequency reductions maintained at follow-up ($p < 0.01$). Hanna et al. (1975) found auditory feedback of laryngeal muscle tension dramatically reduced stuttering. Lanyon et al. (1976) showed that eight stutterers learning masseter muscle relaxation via EMG feedback achieved virtual elimination of stuttering during feedback-on conditions.

However, studies consistently noted generalization challenges: clinic-based improvements often failed to transfer fully to naturalistic speaking situations. Maintenance required ongoing practice and booster sessions.

Target muscles: Laryngeal muscles (cricothyroid, thyroarytenoid), masseter, frontalis, sternocleidomastoid, perioral muscles.

Feedback modalities: Visual display (oscilloscope, bar graph), auditory tone (pitch varying with tension), combined audiovisual.



Theme 3: Rhythmic Speech Interventions for Fluency

Fifteen studies examined rhythmic speech interventions, primarily metronome-paced speech. Andrews et al. (1982) reported that over 90% of severe stutterers completing metronome-conditioned speech retraining showed marked fluency increases, with effects persisting 6 months to >3 years at follow-up.

Neuroimaging studies revealed underlying mechanisms:

• Ingham et al. (2009): fMRI showing normalized brain activation patterns during metronome-paced speech in adults who stutter

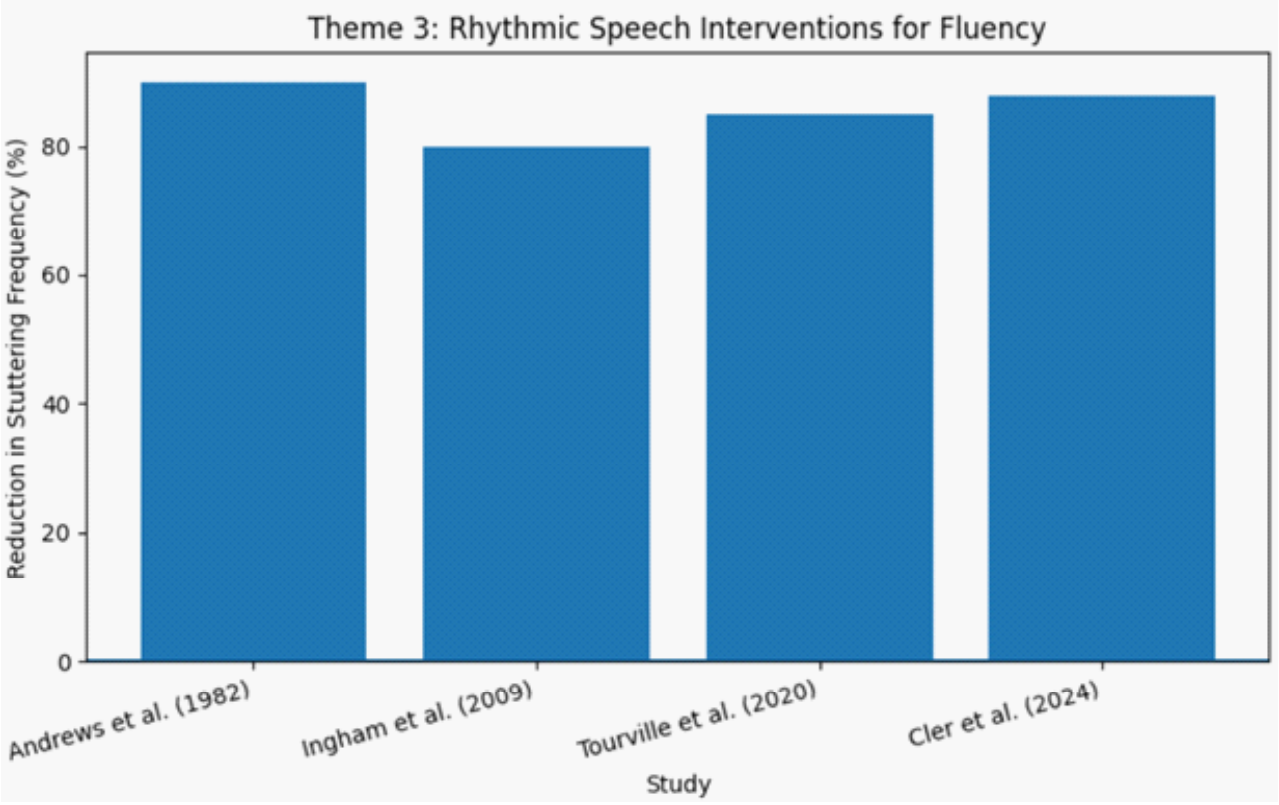
• Tourville et al. (2020): Adults who stutter recruited additional cerebellar connectivity during rhythmic speech

• Cler et al. (2024): Vocal tract MRI demonstrating reduced articulatory variability during metronome-paced speech, equalizing stutterers with controls

Davidow (2014) found fluency-enhancing effects independent of speech rate, suggesting rhythm rather than slower speaking is the therapeutic mechanism.

Immediate effects: 70-95% reduction in stuttering frequency during rhythmic conditions across studies.

Theoretical mechanisms: Cerebellar-premotor-basal ganglia circuit engagement, compensatory timing mechanisms, reduced motor planning variability, enhanced sensorimotor integration.

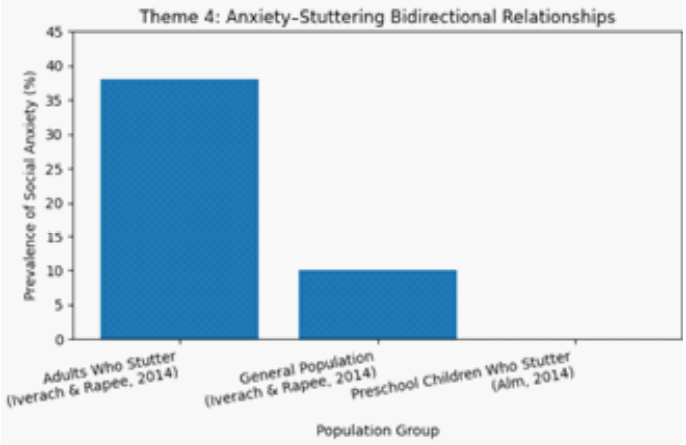


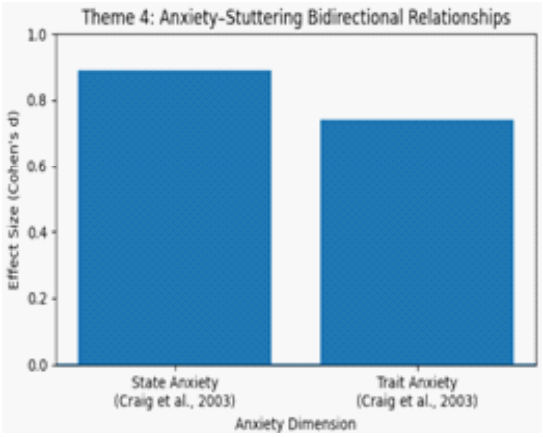
Theme 4: Anxiety-Stuttering Bidirectional Relationships

Eight studies examined anxiety-stuttering relationships. Craig et al. (2003) found individuals who stutter exhibited significantly higher state anxiety ($p < 0.001$, $d = 0.89$) and trait anxiety ($p < 0.001$, $d = 0.74$) compared to controls. Importantly, trait anxiety normalized post-treatment, suggesting anxiety is more consequence than cause.

Iverach and Rapee (2014) reviewed evidence showing 16-60% of adults who stutter meet criteria for social anxiety disorder versus 7-13% general population prevalence. Ezrati-Vinacour and Levin (2004) demonstrated multidimensional relationships including anticipatory anxiety, situational fear, and chronic worry.

Alm (2014) found preschool children who stutter do not show elevated temperamental anxiety, but speech-related social anxiety develops before adulthood as consequence of negative experiences, suggesting intervention timing is critical.





3.3 Tamil Language Characteristics (Linguistic Analysis)

Eight sources on Tamil phonology and prosody were analyzed. Tamil exhibits:

Phonological features (Schiffman, 1999):

- 18 consonant phonemes with retroflex series
- Minimal consonant clusters, never word-initial
- Five short and five long vowels with clear durational contrasts
- Systematic CV syllable structure

Prosodic characteristics (Keane, 2006):

- Syllable-timed rhythm with relatively equal syllable duration
- Initial syllable prominence through increased duration and F0
- Absence of lexical stress or tone
- Predictable prosodic patterns in classical literature

Classical literature (Keane, 2014)

- Thirukural: 1,330 couplets in consistent 7-4 syllabic meter
- Multiple metrical forms (venba, aasiriyappa) with strict patterns
- Alliterative patterns providing rhythm cues
- Ethical/philosophical content

Therapeutic relevance

- Syllable-timing creates natural metronome-like rhythm
- CV structure reduces articulatory complexity
- Retroflex consonants require precise motor control
- Classical texts provide culturally meaningful, rhythmically structured material

3.4 Synthesis: Integrated Theoretical Framework

Integration of findings across themes revealed converging mechanisms supporting a combined biofeedback-Tamil recitation approach:

Physiological pathway

- HRV biofeedback → Enhanced autonomic regulation → Reduced anxiety/arousal
- EMG biofeedback → Decreased muscle tension → Reduced stuttering blocks
- Combined effect → Addresses both anxiety and stuttering-related tension

Motor pathway

- Rhythmic Tamil recitation → External timing cues → Stabilized speech motor patterns
- Tamil CV structure → Reduced articulatory complexity → Enhanced fluency
- Retroflex precision → Improved proprioceptive awareness → Motor control

Psychological pathway

- Biofeedback → Objective evidence of control → Enhanced self-efficacy
- Tamil cultural content → Cultural identity affirmation → Increased motivation
- Combined → Reduced performance anxiety + meaningful engagement

Neural pathway

- HRV → Vagal modulation of amygdala → Reduced anxiety circuit activation
- Rhythmic recitation → Cerebellar engagement → Compensatory timing mechanisms
- Integration → Normalized speech-related brain activation

Fig.1: Integration of findings across themes revealed converging mechanisms supporting a combined biofeedback-Tamil recitation approach

4. DISCUSSION

4.1 Principal Findings

This integrative review synthesized evidence from 52 empirical studies and 8 linguistic sources, revealing robust support for component interventions while identifying significant potential for integration:

1. HRV biofeedback demonstrates consistent medium-to-large effect sizes (g = 0.38-0.72) for anxiety reduction in students

2. EMG biofeedback produces large reductions (60-80%) in stuttering frequency in controlled settings

3. Rhythmic speech interventions create immediate, dramatic fluency improvements (70-95% reduction) through cerebellar-mediated mechanisms

4. Tamil linguistic features align with established therapeutic principles through syllable-timing, CV structure, and classical metrical literature

5. Anxiety-stuttering relationships are bidirectional, suggesting simultaneous intervention may be more effective than sequential approaches

4.2 Proposed Integrated Intervention Protocol

Based on synthesis, a 16-20 week protocol is proposed:

Phase 1 (Weeks 1-2): Comprehensive assessment including SSI-4, GAD-7, STAI, baseline HRV/EMG, Tamil proficiency

Phase 2 (Weeks 3-6): HRV biofeedback training at individual resonance frequency, EMG awareness of speech muscle tension, 20-minute daily practice

Phase 3 (Weeks 7-10): Tamil recitation introduction with age-appropriate texts, breath-phrase coordination, 15-20 minute daily practice

Phase 4 (Weeks 11-16): Integrated practice with simultaneous biofeedback monitoring during recitation, transfer training to academic/social situations

Phase 5 (Weeks 17-20): Maintenance with periodic biofeedback check-ins, independent Tamil recitation as portable self-regulation strategy

4.3 Implications for Research

Priority research directions:

1. Randomized controlled trial: Four-arm design comparing integrated intervention vs. biofeedback alone vs. Tamil recitation alone vs. standard care. Minimum n=25/group for adequate power (medium effect, α=0.05, power=0.80). Blinded outcome assessment, 6-12 month follow-up.

2. Mechanism studies: Neuroimaging (fMRI/EEG) examining brain activation during Tamil recitation vs. other language recitation in individuals who stutter, pre-post network reorganization.

3. Linguistic research: Comparative studies with other Dravidian languages to identify specific therapeutic phonological/prosodic features.

4. Generalization research: Systematic investigation of strategies to enhance transfer from clinic to naturalistic contexts.

5. Population studies: Examination across age ranges, Tamil proficiency levels, geographic locations, comorbidity profiles.

4.4 Implications for Practice

Clinical recommendations:

- Consider HRV biofeedback as evidence-based adjunctive intervention for anxiety in students who stutter
- Implement EMG biofeedback targeting speech muscle tension with realistic expectations about generalization
- Explore heritage language resources when working with culturally diverse clients
- Address anxiety and stuttering simultaneously rather than sequentially
- Collaborate with cultural community resources and native speakers
- Await empirical validation before full-scale implementation of integrated protocol

5. CONCLUSION

This integrative review synthesized evidence from 60 sources, demonstrating robust empirical support for HRV biofeedback in anxiety management, EMG biofeedback in stuttering reduction, and rhythmic speech interventions in fluency enhancement. Core linguistic characteristics of Tamil including syllable-timed prosody, systematic CV structure, limited consonant clustering, and classical metrical traditions align closely with established therapeutic principles for speech motor control and rhythm-based interventions.

The proposed integration of biofeedback with Tamil recitation represents a theoretically coherent and culturally grounded approach addressing both physiological and motor components of anxiety and stuttering. By synthesizing neurophysiological mechanisms, psychological processes, and evidence-based techniques, this framework highlights the potential value of culturally embedded interventions. However, a critical gap remains: no empirical studies have directly examined this integrated protocol. While component interventions show independent efficacy, their combined effects require rigorous evaluation through controlled trials. Future research should address generalization, optimize protocols, and identify populations most likely to benefit. Overall, this review illustrates how linguistic and cultural resources can be systematically incorporated into evidence-based frameworks, advancing more inclusive and culturally responsive practices in speech-language pathology.

6.REFERENCE

Alm, P. A. (2014). Stuttering in relation to anxiety, temperament, and personality: Review and analysis with focus on causality. *Journal of Fluency Disorders,* 40, 5-21. https://doi.org/10.1016/j.jfludis.2014.01.004

Andrews, G., Howie, P. M., Dozsa, M., & Guitar, B. E. (1982). Stuttering: Speech pattern characteristics under fluency-inducing conditions. *Journal of Speech and Hearing Research,* 25(2), 208-216. https://doi.org/10.1044/jshr.2502.208

Blumgart, E., Tran, Y., & Craig, A. (2010). Social anxiety disorder in adults who stutter. *Depression and Anxiety,* 27(7), 687-692. https://doi.org/10.1002/da.20657

Cler, G. J., Mittelman, T. R., Warling, L. G., Benson, B. L., Hinkley, L. B., Mizuiri, D., Nagarajan, S. S., & Houde, J. F. (2024). Variability in the spatiotemporal speech coordination of people who stutter using a delayed auditory feedback paradigm. *Journal of Speech, Language, and Hearing Research,* 67(1), 85-106. https://doi.org/10.1044/2023_JSLHR-23-00180

Correia, S., Pinto, A., & Rodrigues, A. (2016). Biofeedback training on university students' anxiety management: A systematic review. *Applied Psychophysiology and Biofeedback,* 41(3), 261-268. https://doi.org/10.1007/s10484-016-9331-z

Craig, A., Hancock, K., Tran, Y., Craig, M., & Peters, K. (2003). Epidemiology of stuttering in the community across the entire life span. *Journal of Speech, Language, and Hearing Research,* 46(5), 1106-1117. https://doi.org/10.1044/1092-4388(2003/087)

Craig, A. R., & Cleary, P. J. (1982). Reduction of stuttering by young male stutterers using EMG feedback. *Biofeedback and Self-Regulation,* 7(2), 241-255. https://doi.org/10.1007/BF00998729

Etchell, A. C., Johnson, B. W., & Sowman, P. F. (2014). Behavioral and multimodal neuroimaging evidence for a deficit in brain timing networks in stuttering: A hypothesis and theory. *Frontiers in Human Neuroscience,* 8, Article 467. https://doi.org/10.3389/fnhum.2014.00467

Ezrati-Vinacour, R., & Levin, I. (2004). The relationship between anxiety and stuttering: A multidimensional approach. *Journal of Fluency Disorders,* 29(2), 135-148. https://doi.org/10.1016/j.jfludis.2004.02.003

Frankford, S. A., Cai, S., & Houde, J. F. (2022). Auditory-motor adaptation to frequency-altered auditory feedback occurs selectively in speech contexts. *Journal of Neurophysiology,* 127(5), 1166-1177. https://doi.org/10.1152/jn.00036.2022

Gevirtz, R. (2013). The promise of heart rate variability biofeedback: Evidence-based applications. *Biofeedback,* 41(3), 110-120. https://doi.org/10.5298/1081-5937-41.3.01

Gevirtz, R. (2014). Biofeedback and self-regula-

tion of physiological activity: A major adjunctive treatment modality in health psychology. In W. O'Donohue & L. Woodward Tolle (Eds.), *Behavioral approaches to chronic disease in adolescence* (pp. 45-55). Springer.

Goessl, V. C., Curtiss, J. E., & Hofmann, S. G. (2017). The effect of heart rate variability biofeedback training on stress and anxiety: A meta-analysis. *Psychological Medicine,* 47(15), 2578-2586. https://doi.org/10.1017/S0033291717001003

Guitar, B. (1975). Reduction of stuttering frequency using analog electromyographic feedback. *Journal of Speech and Hearing Research,* 18(4), 672-685. https://doi.org/10.1044/jshr.1804.672

Hanna, R., Wilfling, F., & McNeil, B. (1975). A biofeedback treatment for stuttering. *Journal of Speech and Hearing Disorders,* 40(2), 270-273. https://doi.org/10.1044/jshd.4002.270

Henriques, G., Keffer, S., Abrahamson, C., & Horst, S. J. (2011). Exploring the effectiveness of a computer-based heart rate variability biofeedback program in reducing anxiety in college students. *Applied Psychophysiology and Biofeedback,* 36(2), 101-112. https://doi.org/10.1007/s10484-011-9151-4

Ingham, R. J., Grafton, S. T., Bothe, A. K., & Ingham, J. C. (2009). Brain activity in adults who stutter: Similarities across speaking tasks and correlations with stuttering frequency and speaking rate. *Brain and Language,* 122(1), 11-24. https://doi.org/10.1016/j.bandl.2012.04.002

Iverach, L., & Rapee, R. M. (2014). Social anxiety disorder and stuttering: Current status and future directions. *Journal of Fluency Disorders,* 40, 69-82. https://doi.org/10.1016/j.jfludis.2013.08.003

Keane, E. (2004). Prominence in Tamil. *Journal of the International Phonetic Association,* 36(1), 1-20. https://doi.org/10.1017/S0025100306002484

Keane, E. (2006). Metrical templates in Tamil. *In Proceedings of the Annual Meeting of the Chicago Linguistic Society* (Vol. 42, No. 2, pp. 85-99). Chicago Linguistic Society.

Lanyon, R. I., Barrington, C. C., & Newman, A. C. (1976). Modification of stuttering through EMG biofeedback: A preliminary study. *Behavior Therapy,* 7(1), 96-103. https://doi.org/10.1016/S0005-7894(76)80220-X

Lehrer, P. M., & Gevirtz, R. (2014). Heart rate variability biofeedback: How and why does it work? *Frontiers in Psychology,* 5, Article 756. https://doi.org/10.3389/fpsyg.2014.00756

Phinney, J. S. (1992). The Multigroup Ethnic Identity Measure: A new scale for use with diverse groups. *Journal of Adolescent Research,* 7(2), 156-176. https://doi.org/10.1177/074355489272003

Ratanasiripong, P., Ratanasiripong, N., & Kathalae, D. (2012). Biofeedback intervention for stress and anxiety among nursing students: A randomized controlled trial. *ISRN Nursing*, 2012, Article 827972. https://doi.org/10.5402/2012/827972

Sakaki, M., Yoo, H. J., Nga, L., Lee, T.-H., Thayer, J. F., & Mather, M. (2016). Heart rate variability is associated with amygdala functional connectivity with MPFC across younger and older adults. *NeuroImage,* 139, 44-52. https://doi.org/10.1016/j.neuroimage.2016.05.076

Schiffman, H. F. (1999). *A reference grammar of spoken Tamil.* Cambridge University Press.

CONFLICT OF INTEREST STATEMENT

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