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Effect of Using Algerian Rhythmic Melodic Therapy (Algerian RMT) in its Daridja Versionon Alleviating Speech and Voice Disorders in Deaf Children: Traditional Children's Songs as a Model

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Abstract:
This study aims to illuminate the speech challenges encountered by deaf children and to evaluate the efficacy of Algerian Rhythmic Melodic Therapy in ameliorating voice disorders within their native language, Algerian Daridja. This therapeutic approach utilizes rhythmic and melodic exercises designed to assist deaf children in enhancing verbal expression and refining pronunciation. The research sample comprised five children, aged between 8 and 11 years, who were equipped with cochlear implants.
To fulfill the objectives of the study, a quasi-experimental methodology was employed, incorporating Zalal's Speech Scale (1984) and Praat software to analyze and compare the recorded vocal samples with their subsequent productions following the completion of the program. The findings indicated a marked improvement in several vocal attributes, including rhythm, pitch, intonation, and pausing. Additionally, the therapy addressed speech issues across all participants, underscoring the program's effectiveness.
Keywords: Algerian Rhythmic Melodic Therapy, Speech and Voice Disorders, Traditional Children's Songs.

Introduction

Hearing is integral to the acquisition of language and speech during the formative years of a child's development. Typically, children learn to articulate by listening to others and mimicking their speech patterns. For individuals with hearing impairments and those who are deaf, the absence of auditory input poses a significant obstacle to learning speech and retaining the properties of sounds.

The severity of hearing loss directly correlates with the severity of speech disorders. This relationship can be explained by the impact of hearing impairment on the vocal feedback loop, which encompasses three interrelated components: the articulatory aspect of sound production, the physical aspect involving the propagation of sound waves through the air due to the movement of speech organs, and the reception or perceptual aspect, which involves the vibrations corresponding to sound waves that affect the eardrum and function within the mechanics of the inner ear and auditory nerves to perceive sounds (Attiya, 1995).

Disruptions in this loop lead to impaired sound awareness, which negatively affects sound production and pronunciation due to the inability to acquire the phonemic form (Ibrahim, 2002).

Individuals with hearing impairments often encounter specific difficulties in speech production. Notably, they may omit or substitute syllables that do not serve as pauses in speech and exhibit increased nasal resonance that impacts their pronunciation. Predominantly, they rely on vowel sounds over consonants; the latter often represents higher frequencies with reduced sound intensity, making them challenging to discern and replicate.

Additionally, these individuals might extend the duration of certain syllables up to three to four times longer than in typical speech patterns, and they may substitute voiced sounds for voiceless ones or vice versa. Their capability to concatenate sounds into coherent words is compromised, leaving sounds

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isolated—a manifestation of their challenges in linking syllables and differentiating the constituent sounds of words (Hall, Oyer, & Hass, 2001).

According to Steven, Tonya, and Jennifer (2012), controlling rhythmic language aspects such as accent and intonation poses significant challenges for deaf children. O'Halpin (2001) identifies potential underlying causes for tonal issues, including limitations in the respiratory system that reduce the number of syllables per breath unit, coordination difficulties between respiratory and laryngeal muscles leading to atypical stops, and an inability to modulate the fundamental frequency towards the ends of sentences. Additionally, challenges in adjusting the duration of sounds can blur the distinction between tense and lax syllables.

The acquisition of prosodic structure by children is of paramount importance, as it plays a crucial role in various aspects of linguistic function, ranging from lexical fields to syntactic structure and emotional expression. This acquisition is therefore vital for conveying meaning and ensuring clarity in pronunciation and speech (Kent and Kim, 2008).

Based on this understanding, the problem of the study emerged, highlighting the necessity of implementing a therapeutic program that relies on effective activities and techniques to improve suprasegmental features and reduce the severity of voice and speech disorders in deaf children. Consequently, we pose the following research question: What is the impact of using the Algerian Rhythmic Melodic Therapy[1] technique, in its Daridja version (TMR Daridja)[2], on reducing the severity of speech and voice disorders in deaf children?

Sub-questions:

- What is the impact of using the Algerian Rhythmic Melodic Therapy technique, in its TMRD version, on reducing the severity of speech and voice disorders in deaf children?
- Does the Algerian Rhythmic Melodic Therapy technique, in its TMRD version, have effectiveness in improving suprasegmental features (such as rhythm, pitch, stress, and pauses) in deaf children?

To address the posed research question, we formulated the following hypotheses:

- The Algerian Rhythmic Melodic Therapy technique, in its TMRD version, has an impact on reducing the severity of speech and voice disorders in deaf children.
- The Algerian Rhythmic Melodic Therapy is effective in improving suprasegmental features in deaf children.

Study Objectives:

- Address the speech and suprasegmental issues in deaf children equipped with devices using Algerian Rhythmic Melodic Therapy (RMTD).
- Develop familiarity with Algerian Rhythmic Melodic Therapy (RMTD) by focusing on the melodic components of prosodic linguistics, particularly through a rehabilitative program that targets the syllables and phonemes in traditional Algerian children's songs.
- Enhance the melodic, intonative, and rhythmic vocal characteristics of deaf children by employing syllables and phonemes from traditional children’s songs, with an emphasis on attributes like tempo, pitch, speed, rhythm, and tone.

Study Terminology:

Technique of the Study:

Algerian Rhythmic Melodic Therapy (Algerian RMT):

This technique was introduced by Dr. AbdelatifIzemrane in 2018, specifically tailored for the Algerian clinical setting under the name ‘ThérapieMélodique et RythméeAlgérienne’. It originated from the ‘ThérapieMélodique et Rythmée’ developed in the French community in 1991 by Philippe Van

[1]Algerian Rhythmic Melodic Therapy

[2]Rhythmic Melodic Therapy in Algerian Dialect (Daridja)

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Eeckhout, a French speech therapist. This method itself was derived from the American MIT[3] technique, pioneered by Spark in 1974.
The Algerian adaptation incorporates three linguistic variants specific to the regional dialects: Classic Arabic (RMTA), Kabyle (RMTK), and Daridja (RMTD) for the Algerian colloquial dialect. The focus of this therapy is on the enhancement of the suprasegmental features of language, such as rhythm, tone, and intonation, employing a chant-like delivery. It meticulously explores the melodic components and phonemic vocal traits inherent to the specific languages studied.

Phonological Disorders:

Phonological disorders encompass any anomalies in vocal characteristics including intensity, pitch, and quality. These disorders precipitate variations in voice loudness, pitch, and timbre that are incongruent with the typical ranges expected for a given age, sex, and cultural context. In children, significant hearing impairments can lead to these vocal discrepancies, affecting the voice's loudness, pitch, and quality, and resulting in challenges with rhythm and melody.

Articulatory Disorders:

Articulatory disorders refer to challenges associated with the production of phonemes in deaf children who struggle to produce necessary speech sounds accurately. Manifestations of this disorder can include the substitution, distortion, omission, or addition of phonemes, which significantly complicates the clarity of the intended speech. These disorders may affect any or all sounds and can occur at various positions within words.

Method and Tools:

Study Methodology:

The methodology employed was a quasi-experimental approach using a single-group design, with both pre- and post-measurements to evaluate the influence of the Algerian Rhythmic Melodic Therapy on managing speech and phonological disorders. This methodological framework was chosen to meticulously assess the effects of the intervention on the specified dependent variables within the controlled study environment.

Study Sample:

The study sample consisted of five children with profound deafness, aged between 8 to 11 years. These participants were carefully selected using a simple purposive random sampling method, ensuring relevance to the study’s objectives and variables.
All children in the study had no associated cognitive or comprehension difficulties, and were devoid of any additional health, psychological, or neurological complications. Each child had an average mental capacity and had benefited from cochlear implant surgeries, optimizing their potential for auditory processing and response to the therapeutic intervention.

Table (1): Sample Characteristics

Case	Age	Gender	Type of Hearing Impairment	Educational Level	Language Used
A.G.	11 years	Female	Cochlear implant	Second grade primary	Arabic and Daridja
Z.H.	10 years	Female	Cochlear implant	Second grade primary	Arabic and Daridja
N.M.	10 years	Female	Cochlear implant	Second grade primary	Arabic and Daridja
A.S.	10 years	Male	Cochlear implant	Second grade primary	Arabic and Daridja

[3]Melodic Intonation Therapy founded by Spark in 1974

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A.W.	8 years	Male	Cochlear implant	Second grade primary	Arabic and Daridja

Research Location and Scope:
This field study was carried out at the School for Hearing-Impaired Children located in OuledDjellal, spanning a duration from February 11, 2024, to May 15, 2024. The selection of this venue was strategic, leveraging the specialized resources and environment tailored for hearing-impaired children to accurately assess the impact of the intervention.

Study Tools:

Phonetic Assessment:
The phonetic assessment employed the NasiraZalal test, formulated in 1984. This assessment tool specifically targets the isolated letters component, encompassing 27 distinct sounds. This precision allows for a detailed analysis of phonetic capabilities and challenges among the participants.

Praat Software:
Praat, a sophisticated computer program for the physical analysis of sound and speech, was developed by Paul Boersma and David Weenink at the Institute of Phonetics, University of Amsterdam. This tool is essential for capturing and analyzing the acoustic properties of speech, such as fundamental frequency, intensity, pitch, jitter, shimmer, and timbre.
In this study, Praat was utilized to record and analyze the sounds produced by deaf children during traditional children's songs, aiding in the identification and characterization of phonetic and vocal disorders.

Therapeutic Program:
The Algerian Rhythmic Melodic Therapy (ARMT) incorporates a spectrum of non-linguistic and melodic linguistic activities designed to progressively develop speech and pronunciation capabilities while addressing speech disorders. The program emphasizes enhancing the acoustic properties of sound, facilitating pronounced improvements in speech quality through structured melodic intervention.

Algerian Traditional Children’s Songs:
An illustrative example from the therapeutic program is the traditional counting song

وَاحَدْ زُوجْ زُوبيدَةثَلاثَه رَبْعَه رَبِيعَة
خَمْسَة سِتَّة سَتُوتَة سَبْعَة ثَمنيَة يَمِينَة
تِسْعَةعَشْرَة عَاشُورَة

"One, two, Zoobida; three, four, Rabia;
five, six, Sutota; seven, eight, Yamina;
nine, ten, Ashura."

The simple counting song integrates a blend of Arabic vocabulary and colloquial expressions, closely linked to names commonly found in the child’s surroundings. These numbers are sung alongside the names in rhythmically melodic segments. The human mind naturally focuses on the first word it hears, giving it greater attention. Therefore, when phrases like "Wahid Zoubeida" (one Zoubeida) or "ThalathaArbaaRabia" (three, four Rabia) are pronounced, the emphasis is placed on the number that precedes the name.
As a result, the child is more likely to concentrate on the initial words or segments, often overlooking the subsequent ones. This prioritization of numbers over names is reinforced through the repetitive singing of the song during play. This repetitive, rhythmic vocalization not only helps the child recognize phonemes through play but also enhances verbal expression by focusing on rhythm, pitch, and speed, while improving pronunciation and tonal accuracy.

Selection of Words from the Counting Song:
Initially, the responses of the deaf children to the song are observed without intervention. Their utterances are recorded with Praat and transcribed using the International Phonetic Alphabet. This

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documentation serves as a baseline for subsequent comparisons post-intervention, following the conclusion of the RMTD program.

Application of RMTD Technique on Selected Words:

The ARMT principles were meticulously applied to selected words and sound syllables from the song. This involved segmenting the words into their constituent syllables, documenting their syllabic structure, and analyzing their rhythmic and melodic composition, as demonstrated in Table (2).

This table illustrates the applied principles of the Algerian Rhythmic Melodic Therapy, showcasing the transformation in the phonetic and melodic expression of the participants:

Table (2): Represents the principles of Algerian Rhythmic Melodic Therapy

Syllables	Syllabic Writing	Syllabic Structure	Rhythmic Structure	Melodic Structure
[wa/ħed]وَاحَدْ **[zuʤ]زُوجْ** **[zu/ bi/da]زُوبيدَ**	[wa.ħed] [zuʤ] [zu. bi.da]	[cv. cvc] [cvc] [cv. cv.cv]	[ta. tan] ● ○ [tan] ○ [ta.ta.ta] ● ● ●	[ʔa.ʔen] [ʔun] [ʔu.ʔi.ʔa]
[θla/θa]ثَلاثَه **[rab/ʕa]رَبْعَه** **[ra/bi/ʕa]رَبِيعَه**	[θla.θa] [rab.ʕa] [ra.bi.ʕa]	[cvc. cv] [cvc.vc] [cv. cv. cv]	[tan.ta] ○ ● [tan. ta] ○ ● [ta.ta.ta] ● ● ●	[ʔan.ʔa] [ʔan.ʔa] [ʔa.ʔi.ʔa]
[χam/sa]خَمْسَه **[sit/ta]سِتَّه** **[sa/ tu/ta]سَتُوتَه**	[χam.sa] [sit.ta] [sa. tu.ta]	[cvc. vc] [cvc.vc] [cv. cv. cv]	[tan.ta] ○ ● [tan. ta] ○ ● [ta.ta.ta] ● ● ●	[ʔan.ʔa] [ʔin.ʔa] [ʔa.ʔu.ʔa]
[sab/ʕa]سَبْعَه **[θa/man/ja]ثَمَنيَه** **[ja/mi/na]يَمِينَه**	[sab.ʕa] [θa.man. ja] [ja. mi.na]	[cvc.vc] [cv. cvc.cv] [cv.cv.cv]	[tan. ta] ○ ● [ta. tan. ta] ● ○ ● [ta.ta.ta]	[ʔan.ʔa] [ʔa.ʔan.ʔa] [ʔa.ʔi.ʔa]
[tis/ʕa]تِسْعَه **[ʕaʃ/ ra]عَشْرَه** **[ʕa/ʃu/ra]عَاشُورَه**	[tis. ʕa] [ʕaʃ. ra] [ʕa.ʃu.ra]	[cvc.vc] [cvc .vc] [cv.cv.cv]	[tan ta] ● ● ● ○ ● [tan.ta] ○ ● [ta.ta.ta] ● ● ●	[ʔin.ʔa] [ʔan. ʔa] [ʔa.ʔu.ʔa]

Course of Sessions:

The therapeutic program was structured over a period of four months, comprising an average of three sessions per week, with each session lasting approximately 25 to 30 minutes.

- **Individual Sessions:** Each child engaged in rhythmic and melodic exercises by listening twice to the productions within the children's counting song. Following the listening phase, the child was prompted to repeat and practice the sounds and melodies, reinforcing their learning through repetition and auditory feedback.
- **Second Individual Session:** Training progressed from simple monosyllabic words to more complex bisyllabic and trisyllabic words. This session incorporated physical movements and gestures to enhance the integration of melody and rhythm, facilitating a multisensory learning experience.
- **Group Session:** The children participated in group exercises that involved sentence training through play. They formed a circle, which encouraged a communal learning environment where they could familiarize themselves with the numbers by repetitively singing the counting song, thus reinforcing their phonetic and rhythmic skills.

Results and Discussion:

Presentation and Analysis of Results:

Presentation of Results:

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Table (3): Results of Isolated Sounds Before and After the Application of the Therapeutic Program

	Category / Cases	Labial	Labio dental	Dental	Alveolar	Postal veolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
		[w]و [b]ب [m]م	[f]ف	[θ]ث [ð]ذ [ðˤ]ظ	[t] ،ت[s] س [z]،ز[tˤ]ط [d] ،د[dˤ]ض [sˤ]ص	[l]ل [r]ر [n]ن [ṛ]	[ʃ]ش [ğ]ج [j]ي	[x]خ [g]ق [ɣ]غ][kك	[q]ق	[ħ] ح [ʕˤ]ع	[h]ه [ʔ]ء
Before	Case 1	0%	%100	%50	%85.71	%25	%50	%50	%100	%100	%0
	Case 2	%0	%0	%100	%71.42	%25	%50	75	%100	%50	%0
	Case 3	%33.33	%100	%100	%57.14	%25	%75	%50	%100	%100	%100
	Case 4	%0	%0	%100	%71.42	%50	%75	75	%100	%100	%0
	Case 5	%0	%0	%50	%71.42	%25	%50	%0	%0	%0	%0
After	Case 1	0%	0%	0%	%14.28	0%	0%	%25	%100	0%	0%
	Case 2	0%	0%	0%	0%	0%	0%	%25	%100	%50	0%
	Case 3	0%	0%	0%	%14.28	0%	0%	0%	%100	%50	0%
	Case 4	0%	0%	0%	0%	0%	0%	%25	%100	%50	0%
	Case 5	0%	0%	0%	%28.57	%25	0%	0%	0%	0%	0%

Results of Sound Analysis for Cases:

- **Case 1 (A.G.):**

Table (4): Results of Physical Properties of Sound for Case 1 Before and After theApplication of the Therapeutic Program

Physical Properties / Word	Post-Evaluation					Post-Evaluation				
	Pitch HZ	Intensitiy dB	Jitter %	Shimmer %	Effect of Noise on Pitch	Pitch HZ	Intensitiy %	Jitter %	Shimmer%	Effect of Noise on Pitch
Waħed	233.34	48.21	3.61	18.11	9.85	267.82	74.63	2.25	13.81	10.54
zudʒ	243.28	57.63	1.83	13.43	9.01	302.42	75.68	1.43	10.99	12.89
θla.θa	285.45	61.65	2.32	17.01	8.52	301.80	76.52	1.72	10.66	10.00
rabʕa	270.92	61.90	2.15	10.72	11.43	302.80	80.41	0.92	9.80	11.64
Xamsa	216.67	57.94	3.38	15.85	11.67	258.32	75.39	3.27	10.58	12.52
Sitta	265.73	60.25	3.25	16.40	10.48	238.65	71.64	1.52	13.15	12.72
sabʕa	281.97	60.88	2.82	18.37	8.93	237.12	75.10	1.98	9.97	10.05
Θamanja	283.26	61.65	1.98	10.96	8.72	296.48	75.29	1.09	10.91	11.95
tisʕa	282.99	64.65	1.83	12.14	11.34	313.59	73.68	1.01	10.78	11.86
ʕaʃra	279.08	67.47	1.77	7.27	10.60	315.95	80.01	1.04	7.07	15.32

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- **Case 2 (Z.H.):**

Table (5): Results of Physical Properties of Sound for Case 2 Before and After the Application of the Therapeutic Program

Physical Properties / Word	Post-Evaluation					Post-Evaluation				
	Pitch HZ	Intensity dB	Jitter %	Shimmer %	Effect of Noise on Pitch	Pitch HZ	Intensity %	Jitter %	Shimmer %	Effect of Noise on Pitch
Waħed	598.50	69.40	3.21	7.91	10.00	591.07	87.15	1.00	5.90	14.69
zudʒ	541.40	65.71	2.23	10.96	7.77	601.00	86.82	1.67	5.75	8.58
Θlaθa	550.76	70.95	2.59	9.53	11.51	530.78	84.79	1.58	6.04	15.79
rabʕa	485.38	62.86	2.18	12.12	10.01	545.35	88.38	2.12	7.75	10.92
Xamsa	496.70	64.80	2.84	10.23	11.16	544.65	84.26	1.73	5.85	14.08
Sitta	359.03	63.54	3.45	9.73	8.31	408.51	85.57	3.01	3.78	10.95
sabʕa	396.20	57.19	2.57	13.29	6.59	574.77	84.81	2.29	8.57	9.74
Θamanja	413.60	60.83	3.57	9.94	7.21	473.13	86.72	2.41	7.95	12.67
tisʕa	384.51	63.03	5.17	15.38	10.68	443.91	78.46	0.92	5.88	11.89
ʕaʃra	387.55	63.80	2.81	12.18	7.65	552.80	75.17	1.09	9.42	9.78

Case 3 (N.M.):

Table (6): Results of Physical Properties of Sound for Case 3 Before and After the Application of the Therapeutic Program

Physical Properties / Word	Post-Evaluation					Post-Evaluation				
	Pitch HZ	Intensity dB	Jitter %	Shimmer %	Effect of Noise on Pitch	Pitch HZ	Intensity %	Jitter %	Shimmer %	Effect of Noise on Pitch
Waħed	473.54	61.34	1.26	11.15	7.43	470.97	85.09	1.05	9.53	18.62
zudʒ	448.61	59.56	1.46	9.29	8.99	546.86	83.80	0.65	8.82	14.65
Θlaθa	462.44	57.93	2.45	10.4	7.35	426.30	84.23	1.83	9.42	11.78
rabʕa	428.29	67.70	1.40	4.99	10.70	501.69	84.70	0.98	4.34	18.85
Xamsa	424.77	57.98	3.10	12.32	9.62	445.42	76.94	1.40	11.36	11.18
Sitta	223.41	55.96	2.49	14.77	8.08	466.55	77.49	1.78	14.18	10.92
sabʕa	286.21	53.96	5.33	11.38	8.33	479.86	82.18	1.11	14.58	8.80
Θamanja	386.56	54.67	5.45	21.06	6.72	468.72	80.07	2.06	10.68	9.90
tisʕa	452.44	60.16	2.33	10.94	6.30	498.66	84.34	1.20	8.87	14.41
ʕaʃra	236.13	58.53	3.64	23.03	11.11	465.02	81.05	2.38	11.78	11.11

Case 4 (A.S.):

Table (7): Results of Physical Properties of Sound for Case 4 Before and After the Application of the Therapeutic Program

Physical Properties / Word	Post-Evaluation					Post-Evaluation				
	Pitch HZ	Intensity dB	Jitter %	Shimmer %	Effect of Noise on Pitch	Pitch HZ	Intensity %	Jitter %	Shimmer %	Effect of Noise on Pitch

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Waħed	634.55	69.28	2.74	17.55	9.41	493.36	75.79	1.80	7.06	11.52
zudʒ	661.02	67.62	2.29	13.64	7.68	445.54	70.24	1.09	6.87	9.73
Θlaθa	251.27	56.98	2.83	17.46	5.86	437.71	78.06	1.05	11.10	11.58
rabʕa	605.16	64.74	2.75	13.26	8.42	431.09	72.56	1.15	8.73	10.41
Xamsa	71.93	58.44	8.67	15.24	8.41	452.71	73.30	3.00	14.08	10.07
Sitta	678.88	67.12	2.79	13.69	7.24	495.59	82.24	2.74	12.76	10.66
sabʕa	589.08	59.73	2.92	16.28	6.45	432.94	75.82	1.23	11.05	10.00
Θamanja	661.33	60.59	3.20	11.96	5.34	411.47	71.27	1.89	9.75	10.74
tisʕa	640.82	58.05	2.39	16.09	3.29	428.71	80.00	1.03	15.19	11.78
ʕaʃra	576.44	61.92	2.53	14.12	7.52	467.89	75.15	1.04	8.83	13.96

Case 5 (A.W.):

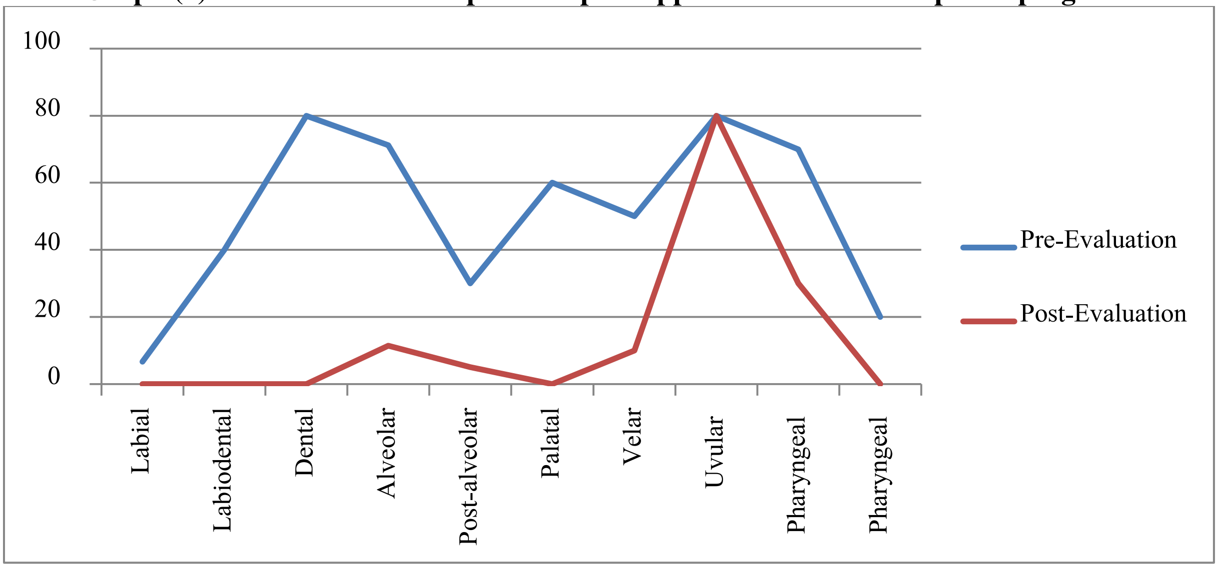
Table (8): Results of Physical Properties of Sound for Case 5 Before and After the Application of the Therapeutic Program

Physical Properties / Word	Post-Evaluation					Post-Evaluation				
	Pitch HZ	Intensity dB	Jitter %	Shimmer %	Effect of Noise on Pitch	Pitch HZ	Intensity %	Jitter %	Shimmer %	Effect of Noise on Pitch
Waħed	211.84	52.46	1.43	16.12	8.76	234.16	70.31	1.20	14.71	9.27
zudʒ	201.31	55.20	2.38	18.06	8.49	241.42	74.88	1.39	10.67	8.79
Θlaθa	211.29	54.73	3.42	18.08	6.61	234.67	77.97	2.12	13.21	8.53
rabʕa	180.15	53.93	3.06	17.52	6,40	218.92	77.99	1.16	13.87	11.89
Xamsa	191.74	57.01	3.65	27.02	5.98	200.43	75.13	3.27	17.46	8.68
Sitta	193.28	50.20	2.90	34.54	8.65	303.80	54.58	2.70	30.80	9.66
sabʕa	199.93	53.39	4.12	20.91	7.76	206.50	72.68	3.05	14.51	9.68
Θamanja	196.12	54.85	2.02	19.34	8.72	228.89	75.91	1.96	10.84	12.25
tisʕa	209.29	46.01	4.43	27.73	6.69	232.72	74.38	3.11	15.58	7.36
ʕaʃra	202.92	56.49	2.65	20.64	6.97	217.14	72.36	1.90	14.35	10.98

Analysis of Results:

Sound Analysis:

Graph (1): Phonetic outcomes pre- and post-application of the therapeutic program.



There was a pronounced enhancement in explosive and recurring sounds such as [b], [t], [d], [r], and nasal (velar) sounds [n], [m]. As Asp (2006) notes, the rhythmic structure of the therapy aids significantly in articulating these sounds due to their phonetic and auditory characteristics.

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In contrast, most cases demonstrated no improvement in uvular sounds [q]. This lack of progress can be attributed to the inherent difficulty of these sounds and the limitations of the speech apparatus in handling them effectively.

Fricative sounds [x], [ħ], [ɣ], [z], [sˤ] also posed challenges, with several casesunable to produce these sounds accurately. The difficulty in articulating these sounds is often related to their complex formation at the vocal tract's constricted regions.

Analysis of Physical Properties:

- **Pitch (Hz):**

The fundamental frequency for a typical child's voice ranges from 400 to 600 Hz. In this study, initial frequency values for Case 1 ranged from 216 to 285 Hz. Post-therapy, there was a noticeable increase, with values ranging from 237 to 315 Hz, indicating an effective adjustment towards normal frequency levels across all cases.

- **Intensity (dB):**

The typical intensity for a normal voice is around 80 dB or higher. Pre-treatment intensity levels for Case 1 were below this normal range, at 48.21 to 67.47 dB. However, post-treatment intensities improved significantly, reaching 71.64 to 80.41 dB. This pattern of improvement was consistent across Cases 2 through 5, with all cases showing increased intensity levels post-treatment, thereby moving closer to the normal intensity range.

- **Jitter (%):**

Higher jitter percentages, exceeding 1.04%, generally indicate potential voice instability. Pre-treatment, Case 1 exhibited jitter percentages ranging from 1.83 to 3.61%, suggesting notable voice instability. However, post-treatment measurements showed a reduction in jitter, with percentages ranging from 0.92 to 3.27%. This improvement was consistent across all cases, reflecting a substantial decrease in voice instability.

- **Shimmer (%):**

Initially, Case 1 displayed shimmer percentages between 7.27 to 18.37%, significantly higher than the normal reference value of less than 3.84%. Post-treatment, shimmer values improved, ranging from 7.07 to 13.81%. While still above the normal reference values, the decrease in shimmer percentages across all cases indicates an improvement in voice quality, albeit not fully normalized.

- **Degree of Noise Impact on Tones:**

Results displaying 20 dB or higher are indicative of a well-defined vocal character, signaling complete vocal cord closure during phonation, which prevents any air leakage. Values between 10-20 dB suggest moderate vocal disruption, while measures less than 10 dB highlight significant disruptions in vocal closure.

For instance, in Case 1, noise impact levels were initially measured between 8.72 and 11.67 dB pre-treatment, indicating substantial vocal disruption due to inadequate vocal cord closure. Post-treatment improvements were significant, with measures increasing to between 10.05 and 15.32 dB, denoting enhanced vocal cord function and reduced air leakage.

- **Variability in Fundamental Frequency:**

The pre-treatment observations revealed variations across cases in fundamental frequency, where higher pitches were associated with a loud and sharp vocal quality. Conversely, a lower pitch often indicated poor control over the vocal cords, manifesting in a whispered tone and evident air leakage.

Notably, Case 1 and Case 5 were characterized by whispered and very low voice qualities, respectively. Cases 5 and 3 exhibited low voice intensities, reflective of weak voice production due to insufficient air volume from the lungs during phonation.

Case 2 displayed a relatively louder and sharper vocal quality but suffered from rapid speech flow, contributing to a less clear articulation. Case 4 was notable for its nasalization, where sharp tones were predominantly nasal, indicating that air was passing through the nasal passages during phonation instead of being projected through the mouth.

Articulatory Disorders:

The study identified frequent occurrences of sound substitutions across the participant cases, where children replaced a target sound with another from their phonemic inventory, often similar in place or manner of articulation. This substitution impacted the semantic integrity of spoken words.

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For example, in Case 5, the pharyngeal sound [ħ] was substituted with [h] in the pronunciation of "waħed," resulting in [wahed]. This substitution involved similar articulatory features but differed in the fricative nature of [ħ] versus the whisper-like quality of [h]. In Case 2, the sound [l] was replaced with [n] in "θlaθa," pronounced as [θnaθa], and in "sabʕa," the sound [s] was replaced with [θ] to produce "θabʕa," both involving changes in the constriction of the air passage, which affects fricative sound production.

Deletion phenomena were also noted; for instance, Case 1 exhibited deletion of the sound [r] in "rabʕa," pronounced as [abʕa]. Furthermore, distortions in articulation were observed, such as in "ʕaʃra" where the sound [r] was unusually produced by raising the back of the tongue towards the soft palate rather than from the alveolar ridge. Case 4 showed an increase in nasalization in the sounds [n] and [m] in the word "θamanja," indicating a deviation from typical articulatory patterns.

Syllabic Structures:

Before treatment, some cases demonstrated difficulty with closed syllables and also exhibited deletions of syllable segments either at the beginning or end of words. For example, Case 1 had difficulty pronouncing the word "zuʤ" (zooj) and omitted the last syllable of the word "wa.ħed" (wahed).

Similarly, Case 4 omitted the final syllable "sa" from the word "χam.sa" (khamsa) and the initial syllable "tis" from the word "tis.ʕa" (tis'a) due to the inability to pronounce sibilant phonemes, as noted by Al-Zarikat (2005). He pointed out that children with hearing impairments often find it challenging to pronounce closed syllables, which require effort to maintain the sound of the final consonant, as these are typically characterized by ending in one or more consonants.

They also struggle to acquire the beginnings and ends of words, with examples of such syllabic structures in colloquial language including cvc (e.g., "aya"), cvvc (e.g., "shoof"), and cvcc (e.g., "la'ab").

Results Discussion:

The pre-treatment evaluations, anchored in objective phonetic assessments facilitated by Praat software and rigorous speech scale analysis, uncovered a spectrum of speech disorders across the cases. These disorders predominantly affected linguistic sounds that demand precise auditory feedback, such as whispered and pharyngeal sounds. The children exhibited difficulty in identifying the correct articulatory positions and characteristics for these sounds, often failing to recognize and accurately pronounce them.

This challenge was compounded by a generalized lack of control over vocal qualities, with some cases inadvertently whispering sounds that should have been voiced, and vice versa. Additionally, a marked decrease in auditory efficiency was noted, particularly affecting the pronunciation of final syllables—a trend that escalated the propensity for errors as the complexity of the syllabic structure increased.

The presence of numerous vocal disorders was also a significant finding, characterized by a lack of rhythm and melody in speech. This issue was often linked to a slow speech tempo, a symptom of difficulty in controlling speech organs. Lyxell et al. (2009) echoed these observations in their comparative study on intonation production among children with cochlear implants and those with normal hearing, noting that children with implants tended to score lower on intonation production scales.

Variations in fundamental frequency (f0) from one case to another were prominent, with Perrin (1999) attributing such deficiencies to inadequate speech production monitoring, which can adversely affect voice frequency, intensity, and duration. These challenges are particularly pronounced when producing high-frequency vowel sounds and can be exacerbated by laryngeal muscle tension, further weakening the fundamental frequency.

All cases demonstrated issues at the level of intensity and vocal character. Lenden and Flipsen (2007) identified similar suprasegmental and vocal characteristics challenges in their study, which assessed conversational and narrative speech among children with cochlear implants. They highlighted significant issues related to voice rate, pitch, laryngeal quality, resonance quality, and pitch level.

Additionally, some cases exhibited disturbances in voice timbre, leading to excessive nasal resonance—a prevalent issue among the hearing impaired and deaf. This is often due to an inability to control movements of the soft palate, which separates the nasal and oral cavities, or due to the tongue being positioned towards the back of the mouth, causing resonance issues.

Despite these challenges, the post-treatment outcomes demonstrated significant improvements. The application of Algerian Rhythmic Melodic Therapy (RMTD version) yielded positive results across all cases. Variations in children's performance before and after the program could be attributed to differences in their exposure to early orthophonic rehabilitation and voice therapy.

Obenchain (2000) suggested that certain pre-linguistic vocal behaviors, such as the use of meaningful gestures with vocalizations, vocal fluency, vocabulary size, and the production of syllables containing one or more consonants, could be crucial for the early development of spoken language and contribute significantly to speech clarity. This underscores the potential of early intervention and specialized therapeutic approaches like the RMTD to enhance communicative abilities in children with cochlear implants.

Conclusion:

The Algerian Rhythmic Melodic Therapy (Algerian RMT), particularly its RMTD variant, has demonstrated significant effectiveness in enhancing the suprasegmental features of speech—such as rhythm, pitch, intonation, and pause—in deaf children. The structured rhythmic exercises have played a crucial role in improving vocal production and control.

These exercises not only enhanced the intensity and pitch of the children's voices but also their ability to manage rhythm and melody, which are critical in speech production. Moreover, these exercises have been instrumental in improving speech tempo, thereby aiding the children in understanding concepts related to speed and duration of speech sounds.

The therapy's melodic verbal exercises have significantly improved the children's pronunciation skills, particularly in the articulation of letter sounds and syllable segmentation. This has led to a more organized internal structure of words, effectively reducing the severity of speech and phonological disorders. Additionally, the incorporation of kinesthetic rhythms and gestures, including hand movements and facial expressions synchronized with the traditional children's counting song, has made vocal segments more distinct and easier to acquire for the children.

This therapeutic approach aligns with Renard's (1976) findings, which suggest that the integration of hand exercises with rhythmic movements not only increases creative activity but also enhances the rhythmic value and phonological sequencing.

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