RESEARCH ARTICLE

The Role of François Le Huche's Vocal Training in Improving the Physical Characteristics of the Voice in Individuals with Vocal Fold Nodules

Bentalbi Lynda

Doctor

Abou El Kacem Saadallah University – Algiers 2, Faculty of Social Sciences, Department of Speech and Language Therapy

Algeria

Email Id: lynda.bentalbi@univ-alger2.dz

Doi Serial https://doi.org/10.56334/sei/8.8.35

Keywords Vocal fold nodules – Vocal training – Physical characteristics of voice – PRAAT software.

Abstract

This study aims to explore the role of François Le Huche's vocal training method in improving the physical characteristics of the voice in individuals with vocal fold nodules a functional voice disorder that affects vocal performance in terms of intensity, frequency, and timbre. The researcher adopted a descriptive methodology using the case study approach. The sample included six cases divided into three groups: healthy individuals, individuals who underwent vocal training, and individuals who received no orthophonic intervention. Various tools were used, including interviews, observation, vocal assessments, and the PRAAT software for analyzing voice samples.

The results revealed similarities in vocal characteristics between the treated cases and the healthy ones, while the untreated cases showed significant vocal deterioration. The study confirmed the effectiveness of François Le Huche's vocal training in enhancing vocal physical properties particularly in intensity regulation, frequency stability, and timbre clarity thus supporting the study's hypotheses and affirming the importance of orthophonic intervention in voice rehabilitation.

Citation

Lynda B. (2025). The Role of François Le Huche's Vocal Training in Improving the Physical Characteristics of the Voice in Individuals with Vocal Fold Nodules. *Science, Education and Innovations in the Context of Modern Problems*, 8(8), 362-377; doi:10.56352/sei/8.8.35. https://imcra-az.org/archive/375-science-education-and-innovations-in-the-context-of-modern-problems-issue-8-vol-8-2025.html

Received: 11.01.2025 | Accepted: 02.04.2025 | Published: 25.06.2025 (available online)

Introduction:

The voice is a primary tool of human communication and a central element of social interaction. However, it can be affected by disorders that hinder its functional use, such as "vocal fold nodules," which are classified as functional voice disorders. This condition results from excessive and improper voice use, leading to changes in its physical characteristics such as intensity, frequency, and timbre. The growing prevalence of voice disorders has prompted the search for effective

therapeutic solutions, among which vocal training under the supervision of a speech-language pathologist stands out. The approach developed by François Le Huche is one of the therapeutic methods that has garnered significant attention due to its impact on restoring voice quality.

This study, therefore, aims to shed light on the importance of this vocal training and its role in improving vocal performance in individuals with vocal fold nodules. It does so by comparing cases that received orthophonic care with those that did not, based on an objective analysis of vocal characteristics using PRAAT software.

1. Research Problem:

The voice is the raw material from which spoken language is formed, and it constitutes a core component of human identity. It accompanies an individual from the moment of birth to death, with crying being the first vocal function performed by a newborn. Proper vocal function depends on the integration of the vocal organs and the mechanisms responsible for sound production. These mechanisms vary from person to person, both in terms of anatomical structure and vocal performance. However, in some individuals, this function may be impaired due to various factors that lead to voice disorders, negatively affecting the physical characteristics of the voice and altering its quality and nature.

A person's ability to produce sound depends on the integrity of the systems involved in this complex function. Accordingly, voice disorders have garnered increasing attention due to the communication challenges they create and the potential psychological effects, such as feelings of inadequacy or social embarrassment. These disorders are defined as dysfunctions in vocal behavior that lead to changes in voice quality, pitch, tone, or any other aspect of vocal performance. Such dysfunctions may stem from organic causes or may be the result of functional impairments in the operation of the vocal folds or the glottis, which should ideally be narrow enough to prevent air leakage except under appropriate pressure for sound production and normal speech (Allali & Le Huche, 1990, p. 42).

Vocal injury directly affects the physical characteristics of the voice, causing changes in intensity, frequency, or tonal quality (timbre). Le Huche described this type of disorder as a corruption of one or more physical voice traits, resulting from disorganized recognition and use of the voice (Allali & Le Huche, 1990, p. 71).

Intensity is the attribute that gives the voice its strength or weakness and is generally linked to the muscular energy of the speech organs and subglottic pressure; the greater the pressure and energy, the wider the range of sound waves (Al-Abidin, 2016, p. 07). Audibly, intensity can be perceived in terms of loudness how high or low a sound seems. Excessively loud speech may indicate a vocal disorder (Amayra & Al-Nadhour, 2012, p. 184).

Timbre, on the other hand, is the feature that distinguishes one voice from another. It is influenced by how the vocal folds meet and by the anatomical features of the supraglottic cavities that modulate the laryngeal sound (Houla, 2007, p. 76). Frequency refers to the number of vocal fold vibrations per second. A complete vibration cycle begins at an original point and returns to it, encompassing the duration of contact, separation, and recontact between the folds (Al-Anani, 2007, p. 125).

These physical characteristics are primary indicators affected when a voice disorder occurs. Functional voice disorders are defined as impairments in vocal motor performance that arise in the absence of any apparent organic cause. They are often due to improper voice use, such as excessive shouting or speaking during inhalation, which can strain the voice and lead to pathological symptoms (Rondal & Seron, 2003, p. 439).

One of the most common and significant of these functional voice disorders is vocal fold nodules, which present as swelling (a slight bulge) on one or both vocal folds. These nodules develop progressively due to vocal fatigue and prevent full closure of the folds during phonation (Akroun, 2019, p. 21).

The vocal strain associated with functional disorders, particularly nodules, results from repeated and excessive pressure on the vocal folds. This strain leads to the formation of the nodules, which in turn hinder full glottal closure, allowing air to leak and altering the physical characteristics of the voice. In an effort to maintain voice quality, affected individuals often

increase their vocal intensity, further exacerbating the condition and creating a vicious cycle of chronic vocal strain. Nodules can vary in form, location, and size.

Such disorders clearly require multifaceted therapeutic intervention whether pharmacological, surgical, or functional. Herein lies the importance of the speech-language pathologist's therapeutic role in conducting voice rehabilitation through precise voice assessment and the development of individualized treatment plans aimed at restoring natural vocal properties. Vocal training consists of a series of therapeutic exercises guided by the speech therapist, designed to progressively restore proper vocal performance (Rekza, 2018, p. 66).

In this context, various scientific studies have examined the effectiveness of different vocal therapy approaches and their impact on the physical characteristics of the voice, particularly in individuals suffering from hoarseness or vocal nodules.

In a study conducted by Imededdine Bousahel (2018), titled *The Effectiveness of the VOCALAB Program in Improving Voice Characteristics in Patients with Hoarseness*, a sample of eight individuals aged 31 to 49 was studied. The sample included three patients with vocal nodules, one with a mucosal polyp, and four with recurrent laryngeal nerve paralysis. The VOCALAB program was used alongside classical therapy techniques. The results showed positive differences between pre- and post-treatment assessments in both the control and experimental groups, indicating the program's effectiveness in enhancing voice quality.

Another study, *Hoarseness: Causes and Treatments* by Thomas Karl Hoffmann, Rudolf Reiter, and others (2015), found that 80% of patients with voice disorders regained their normal voices solely through voice therapy. The study also noted that men particularly smokers are most susceptible to vocal nodules, with an incidence rate of 55%.

The study *Etude de cas de voix dans le cadre de la prise en charge orthophonique* by Etienne Sicard and speech therapist Anne Menin-Sicard (2021) focused on a group of patients undergoing orthophonic rehabilitation due to voice disorders, including three with vocal nodules. The results showed clear improvement in vocal characteristics following vocal training, although full recovery was not always achieved, highlighting the importance of consistent therapy sessions.

In another context, Samir Feni (2020) conducted a study titled *Effectiveness of the Melodic Verbal Method in Improving the Physical Characteristics of Voice in Children with Cochlear Implants*, involving a sample of eight children aged 5 to 6 divided into experimental and control groups. Using PRAAT software, the results indicated greater improvement in the experimental group, confirming the method's effectiveness.

Also noteworthy is Safia Tensawt's (2020) study, *The Physical Analysis of the Speech of a Child with Functional Hoarseness in an Algerian Hospital Setting*, which examined four cases of functional hoarseness three due to bilateral nodules. Using PRAAT software and structured interviews, the researcher concluded that bilateral nodules hinder vocal fold vibration and negatively affect fundamental frequency and voice quality. It was also found that voice intensity and duration varied depending on the severity of the condition and the patient's control over breathing and phonation.

The choice of this research topic was not random; it stemmed from a deep personal interest in the field of voice and its various disorders particularly vocal nodules. One of the main goals of this study was to understand the physical changes in the voice among individuals with functional voice disorders, with a focus on comparing vocal characteristics between those who underwent vocal training and those who did not, using a healthy voice case as a reference for comparison.

Thus, the study aims to deepen understanding of the effectiveness of orthophonic intervention in restoring natural vocal characteristics and improving communicative quality of life for affected individuals, through the following research question:

Does François Le Huche's vocal training contribute to improving the physical characteristics of the voice in individuals with vocal fold nodules?

Sub-questions:

1. Does François Le Huche's vocal training play a role in improving vocal intensity in individuals with vocal fold nodules?
2. Does François Le Huche's vocal training play a role in improving vocal frequency in individuals with vocal fold nodules?
3. Does François Le Huche's vocal training play a role in improving vocal timbre in individuals with vocal fold nodules?

2. Study Hypotheses:

Main Hypothesis:

François Le Huche's vocal training plays a role in improving the physical characteristics of the voice in individuals with vocal fold nodules.

Sub-Hypotheses:

1. François Le Huche's vocal training plays a role in improving vocal intensity in individuals with vocal fold nodules.
2. François Le Huche's vocal training plays a role in improving vocal frequency in individuals with vocal fold nodules.
3. François Le Huche's vocal training plays a role in improving vocal timbre in individuals with vocal fold nodules.

3. Definition of Terms:

1. **Physical Characteristics of Voice:**

   These are the attributes that determine how we perceive and understand sound. In this study, the physical characteristics include **intensity**, **frequency**, and **timbre**.

2. **Vocal Training:**

   A set of exercises and techniques aimed at improving impaired vocal capabilities. This study specifically uses **François Le Huche's vocal training** approach.

3. **Vocal Fold Nodules:**

   Defined in this study as the formation of a thickening or small mass on the vocal folds, typically bilateral in nature, which impairs their ability to vibrate fully and harmoniously. This results in disturbances in the physical characteristics of the voice such as **frequency**, **intensity**, and **timbre** and is assessed using speech analysis via **PRAAT** software.

4. Research Methodology:

This study adopted a descriptive case study approach, chosen for its suitability to the nature of the topic and the study's objectives. This methodology is characterized by its ability to analyze phenomena as they exist in reality through precise and comprehensive description, combining both quantitative and qualitative dimensions.

Since the goal of this study is to explore the role of vocal training in improving the physical characteristics of the voice in individuals with vocal fold nodules, and to compare them with unaffected individuals, the descriptive method is considered the most appropriate. It allows for in-depth and holistic examination of the studied cases, with focus on medical history, vocal features, and individual capacities, thereby contributing to a scientifically accurate analysis of the variables involved.

5. Study Group:

Given that the topic revolves around the role of **François Le Huche's vocal training** in improving the physical characteristics of the voice in individuals with functional voice disorders specifically vocal fold nodules a purposive sample of **six cases** was selected to allow comparison based on the presence of the disorder and whether vocal training was received.

The sample was divided into three groups:

- ✓ **Group 1:** Two individuals (one male and one female) without any functional voice disorders, serving as the reference group with healthy voices.
- ✓ **Group 2:** Two individuals (one male and one female) diagnosed with single or bilateral vocal fold nodules, who underwent vocal training sessions.
- ✓ **Group 3:** Two individuals (one male and one female) also diagnosed with single or bilateral vocal fold nodules, who did **not** undergo any vocal training.

The following table presents the general characteristics of the study group:

Table (01): Characteristics of the Study Group

Case	Code Name	Age (Years)	Gender	Diagnosis	Voice Training
First	M.T.	55	Male	No disorder	No
Second	T.H.	22	Female	No disorder	No
Third	Ch.M.	47	Male	Vocal fold nodule	Yes
Fourth	M.I.	19	Female	Bilateral vocal nodules	Yes
Fifth	B.J.	63	Male	Vocal fold nodule	No
Sixth	B.D.	20	Female	Bilateral vocal nodules	No

5. Study Tools:

The present study relied on a set of tools that contributed to comprehensive data collection and analysis, in line with the nature and objectives of the research, as follows:

5.1 Observation:

Observation is one of the fundamental tools in human sciences research, allowing the researcher to monitor the studied phenomenon in its natural context. In this study, we employed close observation of the vocal behavior of the cases and its progression, with particular focus on the physical characteristics of the voice throughout the study stages.

5.2 Interview:

Individual interviews were used as a means of collecting qualitative information about the studied cases through a vocal budget form. The interviews focused on pathological aspects, vocal behavior, and factors associated with the disorder.

5.3 Vocal Budget:

This tool provides a comprehensive assessment through which administrative and personal data are collected (such as age, marital status, daily habits), medical information (such as onset of the disorder, comorbidities, medications), in addition to orthophonic data (such as laryngeal sensations, muscular tension, and self-evaluation of the voice). Clinical observations related to vocal behavior and physical characteristics are also recorded.

5.4 PRAAT Software:

PRAAT is one of the leading tools widely used in the field of phonetic analysis, especially in studies related to voice disorders, offering advanced functions for analyzing sound signals with high accuracy.

The software was developed by researchers Paul Boersma and David Weenink at the Phonetics Department, Faculty of Humanities, University of Amsterdam. It is used to analyze the physical characteristics of voice such as fundamental frequency, intensity, speech duration, formants, and pitch, along with spectrographic representation that reflects the distribution of acoustic energy over time.

PRAAT is open-source and freely available for download from its official website. It is used by researchers and speech-language pathologists to evaluate vocal performance before and after therapeutic intervention.

In this study, the program was used to record voice samples from the studied cases and analyze them spectrally in order to extract physical vocal characteristics and compare them between healthy individuals and those with vocal fold nodules.

Steps for Using the Program in the Study:

- Open the "Praat Objects" window.
- To record a voice sample, select **"Record stereo sound"**, then click **"New"**.
- Save and name the recording.
- To obtain the spectrographic representation and analyze physical parameters, click **"View and Edit."**

The software provides a detailed visual display of frequency changes, energy levels, and temporal aspects of voice, contributing to a better understanding of the vocal condition's progression or improvement following vocal training. (Boersma & Weenink, 2024)

6. Presentation and Analysis of Study Results

- **Recording Corpus Presentation:**

  In the context of our study, we selected a vocal corpus that relies solely on the production of the vowel [i], due to its effectiveness in evaluating vocal fold closure and accurately monitoring vocal behavior. The same instruction was given to all participants: they were asked to pronounce the vowel [i] in a sustained manner for as long as possible.

6.1 Presentation and Analysis of the Reference Group Results

• Case 1:

Case "M.T.", a 55-year-old customs officer residing in Algiers, showed no signs of voice disorder based on clinical observations. The results of his voice analysis using the PRAAT software were as follows:

Table 01: Results of PRAAT Software Analysis for Case 1

Fundamental Pitch Frequency	Jitter Percentage	Intensity	Shimmer	Maximum Phonation Time TMP	Voice Breaks	Harmonicity of the voiced sound
133.75	0.51	75.73	2.74	17.10	0	21.29

Fundamental Frequency (Pitch): Reached **133.75 Hz**, which falls within the normal range for adult males (typically between 100 and 150 Hz), indicating a natural vocal pitch.

Jitter (Frequency Stability): Measured at **0.51%**, a low value indicating good consistency in vocal fold vibrations and reflecting stable vocal performance.

Voice Intensity: Recorded at **75.73 dB**, which is an appropriate level and demonstrates a good ability to produce a clear and audible voice.

Shimmer (Amplitude Stability): Measured at **2.74%**, an acceptable rate indicating relatively stable vocal intensity without significant fluctuations.

Maximum Phonation Time (MPT): Reached **17.10 seconds**, a good duration reflecting healthy respiratory and phonatory efficiency.

Voice Breaks: No voice breaks were recorded (**0%**), confirming continuous phonation without interruptions an excellent indicator of healthy vocal fold function.

Harmonics-to-Noise Ratio (HNR): Measured at **21.29 dB**, a relatively high value indicating vocal clarity with minimal noise interference, reflecting good voice quality.

Conclusion: The PRAAT analysis results for case "M.T." clearly indicate the absence of any apparent voice disorder. All physiological voice indicators fall within normal ranges. His voice shows stable pitch, consistent intensity, and high clarity, which reflects a healthy phonatory system.

- **Case 2:**

Case "T.H." is a 22-year-old university student residing in Algiers. She shows no signs of a voice disorder. Her voice was analyzed using PRAAT software through the sustained pronunciation of the vowel [i].

Table 02: PRAAT Software Results for Case 2

Pitch	Jitter	Intensity	Shimmer	Maximum Phonation Time TMP	Voice Breaks	Harmonicity of the voiced
250.15	0.48	72.82	2.07	25.42	0	23.19

Fundamental Frequency (Pitch):

Recorded at **250.15 Hz**, which is within the normal range for adult females (typically between 180 and 250 Hz), indicating a healthy vocal pitch appropriate for her age and gender.

Jitter (Frequency Stability):

Measured at **0.48%**, a low percentage that reflects good regularity in vocal fold vibrations, indicating stable vocal fold movement.

Voice Intensity:

Recorded at **72.82 dB**, which is an appropriate intensity level that demonstrates a good ability to produce a clear and audible voice.

Shimmer (Amplitude Stability):

Measured at **2.07%**, a relatively low value indicating good consistency in vocal loudness without significant fluctuations.

Maximum Phonation Time (MPT):

Reached **25.42 seconds**, an excellent duration that reflects strong respiratory and phonatory efficiency, especially for a young adult.

Voice Breaks:

No voice breaks were recorded (**0%**), indicating continuous and stable phonation with no interruptions an excellent sign of healthy vocal function.

Harmonics-to-Noise Ratio (HNR):

Recorded at **23.19 dB**, a high value that indicates a pure voice with minimal noise components, reflecting excellent voice quality.

Conclusion: The results for case "T.H." clearly show that all vocal indicators fall within normal values, confirming the absence of any voice disorder. Her voice is stable, clear, pure, and consistent in both pitch and intensity, reflecting a healthy vocal and respiratory system.

6.2 Presentation and Analysis of Results for the Group with Vocal Fold Nodules Who Underwent Vocal Training

- **Case 3:**

Case "Ch.M." is a 47-year-old soldier residing in the municipality of Chéraga (Algiers Province). In November 2023, he visited the ENT department at Beni Messous Hospital due to vocal difficulties, specifically hoarseness and vocal fatigue. Following medical examination, he was diagnosed with a vocal fold nodule, which is a type of functional voice disorder commonly resulting from vocal strain.

The case was referred for orthophonic (speech-language) rehabilitation, and he has been undergoing regular voice therapy sessions up until the time this study was conducted. During the interview, he reported experiencing communication difficulties, persistent vocal fatigue, and discomfort in the laryngeal area especially prior to the beginning of treatment.

Table 03: PRAAT Software Results for Case 3 (Ch.M.)

Pitch	Jitter	Intensity	Shimmer	Maximum Phonation Time TMP	Voice Breaks	Harmonicity of the voiced
138.85	0.59	83.98	2.83	14.14	0	16.04

Considering the PRAAT software results for Case "Ch.M." a patient with a functional voice disorder (vocal fold nodule) who underwent orthophonic follow-up with vocal exercises and comparing them with the two reference cases ("M.T." and "T.H."), who do not present any voice disorders, we observe the following:

Despite being diagnosed with a voice disorder, the acoustic analysis results for "Ch.M." show **notable improvement** in several vocal parameters, indicating the effectiveness of vocal exercises in enhancing vocal performance:

- **Fundamental Frequency (Pitch = 138.85 Hz)** is very close to that of the male reference case "M.T." (133.75 Hz), suggesting that the voice has returned almost to the normal range for an adult male. This indicates that the exercises have helped stabilize pitch and improve vocal fold performance.
- **Jitter (0.59%)** and **Shimmer (2.83%)** are still slightly higher than in the two reference cases ("M.T.": 0.51% and 2.74%; "T.H.": 0.48% and 2.07%), but they do not reflect severe dysphonia. This implies improved vocal stability due to orthophonic intervention, with only minor residual irregularities.
- **Maximum Phonation Time (MPT = 14.14 seconds)** is lower than in the two healthy cases (17.10 and 25.42 seconds), but still within a moderate range. This reflects progress in respiratory and phonatory control, particularly considering that vocal nodules often impact sustained phonation.
- The **absence of voice breaks (0%)** is a strong indicator of improvement. Voice breaks are typically associated with voice disorders. Their absence here confirms that the vocal exercises helped enhance vocal continuity and smoothness in phonation.
- The **Harmonics-to-Noise Ratio (HNR = 16.04 dB)** is lower than the values recorded in the healthy cases (21.29 and 23.19 dB), indicating some residual hoarseness and vocal noise. This remains a hallmark of voice disorders, despite the improvements observed in other parameters.

Conclusion: The analysis shows that vocal exercises played a significant role in improving Ch.M.'s vocal performance. Several indicators approached the values of healthy voices, particularly in fundamental frequency, vibratory stability, and the absence of voice breaks. Although some signs of disorder persist (especially in HNR and MPT), the overall results suggest clear progress, affirming the effectiveness of orthophonic voice rehabilitation in restoring key aspects of healthy vocal function.

• Case 4:

Case "M.I." is a 19-year-old university student residing in the municipality of El Madania (Algiers Province). She suffers from a functional voice disorder, characterized by bilateral vocal fold nodules. In October 2024, she consulted the ENT department at Beni Messous Hospital due to persistent voice changes and recurring vocal fatigue, especially during exam periods.

Following a medical diagnosis confirming the presence of nodules, she was referred for orthophonic care. During the initial interview, she reported a fatigued, rough, and altered voice quality compared to her normal voice. She also complained of a foreign body sensation in the larynx, and described difficulty speaking for extended periods, particularly during phone calls or when raising her voice, which caused fatigue and negatively affected her daily communication.

Orthophonic follow-up began in October 2024 and continued up to the time of this study, allowing for observation of her vocal progress and analysis of her voice using PRAAT software.

Table 04: PRAAT Software Results for Case 4 (M.I.)

Pitch	Jitter	Intensity	Shimmer	Maximum Phonation Time	Voice Breaks	Harmonicity of the voiced

				TMP		
205.14	0.37	84.49	2.02	15.52	2	22.98

Fundamental Frequency (Pitch = 205.14 Hz):

This frequency falls within the normal range for adult female voices and is relatively close to the value recorded in the reference case "T.H." (250.15 Hz), indicating that pitch control has improved and stabilized to some extent.

Jitter (0.37%):

This value is lower than that of the other cases (even lower than the reference case "T.H.", which was 0.48%), reflecting improved regularity in vocal fold vibrations and greater pitch stability. This is a positive indicator of the effectiveness of vocal exercises in this area.

Voice Intensity (84.49 dB):

This is the highest intensity value among all cases, both affected and healthy. It suggests improved respiratory effort and subglottic support during phonation, likely as a direct result of targeted vocal exercises.

Shimmer (2.02%):

This value is relatively low, even when compared to the reference cases, reflecting good control over vocal intensity. The vocal vibrations are being produced with consistent strength, which is a sign of quality phonation.

Maximum Phonation Time (MPT = 15.52 seconds):

This value is within the normal range and similar to that of case "Ch.M." (14.14 seconds). While it is slightly lower than the reference cases, it is still acceptable and indicates progress in breath and voice control.

Voice Breaks (2):

This is the only indicator that still reflects signs of a voice disorder. Compared to other cases where no voice breaks were recorded, this suggests some interruptions in vocal continuity, though the number is minimal.

Harmonics-to-Noise Ratio (HNR = 22.98 dB):

This is a relatively high value, very close to that of the reference case "T.H." (23.19 dB), indicating a low level of noise in the voice signal. This suggests that the hoarseness has significantly diminished.

Conclusion: The overall results for case "M.I." show that **orthophonic care was effective**, with most vocal indicators (Jitter, Shimmer, Intensity, HNR) approaching values seen in healthy individuals. The fundamental frequency also returned to the normal range for adult female voices.

Despite the presence of two voice breaks, the other parameters indicate that the hoarseness caused by the nodules has decreased noticeably. This reflects the positive impact of vocal exercises in improving voice quality and stabilizing vocal performance.

It can be concluded that case "M.I." represents a successful example of the effectiveness of **regular orthophonic follow-up in treating functional voice disorders**.

6.3 Presentation and Analysis of Results for the Group with Vocal Fold Nodules Who Did Not Undergo Vocal Training

- **Case 5:**

Mr. "B.J." is a 63-year-old retired man residing in Bab El Oued, Algiers. He was diagnosed with a functional voice disorder caused by a vocal fold nodule, and was referred by his specialist to the ENT department at Bab El Oued Hospital, where he was advised to attend voice rehabilitation sessions with a speech-language pathologist.

During the initial interview, conducted on March 5, 2024, the patient reported difficulty accepting his current voice. He complained of persistent vocal fatigue and strain, which clearly affected his ability to speak. The results from the vocal budget assessment indicated that he often struggled to speak for extended periods, particularly in noisy environments. He also experienced difficulty raising his voice or calling out, with symptoms worsening gradually throughout the day.

Table 05: PRAAT Software Results for Case 5 (B.J.)

Pitch	Jitter	Intensity	Shimmer	Maximum Phonation TMP Time	Voice Breaks	Harmonicity of the voiced
114.18	1.34	82.59	7.65	4	2	14.64

PRAAT Voice Analysis Results – Case "B.J."

The acoustic results extracted using PRAAT software for case "B.J." who suffers from hoarseness caused by a vocal fold nodule and has not received any speech-language intervention reveal a clear and multi-dimensional functional voice disorder.

- **Fundamental Frequency (Pitch = 114.18 Hz):**

  Although this value falls within the normal range for adult males, it is relatively low, suggesting a deeper tone. This may be caused by incomplete closure of the vocal folds during phonation due to the presence of the nodule, contributing to the perceived hoarseness.

- **Jitter = 1.34%:**

  This value is considered high compared to normative levels (typically below 1%), indicating irregular vocal fold vibrations. Such instability is characteristic of hoarseness associated with either organic or functional laryngeal disorders.

- **Voice Intensity = 82.59 dB:**

  This relatively high intensity may reflect **compensatory behavior**, where the patient exerts excessive pressure to make himself heard, especially in noisy environments. This effort causes vocal fatigue, as reported by the patient during the initial interview.

- **Shimmer = 7.65%:**

  This is significantly above the normal threshold (typically under 3.5%), indicating irregular variations in vocal intensity between cycles. This lack of consistency compromises vocal balance and steadiness.

- **Maximum Phonation Time (MPT) = 4 seconds:**

  This is **far below** the normal range for adult males (typically above 10 seconds), indicating a clear weakness in breath support and phonatory control. It may result from poor coordination between respiratory and laryngeal systems or rapid energy depletion due to excessive vocal effort.

- **Voice Breaks = 2:**

  These breaks reflect **interruptions in vocal continuity**, weakening fluency and stability, and making both the speaker and listener perceive an unstable vocal tone.

- **Harmonics-to-Noise Ratio (HNR) = 14.64 dB:**

This value is **below the typical range** (20–30 dB), indicating a high level of noise components in the voice signal. This imbalance reflects **clear hoarseness**, where the pure tone is masked by turbulent noise due to irregular vocal fold closure.

Conclusion: Case "B.J." presents with an **advanced voice disorder**, characterized by unstable frequency, reduced vocal endurance, excessive vocal effort, and poor vocal continuity. The data strongly indicate the need for **urgent speech-language therapy** through a structured voice rehabilitation program. Such a program should aim to improve vocal quality, enhance breath–voice coordination, and correct phonation mechanisms, ultimately preventing further deterioration and improving both functional voice use and the patient's quality of life.

● Case 6:

Case "B.D." is a 20-year-old university student residing in Bab El Oued, Algiers. She suffers from a functional voice disorder, diagnosed as bilateral vocal fold nodules. She was referred by her specialist to the ENT department at Bab El Oued Hospital and was subsequently directed to a speech-language pathologist for voice rehabilitation therapy.

During the initial assessment, conducted on February 26, 2024, several clinical indicators revealed a clear disturbance in voice quality. The patient complained of low voice intensity accompanied by irregular vocal dynamics, with fluctuations between high and low pitch, suggesting weak control over phonation mechanisms.

She also reported persistent vocal fatigue and the presence of audible noise in her voice symptoms consistent with impaired vocal fold closure caused by the nodules. Additionally, she stated that she was unable to call out across long distances and had difficulties communicating in noisy environments. She could not speak for extended periods without experiencing fatigue.

Notably, she mentioned a family history of a hoarse voice, which may point to a genetic or behavioral predisposition affecting her phonation style.

These symptoms underscore the need for targeted orthophonic intervention focused on improving voice quality, enhancing respiratory–phonatory coordination, and reducing vocal fold strain by retraining faulty voice behaviors.

Table 06: PRAAT Software Results for Case 6 (B.D.)

Pitch	Jitter	Intensity	Shimmer	Maximum Phonation Time TMP	Voice Breaks	Harmonicity of the voiced
114.18	1.34	82.59	7.65	4	2	14.64

PRAAT Voice Analysis Results – Case "B.D."

The acoustic analysis of case "B.D." who presents with hoarseness resulting from bilateral vocal fold nodules and has not yet undergone any voice therapy reveals a functional voice disorder, with its effects clearly reflected in several physical voice parameters.

- **Fundamental Frequency (Pitch = 251.21 Hz):**

  This value is relatively high, located at the upper limit of the normal range for adult females. It suggests a sharp, potentially strained or uncomfortable vocal tone, likely caused by excessive tension in the vocal folds common among individuals with nodules due to overexertion during phonation.

- **Jitter = 0.74%:**

This value is near the upper acceptable limit (typically <1%), indicating slight irregularities in vocal fold vibration. It suggests the **early functional impact** of the disorder on phonatory dynamics, despite the absence of any intervention.

- **Voice Intensity = 80.99 dB:**

  This is a relatively high value and may reflect **compensatory vocal effort** to overcome reduced vocal clarity. Such behavior often results in **significant vocal fatigue**, as reported by the patient during the initial interview.

- **Shimmer = 4.52%:**

  This is an elevated value (normal range usually <3.5%), indicating **noticeable variability in vocal intensity** between vibratory cycles. This affects vocal **consistency and stability**, contributing to a less coherent sound.

- **Maximum Phonation Time (MPT = 9 seconds):**

  This is slightly below the expected normal range for adult females (typically 10–15 seconds), indicating **mild weakness in breath control** during phonation. This could stem from muscular fatigue or poor coordination between the respiratory and phonatory systems.

- **Voice Breaks = 1:**

  The presence of a single voice break reflects a **limited disruption** in vocal continuity. While not severe, it may signal **early-stage deterioration**, which could worsen without appropriate therapy.

- **Harmonics-to-Noise Ratio (HNR = 10.52 dB):**

  This is **significantly below the normal range** (usually 20–30 dB), suggesting a **high noise component** in the voice and reduced clarity one of the hallmark characteristics of hoarseness caused by vocal nodules.

Conclusion: The vocal indicators for case "B.D." clearly point to a moderate functional voice disorder, marked by a high-pitched, unclear voice with notable fluctuations in both frequency and intensity. There is a visible reduction in vocal quality, driven by the presence of bilateral vocal nodules.

Although her MPT has not decreased drastically, the combination of high jitter and shimmer, elevated intensity, and especially the low HNR, indicate significant vocal strain and instability.

These findings emphasize the urgent need for speech-language intervention to correct phonation mechanisms, improve voice quality, reduce vocal fold tension, and prevent further deterioration into a more complex voice disorder.

7. Discussion of the Study Results

7.1 Discussion of the General Hypothesis

Based on the acoustic voice analysis results extracted using PRAAT software and the clinical data obtained from the vocal budget, there appears to be a clear convergence in the physical vocal parameters between the cases that underwent vocal training based on François Le Huche's approach and the healthy reference cases. In contrast, the cases that did not receive any orthophonic intervention presented significantly altered values.

Notable improvements were observed in key voice quality indicators such as increased HNR, better Jitter and Shimmer regularity, and enhanced MPT. These results support the general hypothesis that François Le Huche's vocal training method plays an effective role in improving the physical characteristics of the voice in individuals with functional voice disorders, particularly vocal fold nodules.

These findings are consistent with the conclusions of Estienne-Sicard (2005), who confirmed that systematic voice therapy leads to clear improvements in the acoustic features of patients with functional voice disorders. They are also supported

by Reiter & Roffman (2011), who found that approximately 80% of patients who received voice therapy regained their normal vocal performance. Additionally, this study aligns with the work of Boone et al. (2014), which emphasized the importance of vocal training in rebalancing muscular and respiratory effort during phonation.

7.2 Discussion of the First Partial Hypothesis

When analyzing vocal intensity and its consistency across the studied cases, it was found that both the treated and untreated groups exhibited intensity levels ranging from normal to relatively high, reflecting a common compensatory behavior among patients especially in noisy environments.

However, the treated cases demonstrated greater intensity regularity (with relatively low Shimmer values), whereas untreated cases suffered from significant variability in this indicator, pointing to poor control over vocal intensity dynamics.

These findings are in line with Tensawt (2019), whose study on a child with functional hoarseness in a hospital setting highlighted that vocal intensity and its stability depend greatly on the quality of orthophonic care and the level of control over phonatory mechanisms. Additionally, Verdolini & Ramig (2001) confirmed that regular voice therapy improves neuromuscular regulation of vocal intensity.

Thus, the first partial hypothesis that François Le Huche's vocal training contributes to improving vocal intensity and its stability in individuals with functional voice disorders has been confirmed.

7.3 Discussion of the Second Partial Hypothesis

The results for fundamental frequency (Pitch) showed that most of the studied cases fell within the normal range for age and gender. However, the variation lies in the stability of the frequency. Case 5 (untreated) showed clear disturbance in frequency regularity (elevated Jitter), while treated cases showed more balanced and stable values.

This variation reflects the effect of vocal training on the regulation of laryngeal muscle movements, which control the vibration of the vocal folds. This finding aligns with Feni (2022), who demonstrated that the verbo-tonal method helped improve pitch and tonal features in children with voice disorders. It is also supported by LeBorgne & Weinrich (2002), who noted that structured voice therapy enhances vocal fold stability and reduces pitch-related disturbances.

Therefore, the second partial hypothesis that François Le Huche's vocal training plays an effective role in improving the regularity of fundamental frequency in patients with vocal fold nodules is validated.

7.4 Discussion of the Third Partial Hypothesis

Regarding voice clarity, measured by the Harmonics-to-Noise Ratio (HNR), this was one of the most affected characteristics in untreated cases, which showed low HNR values indicating a high level of noise within the voice signal (as seen in Cases 5 and 6). In contrast, treated cases recorded values closer to the healthy reference group, reflecting significant improvement in voice purity and a decrease in noise components.

These results are consistent with Bousahel (2018), whose study on the effectiveness of the VOCALAB program in improving voice characteristics found that regular vocal training significantly reduced noise and enhanced tonal quality. This is also supported by Behrman (2005), who showed that voice therapy interventions produce qualitative improvements in timbre, particularly in cases of functional hoarseness.

Therefore, the third partial hypothesis that François Le Huche's vocal training plays a role in improving vocal timbre in individuals with functional voice disorders is confirmed.

Conclusion:

This study concluded that vocal training particularly the approach based on François Le Huche's method is an effective tool for improving the physical characteristics of the voice in individuals with vocal fold nodules. The results showed significant differences between cases that received orthophonic care and those that did not, especially in terms of frequency stability, intensity consistency, and vocal timbre clarity. These findings align with numerous previous studies that have demonstrated the efficacy of voice therapy in restoring voice quality and improving the functional performance of the vocal folds. Moreover, the use of PRAAT software as an analytical tool enhanced the objectivity and accuracy of the results. Hence, the integration of vocal rehabilitation programs emerges as a key component in the management of functional voice disorders.

Based on these findings, the study recommends:

1. Intensifying vocal training programs in healthcare institutions, adopting François Le Huche's method as a standard therapeutic approach for functional voice disorders.
2. Integrating voice analysis software such as PRAAT into daily orthophonic practice to assess the effectiveness of therapeutic programs.
3. Ensuring early intervention for individuals with vocal fold nodules to prevent the disorder from progressing into chronic or organic forms.
4. Training speech-language pathologists in vocal training techniques through workshops and continuous professional development.
5. Encouraging experimental scientific research on the effectiveness of various therapeutic vocal techniques, especially those grounded in scientific melodic principles.
6. Raising public awareness about the risks of vocal overuse, particularly in vocally demanding professions (teachers, muezzins, artists...), and promoting vocal health prevention strategies.

Reference List:

1. Al-Abidin, F. (2016). Introduction to Voice Disorders. Amman: Dar Al Fikr.
2. Al-Anani, H. (2007). Diseases of Voice, Speech, and Language. Cairo: Anglo-Egyptian Library.
3. Akroun, S. (2019). Voice Disorders: A Practical Guide. Algiers: Dar Al-Ummah.
4. Amayra, A., & Al-Nadhour, M. (2012). Guide to Voice Disorders. Amman: Dar Al-Maseera.
5. Feni, S. (2022). The effectiveness of the melodic verbal method in improving vocal characteristics in children with functional voice disorders. Journal of Physical and Sports Activity Sciences and Techniques, 11(2), 78–92.
6. Bousahel, A. D. (2018). The effectiveness of the VOCALAB program in improving voice characteristics in individuals with hoarseness. Journal of Linguistics and Language Sciences, 6(1), 45–59.
7. Tensawt, S. (2019). Physical analysis of speech in a child with functional hoarseness in an Algerian hospital setting. Algerian Journal of Orthophony and Special Education, 3(1), 17–29.
8. Houla, S. (2007). Articulatory Phonetics. Algiers: Dar Al-Huda.
9. Rekza, F. (2018). Orthophonic Management of Voice Disorders. Algiers: Dar Al-Bassaer.

10. Allali, A., & Le Huche, F. (1990). Dysphonias: Assessment and Rehabilitation. Paris: Masson.
11. Behrman, A. (2005). Common practices of voice therapists in the evaluation of patients. Journal of Voice, 19(3), 454–469. https://doi.org/10.1016/j.jvoice.2004.11.002
12. Boone, D. R., McFarlane, S. C., Von Berg, S. L., & Zraick, R. I. (2014). The Voice and Voice Therapy (9th ed.). Pearson.
13. Estienne-Sicard, M. (2005). Vocal Rehabilitation: A Multidisciplinary Approach. Paris: Masson.
14. Hoffmann, T. K., Reiter, R., et al. (2015). Hoarseness: Causes and Treatments. Journal of Voice, 29(6), 631.e1–631.e7.
15. LeBorgne, W. D., & Weinrich, B. D. (2002). Phonational frequency range of actors. Journal of Voice, 16(4), 517–521.
16. Reiter, R., & Roffman, T. K. (2011). Long-term outcomes of voice therapy in functional dysphonia. Logopedics Phoniatrics Vocology, 36(1), 28–34.
17. Rondal, J. A., & Seron, X. (2003). Language Disorders: Cognitive Approach and Neuropsychological Foundations. Brussels: De Boeck Université.
18. Verdolini, K., & Ramig, L. O. (2001). Review: Occupational risks for voice problems. Logopedics Phoniatrics Vocology, 26(1), 37–46.