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MUSIC THERAPY FOR SPEECH REHABILITATION IN PARKINSON'S DISEASE

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Abstract
Parkinson's Disease is a neurodegenerative disease that causes deterioration of the nervous system and, among the generality of symptoms it produces, the ability to speak in the person who suffers from it decreases.
As healthcare professionals, caregivers, and individuals affected by Parkinson's Disease, your role in this intervention proposal is crucial. Together, we aim to rehabilitate the speech mechanisms impaired by the disease, enabling the affected person to express themselves orally in a comprehensible manner and function independently in their daily environment.
The methodology used to recover these mechanisms is based on techniques developed by Thaut and Hömberg in what is called Neurological Music Therapy, an aspect of music therapy aimed at preserving or rehabilitating cognitive, motor and language dysfunctions caused by sudden injuries or neurological degeneration conditions.
In the case of language dysfunctions, singing therapeutically involves, on the one hand, relaxation, breathing and vocal emission activities to improve phonation; on the other hand, exercises aimed at recovering the mobility of the articulatory organs for the adequate production of vowels and letters and, finally, rhythm, intonation, melody and accentuation activities to recover the expressiveness of speech.

Keywords: music therapy, parkinson's, speech, rehabilitation, voice.

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BACKGROUND

The characteristics of Parkinson's speech and voice are determined by the way and degree to which the disease progressively deteriorates the processes of breathing, phonation, resonance, articulation and prosody in those who suffer from it (González & Bevilacqua, 2012).

According to Martínez-Sánchez (2010), people with PD have an abnormal breathing pattern due to decreased cerebral blood supply and lack of muscle mobility. Accordingly, Martínez-Sánchez et al. (2016) believe that this breathing anomaly prevents the lungs from receiving the necessary air, generating problems such as a sharp decrease in airflow with numerous interruptions in airflow, prolonged pauses to breathe between words and hypophony, which is the notable decrease in voice volume. Finally, Parrón (2017) points out that these patients have altered breathing, with an inadequate dosage of air during phonation and little functionality in phonorespiratory coordination.

Phonation

Phonation is the act of producing sound, and the airways must be clear, relaxed, and free of any tension so that they can be produced properly (Colón & Lazo, 2018). Martínez-Sánchez (2010) describes that, as the PD patient does not meet these requirements, his typical voice is hoarse, harsh, weak and of a low tone, as a result of his limited mobility in the vocal cords. For his part, Miller (2017) observes hypophonia as low intensity and describes it as blown, weak, trembling, hoarse, muffled, and choppy. Along the same lines,

Chiaramonte and Bonfiglio (2020) believe that the difficulty in modulating the intensity of the voice is due to the impossibility of properly closing the glottis, which leads to involuntary leakage of air during speech production, resulting in a notable decrease in phonation time, as well as highly unstable phonation.

Resonance is the sound generated by the movement of the vocal cords, once projected into the space of the supraglottic cavities, which include the pharyngeal cavity, the oral cavity, and the nasal cavity. Resonance increases vocal power and richness, but according to González and Bevilacqua (2012), resonance is affected for two reasons in people with Parkinson's disease.

First, the soft palate, with limited mobility, does not properly close the nasal passage, resulting in a higher-pitched, monotone nasal voice. Second, the difficulty in opening the mouth properly reduces the resonator function of the oral cavity, resulting in a significant loss of power and sound richness. Parrón (2017) argues that this problem is related to the inefficiency in the contraction and elevation of the soft palate, which allows air to escape into the nostrils, producing a nasal effect on phonation.

During the articulation process, the organs involved adopt different positions to allow the modification of the vocal tract and produce the voice. Parkinson's disease alters the stability of these organs due to the tremors it generates and, according to Martínez-Sánchez (2010), speech sounds decay, significantly reducing its intelligibility. For his part, Miller (2017) believes that the typical PD joint is characterized by imprecision due to a lack of muscle strength and tone, to which he adds a decrease in joint amplitude, coordination, and precision.

Dysfunctions of Parkinson's disease

Similarly, Chiaramonte and Bonfiglio (2020) reached three important conclusions. First, they found that this disease causes a decrease in the strength, extension and speed of the articulatory organs that hinder the production of speech. The second place is the rigidity and bradykinesia (slowness of movements) inherent to PD that affects the muscles and mobility of the patient's lips, tongue, and jaw, which makes it extremely difficult to articulate words. Finally, the reduction in the range of movements due to PD also has negative repercussions on saliva control, chewing and swallowing.

Finally, with respect to prosody, there are three relevant phenomena in the act of speaking: accentuation, intonation, and rhythm. The essential function of these three phenomena is to group the sounds of speech into blocks, called rhythmic groups, to facilitate the decoding and understanding of the message (Miller, 2012). This same author, in the same study, observes a monotonous speech in PD patients that makes it difficult to express their own emotions.

The study conducted by Martínez-Sánchez et al. (2016) identifies several characteristics associated with deficient prosody in patients with Parkinson's disease (PD). These features include significant difficulties in speech motor control, the presence of micro-pauses during speech, and a general decrease in the speed of articulation of words. Parrón (2017) describes that the fundamental frequency of the voice of those affected is very little variable, which means that the ability to sing is lost. Again, Miller (2017) observes difficulties in fluency and rhythm during the speech process.

For their part, Chiaramonte and Bonfiglio (2020) found a series of prosodic dysfunctions, such as low sound intensity produced by tension in the laryngeal and respiratory muscles. In addition, a wide reduction in the range of sound frequency was found to be caused by the decrease in mobility of the pharyngeal-laryngeal tract and rigidity in the cricothyroid muscle, which controls the length and tension of the vocal folds. This produces reductions in stress, use of short sentences, few variations in tone and intensity of speech and a dysfunction in the ability to generate and recognize rhythmic patterns in words and sentences.

Neurological Music Therapy

In order to treat these symptoms produced by the neurological deterioration of both this disease and others with the same character, at the end of the nineties, Michael Thaut, Gerald McIntosh, Volker Hoemberg, Corene Thaut and Ruth Rice developed neuro-logical music therapy (NMT). They also founded the Academy of Neurologic Music Therapy (2014) at the Center for Biomedical Music

Research at the University of Colorado, working together with the Institute of Neurorehabilitation of the Faculty of Medicine of the University of Düsseldorf (Jauset-Berrocal & Soria-Urios, 2018). According to Thaut and Hömberg (2016), NMT is based on the application of standardized and individualized musical interventions based on the latest scientific advances and aimed at preserving or rehabilitating cognitive, motor and language dysfunctions caused by supervening injuries or neurological degeneration conditions.

Neurological music therapy (Thaut, 2010) introduces various techniques that, in line with the current knowledge of musical perception, act by influencing the neural mechanisms involved in these functions, which supposes a stimulus in the damaged brain area that can lead to an activation or an improvement of the dysfunction suffered.

According to Thaut and Hömberg (2016), Neurological Music Therapy is based on scientific knowledge about brain musical perception, acquired thanks to the latest technologies in the field of neuroimaging, such as computerized axial tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), electroencephalography (EEG) and magnetoencephalography (MEG).

The foundation of NMT has four pillars or theoretical principles. The first is based on the technology of neuroimaging studies, which show that music causes an almost global activation of the brain, stimulating the neuronal interaction between both hemispheres and activating the various brain structures involved in the perception of each musical element (Warren, 2008).

The second pillar is based on the effectiveness of performing musical activities to facilitate the recovery of lost or affected functions (Altenmüller et al., 2013), retraining and integrating injured areas of the brain, as well as forming new neural connections. This is what is called neuroplasticity.

The third pillar is based on the evidence that non-musical functions affected by brain injury or accident can be accessed through music, thanks to the existence of neural circuits shared between musical functions and functions of everyday life (Schlaug et al., 2008).

Finally, the fourth pillar is based on rhythm as an auditory stimulus, which is capable of creating a temporal platform on which the brain becomes capable of anticipating each pulsation and programming the necessary movements (Bahrami et al., 2017), demonstrating the existence of rhythmic synchronization or coordinated activity of auditory neurons and motor neurons. Preparing the motor system and facilitating the quality and execution of the movements. This last point is mainly applied to patients with Parkinson's and other types of brain injuries in the form of rhythmic exercises, both for the rehabilitation of limb movement and language rehabilitation (Jauset-Berrocal, 2016).

NMT is aimed at providing support in the rehabilitation of the three areas affected by neurodegenerative diseases: the cognitive, motor and language areas. For each of these areas, Thaut and Hömberg (2016) have developed a set of techniques specialized in the different disorders that those affected may suffer.

With regard to the area of language, these authors have designed up to eight intervention techniques for language rehabilitation, of which, in the intervention proposal presented, the following have been used:

- Motor and Respiratory Exercises (OMREX), whose objective is to enhance the control of the respiratory system through relaxation, breathing and musical vocalization activities;
- Therapeutic Singing (TS), whose purpose is to strengthen the respiratory system, facilitate the initiation and development of speech and improve the articulation of words, using the interpretation of songs for this purpose;
- Rhythmic Speech Cuing (RSC), which uses rhythmic patterns produced by body percussion, percussion instruments and metronome, on which phrases from the chosen song are recited to regulate and coordinate the movements of the oro-facial muscles involved in speech, thus controlling the speed of speech, as well as the inflexion of speech;
- Musical Speech Stimulation (MUSTIM), which encourages the spontaneous generation of speech through the practice of ending and starting words and phrases extracted from the chosen song, thus stimulating prosodic language and non-propositional speech;
- Vocal Intonation Therapy (VIT) uses the musical vocalization of useful phrases imitating the prosody, inflexion and rhythm of normal speech, with the appropriate musical accompaniment, to facilitate its learning and application in everyday use.

Thus, this model of music therapy aims to rehabilitate phonation, articulation and speech prosody that deteriorated due to Parkinson's disease, with the aim of improving the quality of life of affected people, who gradually see how their ability to speak, to express their feelings, to

transmit their opinion is reduced, to the point that they could even stop communicating with the people around them and this can really have very serious consequences, such as ending up isolated from the world around them (González & Bevilacqua, 2012). In addition, this loss of communication ability can also cause significant damage to the PD patient in other areas, such as the emotional area, since, due to the difficulty in maintaining communication with their environment, they may be immersed in a depressive state produced by their linguistic inability (Olanow et al., 2009).

MATERIALS AND METHOD

Participants

The recipient of this intervention proposal is a fictitious 76-year-old patient whose ability to speak has already begun to deteriorate PD. His voice volume is weak; he needs to pause numerous times to breathe between words. His voice is thin, flat, and nasal, with little power and sound richness. Their ability to articulate is also affected. Their speech is made up of short and linear sentences with hardly any accentuation, and they have a slow and not very fluid rhythm that makes it difficult to be intelligible.

Activities

All the activities in this proposal are centred around the beloved carol "Ya se van los pastores" (anonymous, twentieth century). This song holds a special place in the patient's heart, evoking memories of his childhood. The emotional resonance of this song is a key factor in its selection for this intervention. The activities are divided into three blocks, each focusing on phonation, articulation, and prosody.

For the block of phonation activities, the technique used is OM-REX, and its objective is to enhance the control of the respiratory system through relaxation, breathing and emission activities that can be carried out standing or in a sitting position with the back straight, depending on the physical condition of the patient at the time of the session. These activities are designed for practicing and assimilating costo-diaphragmatic breathing. They include exercises to relax the neck and shoulders, facial massages to relieve muscle tension in the face, vocalization exercises, and the use of a plunger flute to strengthen the respiratory system.

Forock of articulation activities will utilize the TS technique, which. It strengthens the respiratory system, facilitates the initiation and development of speech, and improves word articulation through singing. The song was cut into short fragments (see Table 1) to train the phonemes of the Tables. These phonemes will be grouped into five categories based on their production method, providing an approach to articulation training.

Table 1

Phoneme structure

PHONEMES	SOUNDS
bilabial	/b/, /m/, /p/
labiodental and dental	/f/, /d/, /t/, /s/),
Alveolar	/n/, /l/, /r/, /rr/
Palatal and Prepalatal	/ñ/, /y/, /ch/
Sails	/k/, /g/, /j/

Note. Subdivision of phonemes according to placement in pronunciation. Own elaboration.

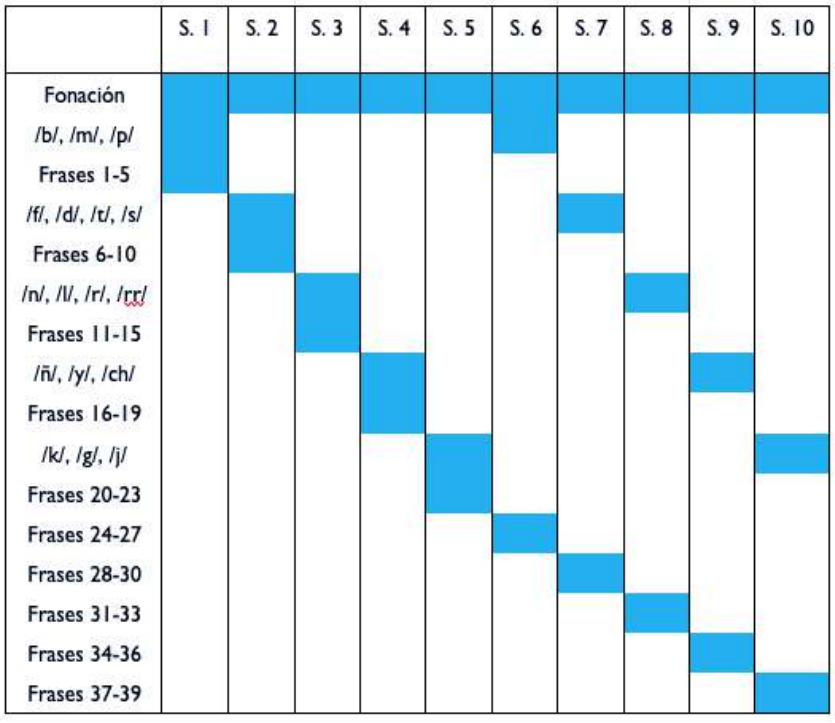
As for the block of activities related to prosody, the CSR, MUSTIM and VIT techniques will be used, working on each of the phrases of the song, which will serve as a formal structure for the therapy. RSC uses rhythmic patterns, produced by body percussion, percussion instruments and metronome, to awaken the normal inflexion of speech, establishing a rhythmic base on which the phrases of the song are practised and which will mark the speed of the speech, as well as the stressed syllables that will allow the correct expressiveness of the patient. In MUSLIM, the music therapist encourages spontaneous speech generation by practising the completion and beginning of words and phrases extracted from the song in a kind of musical game of questions and answers. Finally, in VIT, the musical vocalization practised in the phrases of the song will be used to extrapolate it to other phrases useful in everyday life, imitating the prosody, inflexion and rhythm of normal speech.

Schedule

The duration of the intervention is scheduled for five weeks and consists of ten sessions, distributed at the rate of two weekly sessions of sixty minutes each. The following table shows the distribution and sequencing of content to be carried out in each session.

Table 1

Schedule of sessions Intervention proposal



Note: Temporal distribution of phoneme use throughout the sessions. Own elaboration

All sessions will have the same structure: they will begin with relaxation, breathing and emission activities to properly prepare the muscles that will participate in the production of speech; then, articulation exercises will be carried out, and, finally, the activities corresponding to prosody will be carried out.

Resources

The necessary material resources are, first of all, those related to the furniture: a medium-sized room, well ventilated and with good lighting (natural if possible), two comfortable chairs with armrests, a 90x60cm whiteboard with marker and eraser and a 37x157cm standing mirror. Second, the necessary technical equipment consists of an audio player device and an audio and video recording device. Finally, the musical instruments chosen for the intervention will be an electronic keyboard and small percussion instruments for shared use by the music therapist/patient: a Chinese box, a tambourine, a triangle and two plunger flutes. Due to the individual approach of this intervention proposal, human resources will be limited only to the music therapist in charge of performing the intervention. In reference to the economic investment, since the room where the sessions will be held, the audio player, the electronic keyboard, the percussion instruments, the audio and video recording device, the mirror, the blackboard, the marker and the eraser will be the property of the music therapist, this will be limited to covering the salary of the music therapist for the entire intervention, plus a proportional part to cover the expenses of the investment made in the workshop, which will mean a total cost of the therapy of 600 euros.

Evaluation

The evaluation aims to measure and clearly reflect the client's evolution in relation to specific parameters: the degree of tension of the muscles involved in breathing, the degree of mobility of the orofacial muscles and articulatory organs involved in speech and, finally, the melodic and rhythmic capacity of the voice.

To account for this evolution, the client's status will be taken as a starting point using a validated anamnesis questionnaire (Zurita, 2005). Regarding these parameters, on the day of the first session, the relevant data will be collected at the scheduled time using the selected assessment instruments until the end of the therapy.

The final phase of the evaluation process will be, once the data generated throughout the intervention have been collected and conveniently stored, to proceed to analysis to obtain the results of the evolution in the aforementioned parameters and thus know the impact that the therapy has produced in the subject participating in the study.

To collect and record all the data that will be generated throughout the intervention process, different evaluation instruments will be used, such as:

- Form to reflect the personal data and anamnesis of the therapy user developed by Zurita (2005).
- VHI 30 test for vocal disability developed by Jacobson et al. (1997).
- The questionnaire for the clinical evaluation of speech to know the state of the orofacial anatomy, the oral motor control capacity, the state of the basic motor processes of speech and the functional capacity of the user's speech, developed by González and Bevilacqua (2012).
- The musical preferences questionnaire.
- Registration form for each session.
- Recording of each session.
- The therapy satisfaction questionnaire.

Three stages of action have been established for data collection:

1. The first will be prior to the start of the intervention, where the personal data and anamnesis form, the VHI 30 Test, as well as the questionnaire for the clinical evaluation of speech and the questionnaire of musical preferences, will be completed.
2. The second phase will be carried out during the intervention phase, in which the data will be collected through the session registration form and the recording of each session.
3. The last one, once the intervention is finished, where the VHI 30 Test and the questionnaire for the clinical evaluation of speech will be performed again. The user must also complete a questionnaire aimed at knowing their degree of satisfaction with the therapy received.

In relation to the analysis of the data obtained, the personal data and anamnesis form provide the necessary personal data about the client. It serves to contextualize their clinical status at the time of the intervention, providing important information on the current state of the disease that must be taken into account throughout the process. In relation to the musical preferences questionnaire allows the music therapist to understand the patient's tastes and predilections better in order to select musical material that is attractive and motivating, thus achieving a better and more profitable development of the sessions (Amorós-Sánchez et al., 2024)

The importance of observation in the evaluation process is reflected in the record sheets and recordings of each session, which show the work carried out day by day and the progress that the patient is carrying out, as well as inform the music therapist about the possible changes that should be made in the methodology to increase the effectiveness of the therapy.

As for the data obtained in the VHI 30 test and the questionnaire for the clinical evaluation of speech, both those carried out prior to the intervention and those carried out after the intervention is over will be compared with the aim of identifying the type of evolution that the user has experienced (Fernández, Gamella, & García, 2024).

Finally, the therapy satisfaction questionnaire offers data of great interest to the music therapist, not only about the therapy itself but also about the sensations that the patient has experienced with the methodology used and with the treatment received from the professional. This information must be rigorously re-viewed to apply the appropriate changes, if necessary, to achieve greater satisfaction in future interventions.

For the correct handling of the data that will be collected with the evaluation instruments, these data must be kept in an appropriate place. Firstly, the documents in paper format, such as the personal data and anamnesis form, the VHI 30 tests, the questionnaires for the clinical assessment of speech, the musical preferences questionnaire, the record sheets for each session and the therapy opinion questionnaire, all labelled with the patient's full name and the date of collection, they will be stored in a folder intended for this purpose.

Secondly, the recordings of the sessions will be stored on a single hard disk, indicating at the beginning of each recording the number and date of the session. They must be transcribed for the extraction and classification of the relevant information that they may contain, identifying them with the number and date of the session of each one and saved in the same folder in which the rest of the documents in paper format are together with the one itself hard disk. In addition, all the criteria of informed consent and signature of permits will be followed according to professional ethical rules (Fattorini & Gamella, 2021).

Finally, in order to proceed with the proper analysis of the data, they must be imported into a format that allows their clear interpretation: the VHI 30 tests and the questionnaires for the clinical evaluation of speech will be transferred to double-bar graphs to appreciate the results before and after therapy. In contrast, the evolution of their data will be analyzed in the session registration sheets according to their descriptive statistics and will be represented using graphics for clarity.

RESULTS AND CONCLUSIONS

Since it is an intervention proposal that has not yet been carried out, no real results have been obtained. However, taking into account the conclusions of previous studies, improvements are expected in the phonatory, articulatory, and prosodic areas worked on in therapy. It is expected, therefore, that the patient's voice gains quality, clarity, and power in its emission as a result of the correct performance of costo-diaphragmatic breathing and greater control over the relaxation of the facial muscles. A sufficient recovery of the mobility of the lips, tongue, palate and teeth is also expected, as well as an increase in coordination between them, which allows a correct production of speech sounds; finally, it is expected that the pa-

tient will evolve in such a way that he or she is able to express himself orally in an understandable way, thanks to having achieved a more fluid and stable rhythm in speech. A more marked accentuation and a more expressive melody in speech (Barnish et al., 2016; Fu et al., 2018; Matthews, 2018; Rojas Romero, 2018; Stegemöller et al., 2017 and Tamplin et al., 2019).

As with the results, the conclusions of this intervention proposal must be based on studies that have already been carried out. Regarding the general objective, the rehabilitation of the speech faculty of a person affected by PD in a way that allows him or her to function sufficiently in his or her environment, the conclusion is that it is feasible to achieve this through the resources offered by music therapy, in accordance with the results of the studies of Fodor et al. (2011). García-Casares et al. (2018) and de Leonardi et al. (2018).

On the other hand, studies such as that of Abell et al. (2017) or Barnish et al. (2016) support the possibility of achieving correct respiratory mechanics that allow controlling and optimizing the flow of breathed air to increase power and coordination in the emission of the voice through the OMREX technique applied to relaxation. Breathing and vocal emission.

Regarding the objective of toning the orofacial muscles, and as stated in the studies of Fogg-Rogers et al. (2016) and Han et al. (2018), it is concluded that it is feasible to train them and recover their functionality using the OMREX technique, as well as that it is perfectly feasible to recover the mobility of the articulatory organs, lips, tongue, palate and teeth and the coordination between them to carry out a correct production of language phonemes through the TS technique, as demonstrated in the works of Leonardi et al. (2018), Martínez-Sánchez et al. (2016) and Spina et al. (2016). Finally, the conclusion for the objective of improving the rhythm, intonation, melody and accentuation of speech to make the user's oral expression more understandable is that it is perfectly feasible through the use of the RSC, MUSTIM and VIT techniques in line with the conclusions of the studies of Miller (2012), Pohl et al. (2020) and Rojas-Romero (2018).

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