Efficacy of The Adapted Melodic Intonation Therapy: a case study of a Broca's Aphasia Patient

Eficácia da Terapia da Entonação Melódica Adaptada: Estudo de Caso de Paciente com Afasia de Broca

Eficacia de la terapia de Entonación Melódica Adaptada: Estudio de caso de un paciente con afasia de Broca

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Abstract

Introduction: Melodic Intonation Therapy (MIT) is a therapeutic method which uses the ability to sing to promote the recovery of linguistic deficits in aphasic patients with primarily expressive impairment. **Objective:** Testing the efficacy of a music-based language rehabilitation program, adapted from MIT in a patient with Broca's aphasia due to stroke in the left cerebral hemisphere (LH). **Method:** This research used the methodology of AB single case experimental design with multiple baselines. The participant G. is a female, right-handed, 46-year-old Brazilian; presenting Broca's aphasia. G. suffered an ischemic stroke five years before speech therapy intervention began. Neuropsycholinguistic evaluation was undertaken before, during, and at the end of therapy. The treatment took place over three months, in two weekly meetings (24 sessions)**. Results:** significant improvement was observed in verbal fluency, with an increased number of words produced per minute during conversational speech, anomia reduction, improved syntax and reduction of speech dyspraxia. Regarding neuropsychological functions, improvements were observed in the following functions: attention, working memory, verbal episodic semantic memory (recognition), naming, reading sentences aloud, identifying words and repeating words. **Conclusion:** the neuropsychological functions which were not trained in the MIT process remained the same before and after therapy. This indicates that improvements in the trained functions occurred due to intervention. Thus, it can be concluded that the MIT has proven effective in this case of Broca's aphasia.

Keywords: Rehabilitation; Aphasia, Broca's Aphasia; Language; Music; Neuropsychology.

Resumo

Introdução: *A preservação da habilidade de cantar tem sido utilizada para promover a recuperação linguística de pacientes afásicos com défices expressivos, sendo designada como Terapia da Entoação Melódica (TEM).* ***Objetivo:*** *Testar a eficácia terapêutica de um programa de reabilitação de linguagem através da música, com base na TEM, numa paciente com diagnóstico de afasia de Broca pós Acidente Vascular Cerebral (AVC) no hemisfério esquerdo (HE).* ***Método:*** *Desenho experimental de caso único do tipo AB com múltiplas linhas de base. Participante: sexo feminino (G.), destra, 46 anos de idade, pós AVC isquêmico há aproximadamente cinco anos com consequente afasia de Broca. Procedimentos: avaliação neuropsicolinguística antes, durante e no final da terapia. O tratamento ocorreu durante três meses, em dois encontros semanais (24 sessões).* ***Resultados:*** *Importante melhora na fluência verbal, havendo um aumento do número de palavras produzidas por minuto durante o discurso conversacional, redução das anomias, melhora na sintaxe e na dispraxia de fala. Quanto às funções neuropsicolinguísticas: melhora no desempenho da paciente nas funções de atenção, memória de trabalho, memória verbal episódico-semântica (reconhecimento), memória prospectiva, nomeação, leitura em voz alta e escrita espontânea e ditada.* ***Conclusão:*** *as funções neuropsicolinguísticas não envolvidas no processo da TEM permaneceram com desempenhos iguais nas avaliações inicial e final, indicando que as melhoras de G. nas demais funções ocorreram em virtude da intervenção. Desta forma, pode-se concluir que a TEM se mostrou eficaz para um caso de afasia de Broca.*

Palavras-chave: *Reabilitação; Afasia de Broca; Linguagem; Música; Neuropsicologia.*

Resumen

Introducción: *la preservación de la capacidad de cantar ha sido utilizada para promover la recuperación lingüística de pacientes afásicos con déficits significativos, siendo llamada Terapia de Entonación Melódica (TEM).* ***Objetivo:*** *Evaluar la eficacia de un programa de rehabilitación de lenguaje través la música, bajo la base de TEM, en una paciente con afasia de Broca después de Accidente Cerebrovascular (ACV) en el hemisferio izquierdo (HI).* ***Métodos:*** *Diseño experimental de caso único de tipo AB con múltiples líneas de base. Participante: sexo femenino (G.), diestra, 46 años de edad,*

después de Accidente Cerebrovascular isquémico hacen aproximadamente cinco años, con consecuente afasia de Broca. Procedimientos: Evaluación neuropsicolinguística antes, durante y al final de la terapia. El tratamiento fue llevado a cabo por tres meses, con frecuencia de dos sesiones por semana (24 sesiones). ***Resultados:*** *Mejora significativa en la fluidez verbal, con aumento en el número de palabras producidas por minuto durante el habla conversacional, reducción de anomias, mejora de la sintaxis y de la dispraxia del habla. Cuanto a las funciones neuropsicológicas: mejora del rendimiento en las funciones de atención, memoria de trabajo, memoria episódica verbal semántica (reconocimiento), memoria prospectiva, denominación, lectura en voz alta, escritura espontánea y dictado.* ***Conclusión:*** *las funciones neuropsicológicas no involucradas en el proceso de TEM permanecieron con actuaciones iguales en las evaluaciones inicial y final, lo que indica que las mejoras de G. en las demás funciones han sido producido por la intervención. Se puede concluir que la TEM ha demostrado eficacia en un caso de afasia de Broca.*

Palabras clave: *Rehabilitación; Afasia de Broca; Lenguaje; Música; Neuropsicología.*

Introduction

The preservation of the singing ability has been used since 1973 to promote language recovery in aphasic patients with primarily expressive deficits, being designated as melodic-intonation therapy (MIT)[1-3]. It is a rehabilitation technique aimed to develop verbal fluency and prosody through specific steps: phrases/sentences are sung to the patient who is asked to repeat them, with increase in task difficulty level according to individual patient progress[3].

In the MIT the musical elements of speech (melody and rhythm) are used to improve other aspects of expressive language, through the preserved singing ability, which is supposed to be associated to regions of the brain's right hemisphere (RH)[4]. Therefore, patients without right hemisphere lesions, with non-fluent speech or severely restriction of speech, articulation difficulties, difficulty in repeating words, language understanding preserved or moderately impaired, ability to evoke some intelligible words during the singing of familiar songs, who have motivation and emotional stability are indicated to participate in the program with MIT[5].

Although its basic principle is developing the ability of expression of oral language through singing, the MIT has several other applications. The therapy may use, or not, songs that are familiar to the patient, vary intonation and emphasize the natural melody of the phrases and gradually vary the syntactic complexity (of the lyrics), as the patient progresses[6]. The technique also proposes singing with the therapist before trying to sing alone. According to Racette, Bard e Peretz[3], only group singing improves the language of aphasic patients. These authors suggest choral singing as an effective therapy for several language deficits.

The MIT[2] was originally composed of three levels and uses high frequency words and phrases (minimum two syllables) as stimuli, including familiar names and words necessary in the patient's communication. The use of figures or other information with the auditory stimulus (word or phrase) is advised. Each item is presented with a slow and steady intonation, high and low tones and rhythmic patterns that are typical of normal language[4,7].

In Levels 1 and 2 polysyllabic words and short phrases of high frequency are sung, accompanied by the stimulus of the musical rhythm, using hand-tapping of each syllable, and Level 3 uses more complex phrases. Each step has a specific score for the analysis of patient evolution. To be able to progress to the subsequent level, the patient must have an overall score of 90% or more correct responses for five consecutive sessions, with various stimuli[7].

Level 1 is composed of five steps, and each stimulus item goes through all the steps. Level 2 is composed of four steps (practically the same steps of Level 1) when "delays" are introduced between the stimulus and the response. If the patient is

unable to complete a step, it is necessary to return to the previous step. At Level 3 of the original MIT, longer and more complex phrases are used in five steps. The transitory technique of "singing words and phrases" is used, and the pace and emphasis of each phrase are intensified. The intonation of the previous levels is abandoned and replaced by normal speech[2].

To be entitled to remain in the MIT program, the patient must have an average score of the last three sessions higher than that of the three previous sessions. The efficiency of the MIT must be assessed on a case-by-case basis, considering the improvement of communication skills in daily life. The ultimate goal is to improve fluency and expression of oral language[4].

Albert, Sparks e Helm[8] were the first authors to describe the MIT. They reported the case of a 67-year-old patient, affected by aphasia 18 months ago, who had done speech and language therapy for three months, without success, and, thus, decided to try the MIT. After only two days of treatment, the patient began to utter a few words. Two weeks later, the patient had a vocabulary of 100 words, and six weeks later, he was able to keep simple conversations. Since the first report of these authors, the number of studies aimed to investigate the efficacy of the MIT is gradually increasing, although there are still few studies on this theme, compared to others involving more standard techniques (e.g. naming technique).

In one chapter of his book "Musicophilia", Sacks[9] described the case of an aphasic patient (severe expressive aphasia) who did not obtain improvement in language after two years of intensive speech therapy. However, as it was noted that the patient could sing, articulating two to three words properly and singing a familiar tune musical therapy sessions began, three times a week, lasting half an hour each. The patient was able to sing in unison with the therapist and accompanied him on the accordion. Two months later, the patient was capable of producing short and functional sentences, which had a significant effect on his daily life.

One hypothesis to explain how the MIT can help in the communication of aphasic patients is that the skills of language production, normally activated in the left hemisphere (LH) of the brain, are then processed in areas of the intact right hemisphere (RH). Thus, to some extent, this would be a compensation for the deficiency of the LH [3]. Studies conducted at the end of the 19th century are consistent with this theory, since they demonstrated that aphasic patients with left hemisphere lesions who developed skills of language expression following MIT had these recovered skills reduced after new lesions in the right hemisphere.

In this context, it is hypothesized that brain plasticity occurs through modifications in non-damaged regions, with the promotion of a reorganization of the intact regions[3]. This form of brain reorganization after lesion is known as plasticity of homologous areas, that is, when an adjacent area compensates for the loss of function due to a localized brain lesion (contra-lateral hemisphere)[10]. Also, there is evidence of significant increase in the fiber number of the arcuate fasciculus following MIT[11], reactivation of areas of the brain associated with language (such as Broca's area in the LH) and reduction in the normal activation of areas of the RH[12].

Besides improving language skills, sung words are articulated more slowly, which favors fluency and intelligibility of speech also in patients with motor disorders such as dysarthria[3,6]. Music (singing and simultaneous rhythmic tapping) can help in the recovery of speech and also create a structure that facilitates the beginning and programming of the complex general motor response[13]. Since the words and melodies are learned at the same time, lexical access is facilitated due to association with the memorized melody[3,6].

Music can also help improve other neuropsycholinguistic functions[13], being related to skills such as perception, emotion, learning, memory[14] and executive functions[15]. So, it is believed that music and language share some important neurological, anatomical and functional processes[16].

Analyzes of studies involving aphasic patients with left hemisphere lesions show positive results regarding the benefits of the use of singing in the improvement of language production. There is evidence that aphasic patients repeat and remember more words when sung than when spoken, showing that singing in synchrony with an auditory model is more effective than speaking in synchrony[3]. In addition to its applicability for aphasic patients, MIT is also an effective method of verbal stimulation in children with Down Syndrome and apraxia[17].

Relatively little research has been conducted on the effectiveness of MIT in aphasic patients compared to the number of studies on more popular and widely used methods, such as the naming technique. In general, the analyzed studies, although differing in the type of application of the MIT, intensity, total time and frequency of intervention sessions, show that the MIT results in improvement of language skills in aphasic patients (LH lesion). The analyzed studies on the recovery of language with MIT involved one[18], three1, six[11] and seven[12] cases of expressive aphasic patients. All the studies stress the effectiveness of the therapy in the studied cases, However, they changed regarding the number of sessions and weekly frequency. These studies reported the use of five hours per week of MIT during two months[18], fifteen sessions, three times a week1, of 75 to 80 sessions (five times a week)[11] and one month to nine years of therapy[12].

Studies show significant improvements in understanding skills, as well in those associated to the expression of oral language1, increase in the amount of correct information produced during spontaneous speech (per minute)[11,18], improved verbal skills in spontaneous speech, repetition and naming[19.] In general, Racette, Bard and Peretz[3] propose the use of musical therapy in the treatment of aphasic patients because of benefits that can only be provided by music.

In this context, the main purpose of this study was to demonstrate the therapeutic efficacy of a program of language rehabilitation using music, based on the MIT[2], in one female patient diagnosed with Broca's aphasia post stroke (CVA) in the LH. It should be stressed that the main aspect that distinguishes this study from others is the use of an innovative technique: an adaptation of the original MIT using Brazilian popular music to promote the expression of the patient's oral language. Also, by using pre and post neuropsycholinguistic investigation, we intended to demonstrate the overall cognitive evolution of the patient, not only in language aspects.

Presentation of the clinical case

Participant

The present study used A-B single-subject experimental multiple baseline design[19]. The participant is a 46-year-old, right-handed woman from Porto Alegre (RS/Brazil). She is a retired secretary who has completed nine years of formal education, with C1 economic classification. The patient had a stroke (CVA) about five years before the onset of speech therapy. Neuroimaging (CT of the skull) showed lesion affecting irrigation topography of the left middle cerebral artery (frontotemporal region). As a consequence of ischemic stroke in the LH, the patient had Broca's aphasia (diagnosed after clinical evaluation with the Boston Diagnostic Aphasia Examination) and right hemiplegia.

Regarding language aspects, in the initial assessment the patient had non-fluent speech associated to speech dyspraxia, anomias, phonological paraphasias and agrammatism, with reasonably preserved understanding of language, as will be detailed in the results of her neuropsycholinguistic assessment. The patient showed no signs of depression, according to scores of the Beck Depression Inventory.

The patient never had consistent reading and writing habits. She is currently reading one book a few times a week and writes telephone messages. A former smoker, who used to smoke around five cigarettes per day, she quit smoking ten years ago. Besides, she occasionally consumed alcoholic beverages before the neurological lesion, which she does not do anymore.

The patient lives alone, despite receiving weekly visits from her sister, who provides lunch and the other meals. She manages to move around (by bus), goes shopping and pays bills independently. Also, she has been doing physiotherapy since the stroke (currently two weekly sessions). She had traditional speech and language therapy sessions for six months after the lesion and began MIT sessions five years after the stroke.

Specific instruments and procedures

The study was conducted according to the ethical principles for conducting research with human participants. The project was approved by the Research Ethics Committee of Hospital de Clínicas de Porto Alegre (HCPA), Porto Alegre, RS, Brazil), under protocol number 09097.

For inclusion in the study and collection of clinical and demographic information, the initial assessment comprised the completion of the general health and socio-demographic questionnaire and the Beck Depression Inventory, in order to exclude evidence of moderate to severe depression. The following instruments were used in the neuropsycholinguistic assessment: the Boston Diagnostic Aphasia Examination – Short Form, Brazilian version published by Bonini[20], Short Form Token Test for Aphasia, the Functional Assessment of Communication Skills (ASHA-Facs – American Speech and Hearing Association) and the NEUPSILIN-Af Brief Neuropsychological Assessment Instrument for patients with expressive aphasia[21,22]. NEUPSILIN-Af is an adaptation of the Brief Neuropsychological Assessment Instrument NEUPSILIN[23] to be used in patients with expressive aphasia. It briefly assesses the following cognitive functions: temporal and spatial orientation, perception, arithmetic skills, language, memory, executive functions and praxias.

A neuropsycholinguistic assessment was then performed before, during (evaluation of speech) and at the end of the therapy. To avoid the possibility of biased judgments, the expert who made the initial and final assessments was not the same who developed the procedure. The patient had no in-depth musical knowledge before the stroke.

In the three first assessment sessions, at the end of each eight sessions and after the therapy, the patient's speech rate was measured (SR)[24]. For this measure, two minutes of conversation between the therapist and the patient were recorded and later transcribed. All the sessions were recorded in audio and video to assist the analysis of data and ensure greater control of the therapeutic process. Thus, sessions 8, 16 and 24 were therapy sessions where the speech rate was measured at the end of the appointments. The other sessions (1st, 2nd, 3rd and 27th) were assessment sessions (neuropsycholinguistic assessments).

After the three months of treatment set out by the study, the patient was referred to the speech and language therapy service of Universidade Federal do Rio Grande do Sul (UFRGS), to continue the treatment and began rehabilitation treatment in a group for aphasic patients.

Adapted Melodic Intonation Therapy (Adapted MIT)

The speech therapy lasted three months, in two weekly meetings, with an average duration of 45 minutes each, totaling 24 sessions. In adapted MIT, the patient went through the same previously described steps of the traditional MIT. However, the stimuli used were not highly familiar and desirable words and phrases, but lyrics of popular Brazilian songs. The choice of this adaptation is related to the patient's motivation and the interest in investigating the effectiveness of this approach. Songs with lyrics containing simple words and sentences, which are usually used in everyday life. The song was selected with the patient, taking into consideration her musical preferences. The two following popular Brazilian songs were used for stimulation: *"Como é grande o meu amor por você"*, by Roberto Carlos, and *"Coração em desalinho",* by Mauro Diniz and Ratinho. In order to facilitate lexical access in the song, the therapy began with slow tempo music, with the aid of reading and illustrative figures.

At first, the patient listened to the music selected during the therapy. The song lyrics were trained with the aid of reading and figures related to the content of the reading. At the same time, the correct intonation of the music was exercised with the use of audio (CD). When the patient was able to sing the whole song without the help of the therapist, merely watching the visual material, and managed to recite it with the intonation used in normal speech, a new song was picked up, which had the same above mentioned patterns, i.e., simple words and sentences and slow tempo music.

The music therapy was divided in the three steps of the MIT, initially targeting isolated words and then musical phrases. The purpose here was that the whole lyrics was sung and then recited. Each part of the song was separately stimulated, in order to stimulate the patient to sing short passages of the song. Gradually, as the patient advanced to a subsequent level, longer passages of the song were introduced, and the patient was encouraged to just reciting the lyrics, leading to normal prosodic speech production. Each musical phrase went through the three levels, and, consequently, through all the

steps of each level. However, in Level 1, the patient should verbalize only the last word of the phrase; in Level 2, the last two words of the phrase and in Level 3, the whole phrase.

Images related to all the phrases were displayed on the computer screen. After training all the phrases of a musical stanza (going through all the levels), the patient was encouraged to sing and then to speak the words of the whole stanza. After the training of all stanzas, the patient was encouraged to sing and then recite (speak) the words/phrases of the whole song.

Approximately 18 phrases were trained in each session, with only level covered in each appointment. The phrases were repeated in the following sessions. Level 2 only began when Level 1 was extensively exercised. Thus, in average, twelve sessions were used for each music, with four sessions for each level.

Results

Initially, the results related to the patient's performance in the language tasks assessed by the Boston Diagnostic Aphasia Examination - Short Form, Token Test and speech analysis (speech rate) will be exposed. Subsequently, the patient's performance in the tasks of the NEUPSILIN-Af - Brief Neuropsychological Assessment Instrument for patients with expressive aphasia, before and after intervention with adapted MIT, will be presented.

1.1. Patient's performance in Language tasks before, during and after intervention with adapted MIT

In the initial assessment of language (Boston Diagnostic Aphasia Examination Short Form and speech analysis), the patient showed non-fluent speech associated to speech dyspraxia, phonological paraphasias and agrammatism. From the 16th session on and after treatment (27th session) there was significant improvement in verbal fluency, with increase in the number of words produced per minute during conversational speech (SR) (Chart 1). Besides, qualitative observational assessment, showed reduction in anomies and improvement in syntax and speech dyspraxia.

Chart 1 – Speech Rate (SR)– number of correct words produced per minute during the speech

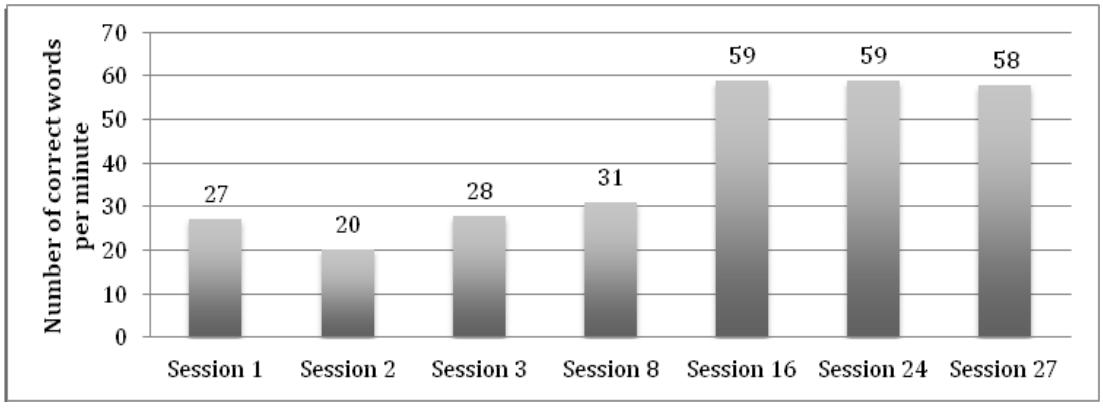
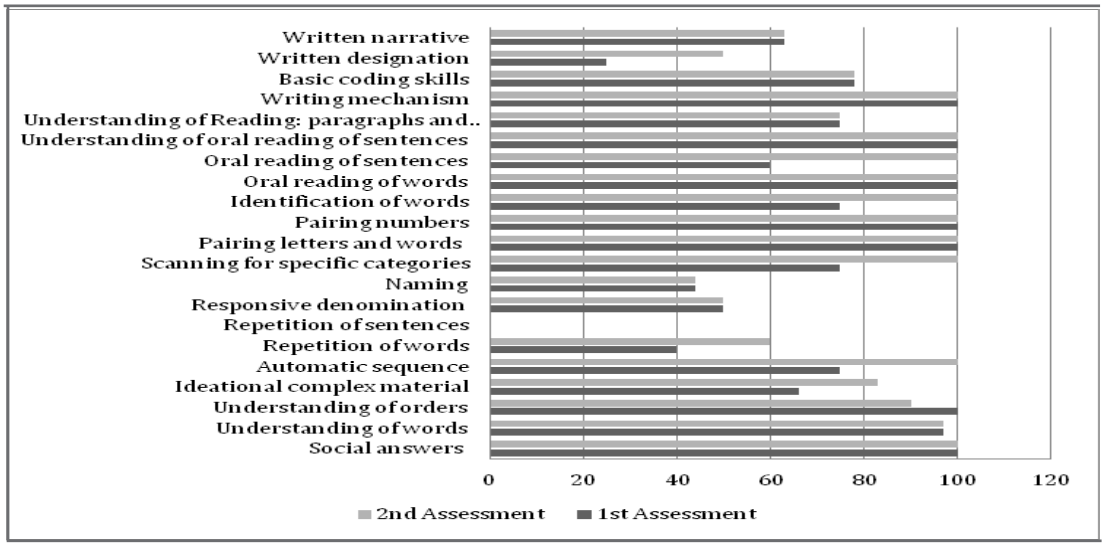


Chart 2 shows the patient's results in the assessment of oral and written language skills using Boston Diagnostic Aphasia Examination - Short Form before and after the intervention. This test revealed increase in the percentage of correct answers of the patient in the tasks of oral language understanding Complex Ideational Material), naming of specific categories (letter, number and color), word repetition, verbalization of automatic sequences, reading (oral reading of sentences and identification of words) and written designation, as illustrated in Chart 2. Token Test for Aphasia showed that the percentage of correct answers increased from 72% to 78%.

Chart 2 – Percentage of correct answers in the assessment of language using the Boston Diagnostic Aphasia Examination, Short Form before and after the intervention



Performance of the case in NEUPSILIN-Af and ASHA-Facs tasks, before and after intervention with adapted MIT

Regarding the neuropsycholinguistic functions assessed with NEUPSILIN-Af (Table 1), the patient showed improved performance in the functions attention, working memory (word and sentence span), semantic and episodic verbal memory (recognition), prospective memory, naming technique, reading aloud and spontaneous and dictated writing. In the semantic and episodic verbal memory (recognition) and dictated writing tasks, the patient obtained only one raw score above the score obtained in the first assessment, suggesting that the evolution was not significant. Regarding the naming technique, prospective memory and spontaneous writing tasks, despite the difference of only one raw score again, the performance evolved to the maximum scores.

The tasks of repetition, praxias, spelling fluency and semantic fluency obtained scores slightly lower. However, in all these subtests the reduction was only one raw score below the score obtained in the first assessment (e.g. the score of semantic fluency changed from 13 to 12 verbalized words). The other assessed functions maintained the same score of the initial assessment.

Table 1 - Performance (raw scores and Z scores) and interpretation of the results of the patient in the NEUPSILIN-Af in the first and second neuropsycholinguistic assessments

Neuropsycholinguistic Tasks (maximum score)	1st Assessment Raw score (Z)	2nd Assessment Raw score (Z)	Interpretation
Total Temporo-spatial Orientation (Oral Response) (8)	8 (0,46)	8 (0,46)	Unchanged
Total Temporo-spatial Orientation (Motor Response) (8)	8 (0,28)	8 (0,28)	Unchanged
Temporal Orientation (Oral Response) (4)	4 (0,5)	4 (0,5)	Unchanged
Orientação Temporal (Resposta Motora) (4)	4 (0,30)	4 (0,30)	Unchanged
Temporal Orientation (Oral Response) (4)	4 (0,38)	4 (0,38)	Unchanged
Temporal Orientation (Motor Response) (4)	4 (0,24)	4 (0,24)	Unchanged
Total Attention (34)	12 (-0,66)	16 (-0,27)	1ª < 2ª
Reverse Counting (20)	12 (-0,32)	16 (0,16)	1ª < 2ª
Digit Sequence Repetition (14)	0 (-1,27)	0 (-1,27)	Unchanged
Total Perception (12)	10 (-0,04)	10 (-0,04)	Unchanged
Total Memory (Oral Response) (88)	38 (-0,72)	44 (-0,31)	1ª < 2ª
Total Memory (Motor Response) (88)	38 (-0,82)	44 (-0,38)	1ª < 2ª
Total Working Memory (38)	10 (-1,13)	14 (-0,55)	1ª < 2ª
Inverse Digit Ordering (10)	3 (-0,25)	3 (-0,25)	Unchanged
Word and Sentence Span (28)	7 (-1,22)	11 (-0,51)	1ª < 2ª
Total Episodic-Semantic Verbal Memory (40)	20 (-0,35)	21 (-0,21)	1ª < 2ª
Immediate Evocation (9)	3 (-0,61)	3 (-0,61)	Unchanged
Delayed Evocation (9)	2 (-0,32)	2 (-0,32)	Unchanged
Recognition (22)	15 (-0,16)	16 (0,14)	1ª < 2ª
Long Term Semantic Memory (Oral Response) (5)	5 (0,51)	5 (0,51)	Unchanged
Long Term Semantic Memory (Motor Response) (5)	5 (0,45)	5 (0,45)	Unchanged

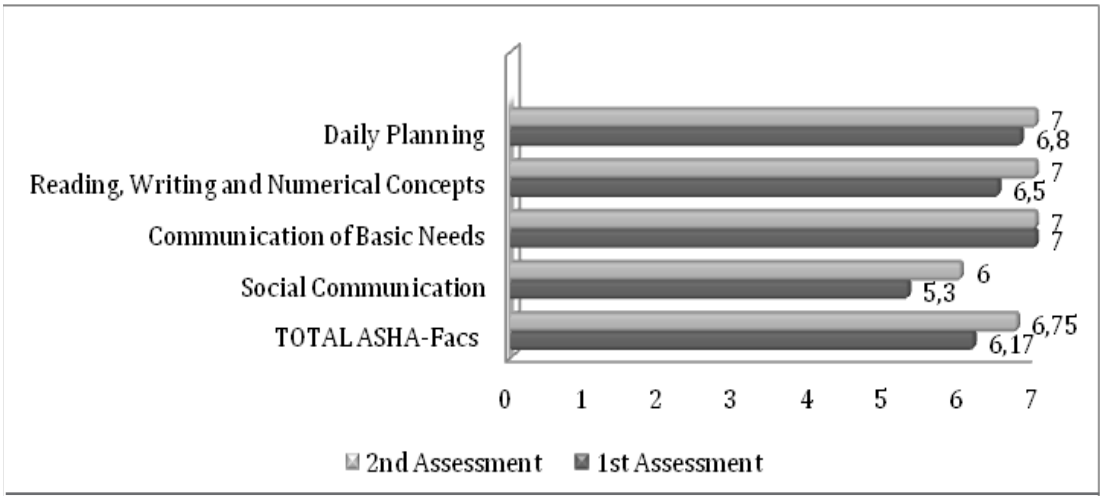
Continuation Table 1 - Performance (raw scores and Z scores) and interpretation of the results of the patient in the NEUPSILIN-Af in the first and second neuropsycholinguistic assessments

Neuropsycholinguistic Tasks (maximum score)	1st Assessment Raw score (Z)	2nd Assessment Raw score (Z)	Interpretation
Short-Term Visual Memory (3)	2 (-1,30)	2 (-1,30)	Unchanged
Prospective Memory (2)	1 (-1,02)	2 (0,59)	1ª < 2ª
Arithmetic Skills (8)	6 (-0,01)	6 (-0,01)	Unchanged
Total Language (Oral Response) (55)	33 (-0,58)	39 (-0,20)	1ª < 2ª
Total Language (Motor Response) (55)	34 (-0,56)	40 (-0,17)	1ª < 2ª
Total Oral Language (Oral Response) (24)	17 (-0,37)	17 (-0,37)	Unchanged
Total Oral Language (Motor Response) (24)	18 (-0,32)	18 (-0,32)	Unchanged
Automatic Language (4)	2 (-0,83)	2 (-0,83)	Unchanged
Naming Technique (4)	3 (-0,35)	4 (0,46)	1ª < 2ª
Repetition (10)	7 (-0,40)	6 (-0,74)	1ª > 2ª
Oral Understanding (3)	3 (0,46)	3 (0,46)	Unchanged
Processing of Inferences (Oral Response) (3)	2 (0,08)	2 (0,08)	Unchanged
Processing of Inferences (Motor Response) (3)	3 (0,64)	3 (0,64)	Unchanged
Total Written Language (31)	16 (-0,71)	22 (-0,07)	1ª < 2ª
Reading Aloud (12)	5 (-0,97)	9 (-0,03)	1ª < 2ª
Written Understanding (3)	3 (0,54)	3 (0,54)	Inalterada
Spontaneous Writing (2)	1 (-0,19)	2 (0,99)	1ª < 2ª
Copied Writing (2)	2 (0,65)	2 (0,65)	Inalterada
Dictated Writing (12)	5 (-0,72)	6 (-0,49)	1ª < 2ª
Total Praxias (22)	15 (-0,30)	14 (-0,55)	1ª > 2ª
Resolution of Problems (Oral Response) (2)	2 (0,74)	2 (0,74)	Inalterada
Resolution of Problems (Motor Response) (2)	2 (0,64)	2 (0,64)	Inalterada
Executive functions Spelling Fluency (number of words)	2 (-0,97)	1 (-1,05)	1ª > 2ª
Semantic Fluency (number of words)	13 (-0,56)	12 (-0,65)	1ª > 2ª

Note. Unchanged = the results remained unchanged before and after MIT. 1ª > 2ª = results of the first assessment with higher scores than those of the second assessment. 1ª < 2ª = results of the first assessment with lower scores than those in the second assessment.

In the assessment of functional communication with ASHA-Facs, which provides information on communication in the daily life, there were also some progresses after treatment (Chart 3). It is important to stress that the maximum value assigned to patients in this scale is seven, that is, the higher the value, the more the patient is functional. Also, the area that showed greater progress is social communication. The areas of planning and reading, writing and numerical concepts, which had already obtained high scores, reached the maximum score.

Chart 3 – Patient responses to ASHA-Facs in the first and second assessment



Discussion

At first, the results referring to the performance of the patient in language tasks (expression and understanding of language and speech analysis) will be discussed. Then, the performance of the patient in the tasks of the Brief Neuropsychological Assessment Instrument for patients with expressive aphasia - NEUPSILIN-Af[21,22], before and after intervention with adapted MIT will be discussed, and finally the results of the measures of communication functionality will be discussed. There is a relationship between the results of the assessment of language and of other neuropsycholinguistic functions, especially those related to the functions working memory, semantic and episodic verbal memory and attention, and sometimes it is not possible to separate this evidence during the discussion.

The adapted MIT that uses Brazilian popular music had important implications on the rehabilitation process, since besides stimulating the expression of oral language, has naturally attracted the patient, providing her with the necessary motivation to pursue the treatment. Some studies on the use of MIT in patients with expressive aphasia have already been reported in the literature on the subject[1,13,14,17,21]. However, no studies were found on the use of Brazilian popular music to develop verbal fluency in aphasic patients.

Regarding brain neuroplasticity, it is known that the recovery of language in early and late stages, after stroke (CVA), is presumed to be associated to different underlying neural processes[25]. In the early stages after CVA, improvement in verbal communication may occur because of the recovery of the neural networks originally involved in language production. In the chronic stage, in turn, function recovery is explained by a replacement, in which intact neural tissues, not originally involved with the lost function, are recruited[25]. Thus, interventions aimed to reestablish regions of language in the RH, such as the MIT, are more appropriate in the chronic stage, as demonstrated in this study.

The results of the intervention allowed concluding that adapted MIT was effective in this case of Broca's aphasia. There was improvement only in the linguistic variables directly or indirectly involved in the intervention (naming technique, identification of words, oral reading of words and sentences and word repetition) and the phonological component of the working memory (verbal working memory). Also, there was a gradual increase in the number of words produced per minute, assessed by the Speech Rate (SR) in a spontaneous speech task. Regarding attention (Reverse Counting), another ability in which the patient made progress, this task requires verbal skills and mental control of verbal numerical information. Since there is a close relationship between language and verbal memory[26], it is expected that the intervention used to improve a function also improves the other.

The referred patient also showed improvement in her speech dyspraxia, which was detected in the initial qualitative assessment, in a spontaneous speech task. As it is known that singing can aid in the initiation of speech, by creating a structure that facilitates the beginning and programming of the general motor response[13], this technique is also used in cases of speech dyspraxia. Roper[17] studied the use of MIT in six children with speech dyspraxia and, although his findings were not conclusive because of the method used, the children experienced improvement after the intervention, just as the study reported here.

In addition to the difficulties of lexical access and syntax problems (agrammatism) presented by the patient, speech dyspraxia also impacted speech fluency. One measure that is often used to check speech fluency is the measure of the number of words verbalized per minute (speech rate – SR)[24]. In the initial assessment of the spontaneous speech, the patients produced approximately 25 words per minute, with many pauses and hesitations, besides the articulatory groping typical of dyspraxias. After the therapy, however, the number of words produced per minute increased to an average of 59, indicating a considerable improvement in the fluency of spontaneous speech.

Studies that used MIT in aphasic patients also demonstrated the increase in the number of words produced per minute in spontaneous speech following the intervention[11,16]. Likewise, Sandt-Koenderman and collaborators[18], reported an increase from 22.5 to 55 correct words produced per minute (increase of 32.5 words) in one patient after intervention with MIT, for a two-month period (five weekly hours). The same speech characteristics were observed in this clinical report, in which after three months after MIT (in average one hour and a half hour weekly), the patient was showed an increase of 34 words produced per minute.

Other techniques for the rehabilitation of aphasia also showed increase in speech rate (SR) in patients with expressive aphasia, such as the specific linguistic treatment for agrammatism, intensive therapy for multiple language disorders, Computerized Conversational Script Training: "AphasiaScript", the ORLA – Oral Reading for Language in Aphasia and the augmentative communication system[27]. Thus, besides its wide use, this measure is apparently very functional, since it involves a skill of daily life, being suitable for measuring the generalization of the effects of the therapy.

Other articles that mention the MIT used measures of the expression and understanding of oral and written language assessed with specific tests for aphasia, such as the Boston Diagnostic Aphasia Examination and the Token Test for Aphasia, for example[6,12]. Similarly, the present study also shows increase in the percentage of correct answers in some tasks of the Boston Diagnostic Aphasia Examination and the Token Test for Aphasia.

The percentage of correct answers of the patient in the Token Test for Aphasia and the task with the Complex Ideational Material of the Boston Test (oral understanding) increased. Thus, although G. did not have significant listening problems, there was improvement in this regard too. Bonakdarpour et al.[1], also demonstrated improved understanding of oral language in two of the three aphasic patients who had MIT intervention.

Considerable improvement in working memory was observed, which probably had a significant positive impact on the patient's ability to communicate. The working memory is crucial for understanding language, because it is necessary to integrate information, and resolving pronoun ambiguities[26]. This evidence may explain the improvement in

the scores of working memory tasks (word and sentence span) from NEUPSILIN-Af demonstrated by the patient. Thus, the improvement in working memory has probably led to improved understanding of oral language of phrases and stories (Token Test for Aphasia and Complex Ideational Material) and in the production of oral language.

The tasks performed in Adapted MIT include the repetition of different length musical phrases. Repetitions should occur immediately after and also five seconds after listening to the target--phrase. These activities clearly require the use of the working memory to be properly performed. It is known that the syntactic processing is directly related to the working memory, since the understanding of a phrase involves not only identifying the meaning of words (lexical access), but also understanding the relationships between them in a specific order[28]. Thus, the working memory is essential to keep information (heard or read) activated and simultaneously processing the same or other[26].

There was also improvement in the skills of naming specific categories (letters, numbers and colors), reading (oral reading of sentences and identification of words), spontaneous writing and dictated writing. Adapted MIT used visual stimuli that were always associated to an image (figure) corresponding to the material read and heard concomitantly with the melody of the song. The images used have probably facilitated lexical access, consequently stimulating reading, although this was not initially intended. With the stimulation of reading, it is believed that there was also a generalization for writing.

Increase in the percentage of correct answers involving repetition of words and the verbalization of automatic sequences was also observed after the intervention. This evolution is explained by the fact that the Adapted MIT, as previously mentioned, used many tasks of repetition of words and phrases. Besides, the songs were always selected by the patient, and, thus, familiar to her and sung in an automated way. According to Sacks[9] , singing familiar songs is a sort of automatic speech, explaining the improvement of the patient in this task (verbalization of automatic sequences).

Concerning the neuropsycholinguistic assessment, the patient also showed improvement in her performance between the first and the second assessment in the tasks of attention, working memory, verbal memory (recognition), spontaneous writing and copied writing. Although the main focus of the rehabilitation therapy concerned the oral expressive aspects, the whole intervention was based on the reading of words and phrases and on the repetition of this different length phrases by the patient. Thus, reading and working memory were also constantly practiced. Besides, attention plays an important role in all rehabilitation activities, since difficulty with attention impairs the processing of information, and, in the case of aphasic patients, impairs the ability to understand spoken or graphic stimuli5. The music automatically captures the attention of people, which explains the improvement in attention-related aspects by the patient after the intervention[29].

Likewise, one may think that memory is always required in a therapeutic process, since it is a learning process[5]. One cognitive factor that contributes to the effects of musical therapy is the memory process related to music (e.g. encoding, storage and decoding of musical experiences), as well as processes related to the analysis of musical syntax and musical meaning[29]. These aspects explain the patient's improvement in the functions of recognition of semantic and episodic verbal memory and prospective memory.

It is believed that with music, the words and the melody are simultaneously learnt, facilitating lexical access due to its association with the melody in implicit memory[3,6]. One of the strategies most used in the rehabilitation of memory is the use of preserved implicit memory to compensate for deficits in episodic memory. Therefore, the adapted MIT, although aimed at the improvement in the verbal fluency of the patient, had also a positive effect on memory.

The pre and post intervention measures with traditional neuropsycholinguistic tests showed evidence of the efficacy of the MIT in the clinical case described here. Every rehabilitation process, however, has the ultimate goal of making patients independent, that is, capable of using the functions worked in the therapy, also in their daily activities. So, functionality measures are essential to check the efficacy of the treatment in the patients' everyday

lives. The assessment of functionality is gaining ever more importance in programs of intervention and cognitive rehabilitation, so that the therapist is required to check the individual's ability to perform daily activities[30].

One measure used to assess the functional communication of adult patients is the ASHA-Facs (American Speech-Language-Hearing Association Functional Assessment of Communication Skills for Adults). This is an important assessment that seeks to investigate every form of verbal and non--verbal communication, in addition to the patients' ability to communicate their needs (independence) as appropriate responses to daily demands.

Positive results were also obtained after treatment in the assessment with ASHA-Facs. It should be stressed that the patient, in spite of significant expressive difficulties, had adequate communication skills and was able to express her basic needs. However, she obtained slightly low scores for daily planning; reading; writing and numerical concepts and social communication. All these domains assessed through the ASHA-Facs had higher scores after the intervention. So, it is suggested that there was improvement in the skills exercised during the therapy aimed to facilitate the patient's daily activities.

Finally, neuropsycholinguistic functions not involved in the MIT process, such as temporal and spatial orientation, arithmetic skills and visual memory, praxias, among others, had the same performances in the initial and final assessments, indicating that the improvements of the reported case in the other functions were caused by the intervention. Therefore, it can be seen that there was no widespread improvement in the patient's performance suggesting that an unexpected factor, rather than the treatment administered, would be involved in the referred improvement (e.g. spontaneous recovery)[19].

Final Comments

The main purpose of this study was to demonstrate the therapeutic efficacy of adapted MIT in a patient with predominantly expressive aphasia. The adaptation of the therapy aimed to adjust it to the cultural context of the patient. There was improvement in significant aspects of expressive and comprehensive language (structural and functional aspects), as well as of the working memory and the semantic and episodic verbal memory (recognition) of the patient. Progress on extra linguistic skills demonstrated the relevance of different cognitive skills for communication. A thorough neuropsycholinguistic assessment that goes beyond language should be performed, since the speech rehabilitation process involves a wide variety of cognitive functions.

Moreover, although the intervention has occurred in a short period of time (three months) and only twice a week, the MIT was effective and its use, on a permanent basis, is strongly advised to improve the communication skills of the referred patient.

It could be said that the patient had better performance in the assessed tasks because she has being performing these tasks over time (specific learning on the tests), since, these tests were performed before and only three months after the intervention. However, the linguistic measures of words produced per minute, and the patient's perception on her communication (measured by the ASHA-Facs), indicate that the intervention contributed to a better oral expression of the patient in her daily life. To reinforce these findings, it is recommended to reassess the patient after a few months, without the intervention (ABA method[19]), in order to check the stability of these results. However, it would be unethical to deprive the patient from care.

Aiming to obtain a widespread generalization of these findings to patients with expressive aphasia, we suggest the use of Adapted MIT in groups of patients. However, it is difficult to investigate the therapeutic efficacy in clinical groups due to the great heterogeneity of signs and symptoms in neurological patients and the interference of other variables, such as age, schooling, sex and reading habits. Thus, it can be concluded that the MIT was effective in this case of Broca's aphasia.

References

1.Bonakdarpour B, Eftekharzadeh A, Ashayeri H. Preliminary report on the effects of melodic intonation therapy in the rehabilitation of Persian aphasic patients. Int J Medic Science. 2000;25(3-4): 156-60.

2.Helm-Estabrooks N, Nicholas M, Morgan A. Melodic Intonation Therapy. Austin: Pro-Ed; 1989.

3.Racette A, Bard C, Peretz I. Making non-fluent aphasic speak: Sing along! Brain. 2006;129(10):2571-84.
4.Norton, Zipse L, Marchina S, Schlaug G. Melodic Intonation Therapy: Shared insights on how it is done and why it might help. Ann. N.Y. Acad. Sci. The Neurosciences and Music III: Disord Plastic. 2009;1169:431-6.
5.Helm-Estabrooks N, Albert ML. Manual of Aphasia and Aphasia Therapy. Austin: Pro-Ed.; 2003: 281.
6.Hébert S, Racette A, Gagnon L, Peretz I. Revisiting the dissociation between singing and speaking in expressive aphasia. Brain. 2003;126:1838-50.
7.Helm-Estabrooks N, Albert ML. Manual de terapia de la afasia. Madrid: Editorial Médica Panamericana; 1991.
8.Albert M, Sparks R, Helm N. Melodic intonation therapy for aphasia. Arc Neurol. 1973;29:130-1.
9.Sacks O. Speech and song: Aphasia end music therapy. In O. Sacks, Musicophilia: Tales of music and the brain. New York, Toronto: Alfred A. Knopf; 2007.
10.Muszkat M, Mello CB. Neuroplasticidade e reabilitação neuropsicológica. In J. Abrisqueta-Gomes (Org.), Reabilitação neuropsicológica: Abordagem interdisciplinar e modelos conceituais na prática clínica. Porto Alegre: Artmed; 2012.
11.Schlaug G, Marchina S, Norton A. Evidence for plasticity in white-matter tracts of patients with chronic Broca's aphasia undergoing intense intonation-based speech therapy. Annals of the New York Academy of Sciences. 2009; 1169: 385-94.
12.Belin P, Van Eeckhout M, Zilbovicius M, Remy P, François C, Guillaume S, Chain F, Rancurel G, Samson Y. Recovery from nonfluent aphasia after melodic intonation therapy: A PET study. Neurology. 1996;47:1504-11.
13.Lopez ALL, Carvalho P. Musicoterapia com hemiplégicos: Um trabalho integrado à fisioterapia. Rio de Janeiro: Enelivros; 1999.
14.Pantev, C. Part III Introduction: Musical training and induced cortical plasticity. Ann. N.Y. Acad. Sci. The Neurosciences and Music III: Disord Plastic. 2009;1169:131-2.
15.Trainor LJ, Shahin AJ, Roberts LE. Understandig the benefits of musical training: Effects on oscillatory brain activity. Academy Science. The Neurosciences and Music III: Disord Plastic. 2009;1169:133-42.
16.Kim M, Tomaino CM. Protocol evaluation for effective music therapy for persons with nonfluent aphasia. Top Stroke Rehab. 2008;15(6):555-69.
17.Roper N. Melodic Intonation Therapy with young children with apraxia. Bridges. 2003;1(3):1-7.
18.Sandt-Koenderman M, Smits M, Meulen I, Visch-Brink E, Lugt A, Ribbers G. A case study of Melodic Intonation Therapy (MIT) in the subacute stage of aphasia: Early re-reactivation of left hemisphere structures. Procedia Social Behav Scienc. 2010;6:241-3.
19.Covre P. Desenho experimental de caso único: uma alternativa para a avaliação da eficácia em reabilitação neuropsicológica. In J. Abrisqueta-Gomez (Org.), Reabilitação Neuropsicológica: Abordagem interdisciplinar e modelos conceituais na prática clínica (pp. 343-350). Porto Alegre: Artmed; 2012.
20.Bonini MV. Relação entre alterações de linguagem e déficits cognitivos não linguísticos em indivíduos afásicos após Acidente Vascular Encefálico. [Dissertação de Mestrado]. Faculdade de Medicina da Universidade Federal de São Paulo; 2010.
21.Fontoura DR, Rodrigues JC, Parente MAPP, Fonseca R, Salles JF. Adaptação do Instrumento de Avaliação Neuropsicológica Breve NEUPSILIN para avaliar pacientes com afasia expressiva: NEUPSILIN-Af. Ciênc Cog. 2011;16(3):78-94.
22.Fontoura DR, Rodrigues JC, Mansur L, Monção AM, Salles JF. Neuropsycholinguistic Profile of Patients Post-Stroke in the Left Hemisphere with Expressive Aphasia. Rev Neuropsicol Neuropsiquiat Neurocienc. 2013;13(2):91-110.
23.Fonseca RP, Salles JF, Parente MAMP. NEUPSILIN: Instrumento de Avaliação Neuropsicoplógica Breve. São Paulo: Vetor; 2009.
24.Berndt RS, Wayland S, Rochon E, Saffran EM, Schwartz M. Quantitative production analysis: A training manual for the analysis of aphasic sentence production. Hove: Psychology Press; 2000.
25.Meulen I, Sandt-Koenderman ME, Ribbers GM. Melodic intonation therapy: Present controversies and future opportunities. Arc Physis Med Rehab. 2012;93(1):46-52.
26.Caspari I, Parkinson SR, LaPointe LL, Katz RC. Working memory and aphasia. Brain Cog. 1998;37:205-23.
27.Fontoura DR, Rodrigues J, Carneiro L, Monção A, Salles J. Rehabilitation of language in expressive aphasias: a literature review. Dement Neuropsychol. 2012;6:1-4.
28.Parente MAMP, Salles JF. Processamento da linguagem em tarefas de memória. In. A. Oliveira (Org.), Memória, cognição e comportamento. São Paulo: Casa do Psicólogo; 2007.
29.Koelsch S. A neuroscientific perspective on music therapy. Academy Science. The Neurosciences and Music III: Disord Plastic. 2009;1169:374-84.
30.Novelli MMPC, Canon MBF. Avaliação da funcionalidade nos programas de reabilitação cognitiva. In J. Abrisqueta-Gomes (Org.). Reabilitação neuropsicológica: abordagem interdisciplinar e modelos conceituais na prática clínica. Porto Alegre: Artmed; 2012.