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ETHHAR, DIGITAL APPLICATION TO RECONSTRUCT MEMORIES THROUGH MUSIC

ETHHAR, aplicación digital para reconstruir recuerdos a través de la música

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Abstract

Introduction: Alzheimer's disease affects over 50 million people worldwide, and personalised music is emerging as a promising non-pharmacological option. This case study, conducted in Montevideo (Uruguay), evaluates Ethhar, an app that builds playlists linked to each patient's life history.

Objectives: To examine the cognitive-behavioural impact of personalised musical interventions on autobiographical memory and self-awareness in people with Alzheimer's disease.

Method: An ABA design was applied with four female patients (aged 79-89, GDS 5-6) treated at IMEDER. During twelve sessions (two per week, one month) the quality of autobiographical recall was assessed with the TEMPau test before and after listening to 30-minute playlists generated from a 17-item questionnaire processed by Ethhar. A Wilcoxon test compared pre- and post-scores.

Results: All participants improved immediately after listening (average increase of one TEMPau point); in two cases baseline scores progressively stabilised or rose. The statistical analysis was significant ($W = 0$; $p < 0.01$), suggesting effects beyond chance. Relatives and clinicians also noted greater well-being and social engagement.

Conclusions: Personalised playlists enhance memory retrieval and reinforce identity, providing a simple, non-invasive, low-cost resource that complements pharmacotherapy and cognitive rehabilitation. Broader samples and longer follow-up are recommended to optimise digital music-therapy protocols.

Keywords: alzheimer disease, music theraoy, autobiographical memory, mobile applications, self concept.

Resumen

Introducción: La enfermedad de Alzheimer afecta a más de 50 millones de personas y la música personalizada surge como alternativa no farmacológica eficaz. Este estudio de caso, realizado en Montevideo (Uruguay), evalúa Ethhar, aplicación que genera listas de reproducción a partir de la historia vital del paciente. Estudio de caso Ethhar.

Objetivos: Analizar el impacto cognitivo-conductual de intervenciones musicales personalizadas sobre la memoria autobiográfica y la autoconciencia en personas con Alzheimer.

Método: Se aplicó un diseño ABA con cuatro mujeres (79-89 años; GDS 5-6) atendidas en IMEDER. En doce sesiones (dos por semana, un mes), se midió la calidad de los recuerdos mediante TEMPau antes y después de escuchar playlists de 30 minutos generadas tras un cuestionario de 17 ítems. Se utilizó la prueba de Wilcoxon para comparar puntuaciones.

Resultados: Todos los participantes mejoraron inmediatamente tras la escucha (incremento medio de 1 punto en TEMPau); en dos pacientes los valores pre-intervención se estabilizaron o aumentaron con el tiempo. El análisis fue significativo ($W = 0$; $p < 0{,}01$), sugiriendo efectos más allá del azar. Familiares y clínicos reportaron mayor bienestar y cohesión social.

Conclusiones: Las listas de reproducción personalizadas facilitan la evocación de recuerdos y fortalecen la identidad, constituyendo un recurso sencillo, no invasivo y de bajo costo que complementa la terapia farmacológica y la rehabilitación cognitiva. Se recomienda ampliar la muestra y explorar la duración de los beneficios para optimizar protocolos de musicoterapia digital.

Palabras clave: alzheimer, musicoterapia, memoria autobiográfica, aplicación móvil, autoconcepto.

INTRODUCTION

The World Health Organization (WHO) estimates, according to its 2023 report, that there are currently over 50 million people worldwide suffering from Alzheimer's Disease (AD). Projections indicate that this figure will rise to 65 million by 2030 and 115 million by 2050. The same entity provides a significant statistic: in over 70% of cases, patients are cared for by family members, typically retired spouses.

According to the same WHO report, almost 60% of people with dementia live in underdeveloped countries. In Uruguay's case, the problem is exacerbated as it is the most aged country in the region. 14% of the population is over 65, and according to data from the Uruguayan Association for Alzheimer's and Related Disorders (AUDAS), the number of people with dementia is estimated at 55,000 (2019).

Valuable literature exists on these topics, but I found none that conducted musical interventions using a repertoire associated with the patient's history and experiences, understanding that the more personalised the music, the better the effect it has.

The present study, conducted in Montevideo, Uruguay, investigates the effects of personalised music interventions on individuals diagnosed with AD concerning memory, autobiographical recall, and self-awareness. The quality of memories will be measured using the TEMPau test, pre and post-intervention.

"We found research supporting the idea that emotional sensory stimulations can even temporarily enhance memory, affective state, and personal identity, i.e., self-awareness in Alzheimer's patients" (Arroyo-Anlló, Chamorro Sánchez, & Roger Gil, 2020).

It has been argued that "among Alzheimer's disease, mild cognitive impairment and dementia patients, music has been found effective in treating disruptive behaviour, anxiety, and depression, and is linked to improvements in quality of life and cognitive function" (Levitin, (cited in Zhan et al., 2017)).

In articles (Platel et al., 2003; Satoh et al., 2006) that used music to improve patients' cognitive levels, and others that used what they called familiar music, i.e., more associated with the patient (Guétin et al., 2009; Sakamoto et al., 2013), better results were obtained than in those where the music was chosen by the music therapist.

To carry out our interventions, we will use the Ethhar application (www.ethhar.com.uy). Ethhar is an application I have developed, in collaboration with a multidisciplinary team, including developers, medical professionals, music therapists, etc.; it automatically generates personalised playlists. Starting from an input, which is a 17-question questionnaire, the set of responses is linked through an algorithm to a database of pre-tagged songs to generate personalised playlists.

The general objective of this work is to examine the cognitive-behavioural impact of stimulation with personalised musical interventions, generated by the Ethhar application, in a group of patients diagnosed with Alzheimer's disease.

Alzheimer's Disease

We will analyse the three basic components of our work: Alzheimer's, Music, and Autobiographical Memory. Alzheimer's Disease (AD) is defined by the World Health Organization as a progressive and irreversible neurodegenerative pathology leading to cognitive decline, and it is the main cause of dementia.

Clinically, it is characterised by progressive cognitive decline accompanied by the presence of two pathological protein aggregates (β-amyloid and phosphorylated tau) in the brain. The disease causes cerebral atrophy due to neuronal loss and synaptic degeneration. It generates amnesic cognitive impairment and, in parallel, motor, emotional, and behavioural deterioration (Tzioras, McGeachen, Durrant, Spires-Jones, 2023).

At the cerebral level, Alzheimer's disease is characterised by the accumulation of amyloid plaques and neurofibrillary tangles. Amyloid plaques are deposits of beta-amyloid that interfere with communication between neurons, while neurofibrillary tangles are formed by abnormally phosphorylated tau protein (Hyman et al., 2012). These pathological alterations lead to neuronal death and loss of brain tissue, especially in areas associated with memory and learning, such as the hippocampus and cerebral cortex (Hyman et al., 2012).

It is generally associated with old age, but unfortunately, in recent years, the number of patients under 60 has increased, according to information from the Alzheimer's Disease International.

To begin to understand music personalisation, let's start from the premise that no two people are alike, nor are any two brains alike. If we add physical, social, and emotional environments to this, the differences are even greater. Consequently, the symptoms and deterioration in Alzheimer's disease are as different as the people and their environments. While each of the problems described below can be schematised, their consequences and treatments are as dissimilar as the people who suffer from them. This, and all neurological disorders, have this complexity.

From a clinical perspective, the symptoms of Alzheimer's disease include not only memory loss but also difficulties in language, spatial orientation, and the ability to perform daily tasks. These difficulties typically worsen over time, leading to significant impairment in the ability to carry out daily activities (Alzheimer's Association, 2020).

The progression of the disease is classified into several stages: mild, moderate, and severe. In the mild stage, symptoms are relatively manageable and may include occasional forgetfulness and confusion about time and place. In the moderate stage, symptoms become more evident and can affect the ability to perform daily tasks, while in the severe stage, the patient loses the ability to communicate and is completely dependent on others for personal care (Alzheimer's Association, 2020).

The deterioration of different domains directly and indirectly linked to musical performance are those of language, gnosia, and apraxia (Ventura, 2008).

In the case of language, it is observed that, in the course of Alzheimer's disease, different difficulties progressively appear, for example: anomias (of production), decreased synthesis power, impoverishment of lexical stock, loss of the thread of language, lexical syndrome (articles, verbs, semantic and literal paraphasias), total loss of propositional language (demented façade), alteration of oral language comprehension, and alteration of gestural language comprehension (Ventura, 2004).

In the case of gnosias, their destructuring in the course of Alzheimer's disease shows the progressive appearance of certain types of agnosias. Agnosias are defined as the inability to identify an object using one or more senses, such as olfactory agnosia, topographical agnosia, and finger agnosia, right-left indistinction, prosopagnosia, autotopagnosia, and visual and tactile agnosia of objects, and auditory-verbal agnosia.

Finally, in the praxic domain, the regular sequence is constructive apraxia (with alteration of projective and Euclidean space), dressing apraxia, ideomotor apraxia, undressing apraxia, and ideational apraxia.

As can be observed from the course of deterioration of the three domains analysed in their evolution, it follows that in the language domain, one of the last abilities lost is the comprehension of gestural language. In the gnosias domain, the recognition of sounds or sound sequences that constitute oral language and music. Finally, in the praxias domain, the ability to use objects that may well be musical instruments is maintained even in advanced deterioration. This is why it is still possible, even in severely impaired subjects, for the perception of a melody to be understood, recognised, and still generate emotions in this type of patient (Ventura, 2008).

Music and Musical Memory

A number of authors report that musical memory is at least partially independent of other memory systems. This suggests that the network that encodes musical memory is at least partially independent of other memory systems. It has been shown that different aspects of musical memory can remain intact while brain anatomy and corresponding cognitive functions already show clear deterioration (Levitin, 2011; Jacobsen, 2015). Furthermore, musical processing uses a number of diverse neural networks that might be better preserved than those associated with memory and cognition (Zatorre, 2013).

Music is defined as an art form that organises sounds and silences in time, creating aesthetic and emotional experiences. According to Grout and Palisca (2014), music is based on elements such as rhythm, melody, harmony, and texture, which combine to form compositions that can convey a wide range of feelings and concepts.

From a physical point of view, music is a form of energy generated by structurally organised sound waves. Sound energy is mechanical energy transmitted through a medium (such as air, water, or solids) by the vibration of an object, manifesting as sound waves. This form of energy, which can be detected by living beings, is characterised by its frequency, amplitude, and duration and encompasses the kinetic energy of particle movement and the potential energy of compression and rarefaction of the medium.

When the stimulus is musical, it generates physical, physiological, psychological, and emotional responses. This is because the musical stimulus is the only one that activates most of the brain (Hargreaves, 1998). Music also generates social identity and group belonging. In every society or community, there are symbols and representations with which its members feel identified. Among these symbols, music is, at a cultural level, possibly the most recognised. Although, at present, access to a universal repertoire is unlimited, there remains an attachment to the music with which each culture identifies.

Regarding memory, among other classifications, we have explicit memory and semantic memory. Explicit memory translates into the conscious representation of past events as personal experiences (episodic) or conscious memory for impersonal knowledge of facts and concepts (semantic). Semantic memory is that which is accessed for the retrieval and recognition of abstract concepts, symbols, words, or concrete objects, and the different relationships they may have with each other (Piolino, 2006). The reminiscence bump

occurs in recalling memories encoded in adolescence and young adulthood compared to other periods, although this view is not consensual (Fitzgerald, 1996). Implicit memory involves unconscious processes related to music and is also related to the motor skills for playing an instrument (Zaki, 2023).

As for the relationship between memory and emotion, the recall of emotional experience can show the following variants: The memory of emotion is the recall of an event in which the person experienced such and such an emotion. It is linked to spatio-temporal parameters. The emotion that accompanied an event is recalled (explicit memory).

Emotional memory is the emotional arousal or "reliving the emotion" that corresponds to the recall of a particular event. It can be experienced without the specific recall of the event that originated it (implicit memory). On the other hand, through episodic memory, details about the temporal and spatial context relative to a particular event are stored and retrieved (Sikka et al., 2015). Furthermore, there is an autobiographical memory component, which allows for encoding and retrieving events related to personal experience.

There is evidence suggesting that musical memory can remain intact for people diagnosed with Alzheimer's disease, even while they experience rapid cognitive decline (Cuddy et al., 2012). This is believed to be because musical memory networks are separate from traditional temporal lobe memory networks (Platel et al., 2003; Satoh et al., 2006) which are preserved until later stages of the disease (Jacobsen et al., 2015).

Progress has been made in what are called autobiographical memories (Foster & Valentine, 2001; Irish et al., 2006; El Haj et al., 2012) which are involuntary memories that can be automatically retrieved with a cue, so it can be affirmed that music can be used as that cue to evoke these memories, which in turn invoke an emotional response.

Based on the three concepts presented and the literature accessed, it can be concluded that, in patients diagnosed with Alzheimer's, in the three domains analysed, the last abilities generally lost are the comprehension of gestural language, the recognition of sounds or sequences of sounds that constitute oral language and music, and the ability to use objects that may well be musical instruments. In turn, regarding memory, the least affected is implicit memory, which is related to emotion, without recalling the event that generates it. And that musical stimuli are the most suitable for reconstructing autobiographical memory, associated, among others, with implicit memory.

METHOD

Participants

The study is focused on patients diagnosed with Alzheimer's disease. The tests were performed with this population. The study was conducted at IMEDER (Institute of Memory and Related Disorders), which comprises neurologists, neuropsychologists, and psychiatrists specialising in Cognitive and Behavioural Neurology, allowing for periodic evaluations from each area.

There was no control group, and an ABA (Applied Behaviour Analysis) design was applied, with the Baseline being the quality of memories related to a specific theme, the Intervention being listening to Ethhar, and the Reversal being the quality of memories post-intervention.

With IMEDER patients, we carried out the fieldwork to measure autobiographical memories using the TEMPAu test. Four patients were selected, with an advanced stage of Alzheimer's disease, between 5 and 6 on the Global Deterioration Scale (GDS).

The patient data are as follows:

- Patient 1: Gender: Female, Date of Birth: 29/03/1935, Age: 89 years, Alzheimer's GDS: 5
- Patient 2: Gender: Female, Date of Birth: 10/07/1941, Age: 83 years, Alzheimer's GDS: 5
- Patient 3: Gender: Female, Date of Birth: 11/03/1945, Age: 79 years, Alzheimer's GDS: 5
- Patient 4: Gender: Female, Date of Birth: 04/05/1938, Age: 86 years, Alzheimer's GDS: 6

Patients engage in cognitive rehabilitation activities every day from Monday to Friday, once in the morning and once in the afternoon. Activities include memory exercises, board games, music workshops, body expression workshops, as well as physiotherapy and physical exercises. Consequently, the patients are in a permanent motivational state, even with outings once or twice a week. This is important, given that we are discussing motivated patients, not passive patients with minimal or no activities, as commonly observed in most residential homes or clinics in Uruguay.

The information gathering and tests conducted had the approval of the IMEDER Centre's management, and a Confidentiality Agreement was also signed.

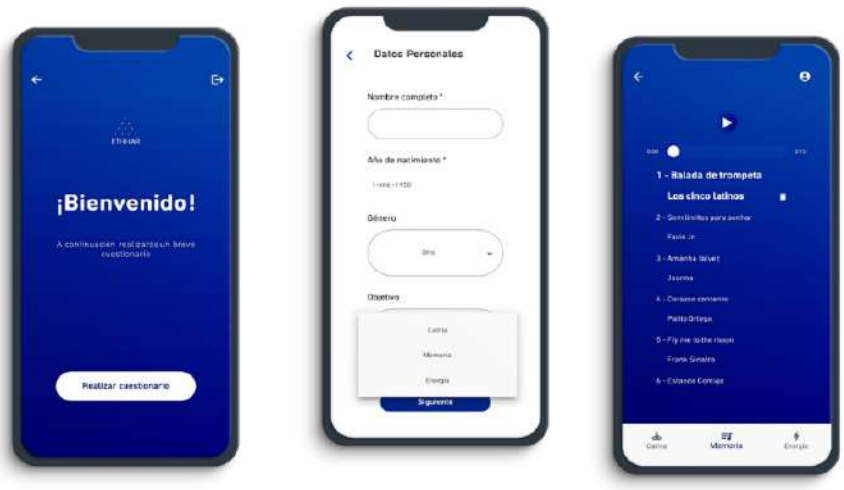
Intervention Manual

Ethhar is an application that generates personalised playlists (see Fig. 1). Each patient has an Ethhar user account. The first step is a questionnaire related to each user's social and cultural life.

The questions relate to the user's social life, primarily during their adolescence and youth, such as where they lived, where they spent their summers, which radio stations they listened to, etc. In addition, it enquires about the music listened to in their home, both by parents and grandparents. This relates to music that evokes memories and emotions. From this questionnaire, the application generates a playlist of approximately 30 minutes, in three states: calm, energy, and memory, depending on the patient's state at the time of listening.

TEMPau: Episodic Test of Autobiographical Past Memory. This is a questionnaire that evaluates the ability to mentally relive the details of autobiographical events based on life periods (Piolino, 2006). It was designed to assess episodic memory in clinical and research contexts. It specifically focuses on the ability to recall specific events, the temporal organisation of memories, and the accuracy of recorded details, such as sequence and context.

Figure 1.
Screenshots of the ETHHAR application



Note: Own compilation

Procedure

Our aim was to conduct personalised musical interventions for one month, twice a week. The procedural outline was as follows:

- Lead the patient to a quiet area of the clinic.
- Engage in informal conversation about a specific topic related to the patient's history. Special attention was paid to the details and spatio-temporal aspects of the narrative.
- Evaluate the pre-intervention score of the TEMPau test using this information.
- Play the personalised playlist, generated by Ethhar, in some cases, in full (30 minutes) and in others until the patient felt motivated.
- Allow a period of time after listening for informal discussion, then resume the previous topic using the same mechanism.
- Evaluate the post-intervention score using this information.

The interventions and tests were conducted by Neuroscience students and supervised by the Neuropsychologists at the IMEDER Clinic. The duration (see Table 1) was for almost a month and a half, but the test could only be performed on two days in four weeks.

Measurement Tool

The TEMPau test measures the quality of autobiographical memories. As indicated in the preceding table, a total lack of recall regarding an event is scored with a value of 0.

To explain this, I will use an example of a conversation about holidays. In a relaxed conversation, far from seeming like a questionnaire, I ask one of the patients about their holidays. If they make no comment or respond that they do not remember their holidays, that answer is evaluated as 0.

A score of 1, continuing the example, would be: "I remember my holidays," with no further comment on the topic. This is evaluated as 1. If the comment were very generic, such as: "I remember going on holiday with my family," there is a specific, generic memory, without spatial or temporal context. This is evaluated as 2. If the comment includes some specific detail, either spatial or temporal, for example, "we used to go on holiday to Punta del Este," this is evaluated as a 3. If the comment includes specific elements, such as, "we used to go to Punta del Este in January with my parents and my siblings," or "the house was opposite the sea," etc., this is evaluated as a 4.

In all interventions, the following table (Table 2) is completed with the respective results:

Table 1

Characteristics of the TEMPau Test

Organización general de la Prueba Episódica de Memoria del Pasado Autobiográfico (TEMPau): períodos probados, temas explorados y ejemplos de índice y tabla de puntuación			
Períodos Codificación / Temas	Infancia y Adolescencia (0 a 17 años)	Adulto joven (18-30 años)	Adulto mayor (mayores de 30 años)
Un encuentro	Un día con un amigo	Un día con tu pareja	Un día con un amigo
Un evento escolar	Un día con un maestro	Primer lugar de trabajo	Reuniones con colegas
Un desplazamiento	Un día durante vacaciones	Un día durante la luna de miel	Un día mientras viajaba
Un evento familiar	Una celebración familiar	Un nacimiento	El día de una visita

Cuadrícula de calificación de recuerdo	
0	Falta de respuesta o información general
1	Descripción vaga sin contexto espacio temporal
2	Evento genérico o específico sin contexto espacio temporal
3	Evento específico ubicado en un contexto espacio temporal no detallado
4	Evento específico ubicado en un contexto espacio temporal detallado

Note: The table indicates the score assigned to the quality of memories, based on their content.

Table 2

Score Table for Each Intervention

	Fechas	12-Ago	09-Ago	05-Ago	02-Ago	29-Jul	26-Jul
Paciente 1	Pre-session	3	3	3	3	3	3
	Post-session	4	3	3	4	3	3
Paciente 2	Pre-session	3	3	3	4	3	3
	Post-session	4	4	3	4	3	3
Paciente 3	Pre-session	3	3	2		2	3
	Post-session	3	3	3		3	4
Paciente 4	Pre-session	2	1	2	2	2	2
	Post-session	2	2	2	3	2	3

	Fechas	22-Jul	15-Jul	08-Jul	05-Jul	01-Jul	28-Jun	21-Jun
Paciente 1	Pre-session	2	3	3	3	3	3	3
	Post-session	3	3	3	4	3	4	4
Paciente 2	Pre-session	3		2	3	2	2	2
	Post-session	3		3	3	3	3	3
Paciente 3	Pre-session	3	2	2	3	3	3	3
	Post-session	3	3	3	3	3	4	4
Paciente 4	Pre-session	1	1	2	2	2	2	
	Post-session	2	2	2	2	3	3	

Note: The table shows the scores assigned to each patient in each of the interventions performed

Data Analysis and Results

The following tables present the TEMPau results, with pre-intervention values shown in blue and post-intervention values in red.

The p-value is a statistical measure that helps determine the significance of the results of an experiment or study. Taking the null hypothesis that there were no changes in the patients' memories, the p-values were as follows:

Patient 1: 0.00376607
Patient 2: 0.00343615
Patient 3: 0.00118764
Patient 4: 0.00118764

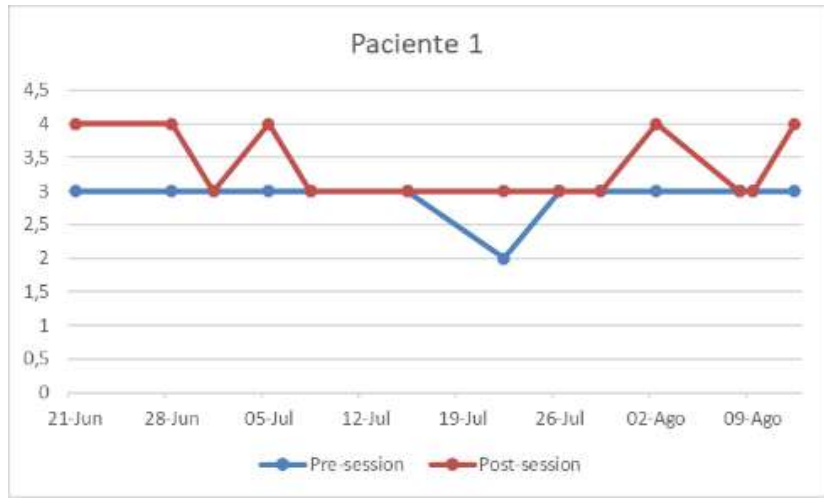
Therefore, this suggests sufficient evidence to reject the null hypothesis, indicating that the results are statistically significant.

Furthermore, the Wilcoxon test will be applied to verify the researcher's hypothesis. The entire sample of the four patients will be analysed pre-intervention and post-intervention.

This patient exhibited very good memory recall in the pre-intervention measurements. The values obtained were consistently 3 across all 12 measurements, except on July 22nd, when it was 2. Of the twelve measurements, she improved in 6, always one point above the pre-intervention measurement. Her concepts are clear and well-thought-out; conversation flows continuously, at her own pace. Her predisposition to these discussions is very good, and she enjoys them, without being overly emotional in her expressions.

Table 3

Patient 1: Gender: Female, Date of Birth: 29/03/1935, Age: 89 years, Alzheimer's GDS: 5



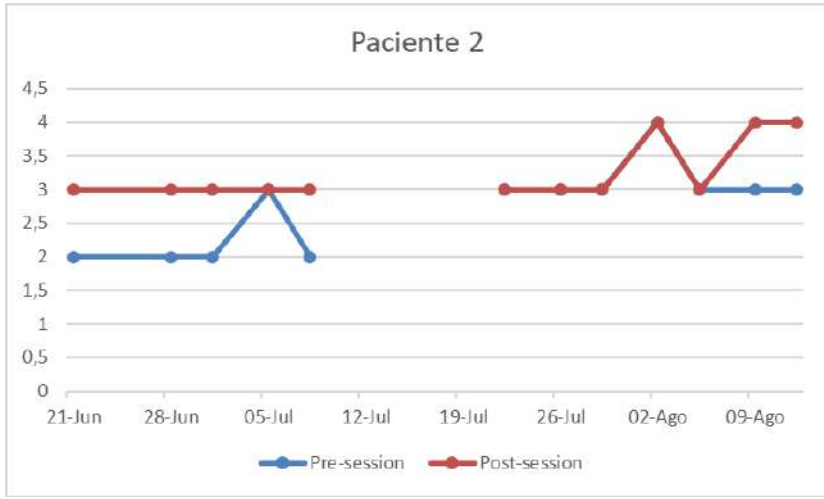
Note: The graph shows pre-intervention values in blue and post-intervention values in red according to the values defined in the TEMPau test.

Patient 2 was hospitalised on July 15th due to cardiac problems. She began the first interventions with moderate pre-intervention memory recall values, achieving continuous improvements in post-intervention values. Following hospitalisation, both her pre-intervention and post-intervention values improved.

She managed to improve both pre- and post-intervention values in 6 out of 12 interventions. Her concepts are quite clear, though conversation occurs discontinuously. Her predisposition to these discussions is very good, and she enjoys them; her enthusiasm is significant, and her joy upon rediscovering memories and emotions is notable.

Table 4

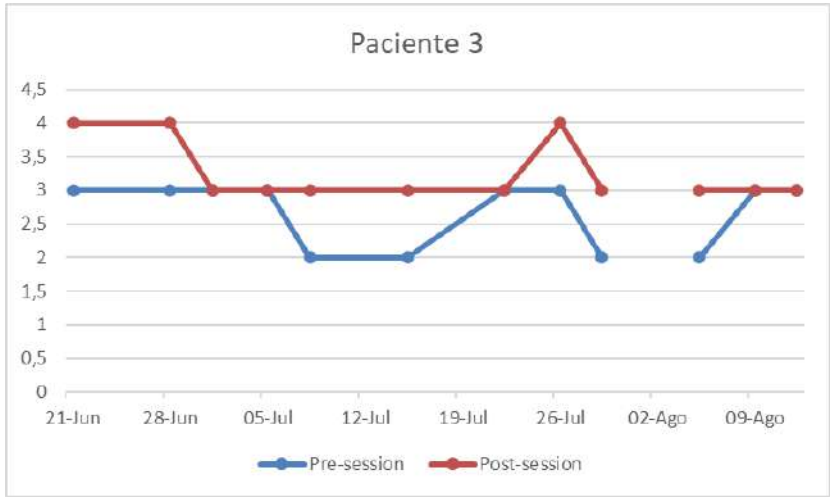
Patient 2: Gender: Female, Date of Birth: 10/07/1941, Age: 83 years, Alzheimer's GDS: 5



Note: The graph shows pre-intervention values in blue and post-intervention values in red, according to the values defined in the TEMPau test.

Table 5

Patient 3: Gender: Female, Date of Birth: 11/03/1945, Age: 79 years, Alzheimer's GDS: 5

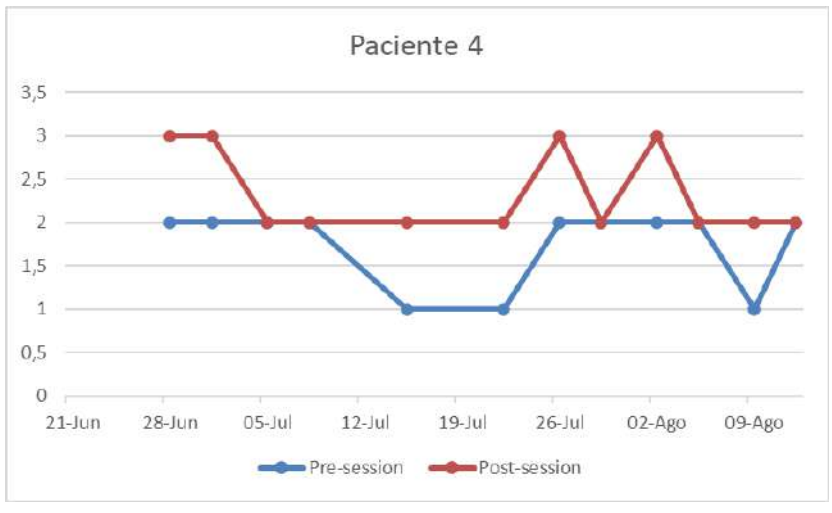


Note: The graph shows pre-intervention values in blue and post-intervention values in red according to the values defined in the TEMPau test.

This patient's results were among the best, as the quality of memories improved in most interventions. She had an absence on August 2nd due to indisposition. However, a very important aspect is that, following the interventions, the pre-intervention values improve and are sustained over time, which does not happen with Patient 3. It can be stated that memory improves immediately after the interventions, but this improvement is not sustained over time.

Table 6

Patient 4: Gender: Female, Date of Birth: 04/05/1938, Age: 86 years, Alzheimer's GDS: 6



Note: The graph shows pre-intervention values in blue and post-intervention values in red according to the values defined in the TEMPau test.

Patient 4 has the lowest pre-intervention values. Although, along with Patient 3, she obtains the best results between pre- and post-intervention, we observe that the pre-intervention values are not sustained over time.

The results (see Table 7) for the first two patients show improvements between pre- and post-intervention values, and the pre-intervention values remain constant or improve over time, whereas for Patients 3 and 4, there are better values between pre- and post-intervention, but these are not maintained as consistently over time.

Table 7

Analysis of Results per Patient

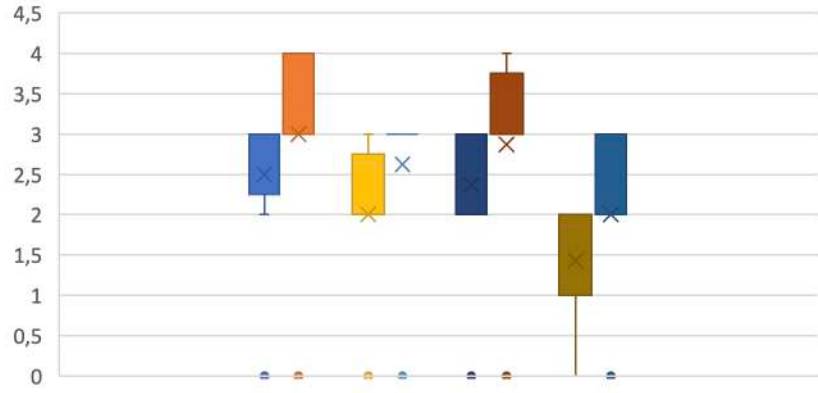
Suma de ranking +	0
Ssuma de ranking -	153
Poblacion	27
valor W	0
valor crítico	107

Note: The graph shows the pre- and post-intervention sample values for the four patients.

The results of the Wilcoxon Test are shown in Table 8:

Table 8

Results of the Wilcoxon Test



Therefore, as the W-value is lower than the critical value, the hypothesis that memories improve in post-intervention measurements is verified.

DISCUSSION

In the articles by Teppo Särkämo et al. and Cuddy et al., similar results are presented in studies using familiar music, highlighting the benefits obtained in terms of memories and emotions. This study follows the same line but with songs that are more personalised than those used previously, which may lead to the conclusion that the more personalised the songs, the better the results.

What can be done from here onwards? More than a lot; everything, I would say. I understand that, professionally, music therapy has a fertile ground for growth. For the moment, pharmacological treatments have a very limited scope for these pathologies, so the implementation of alternative tools to improve the quality of life for both patients and caregivers is essential. At a research level, with sufficient resources, I believe these and other results should be further investigated.

Let us consider that a tool accessible to many more people, given how practical and economical an application is, serves as an ideal complement to the work done in the field by music therapists and the achievements of pharmaceutical drugs. It is within reach for any desperate family member who does not know what to do with their parent, spouse, etc., and it can provide them, and themselves, with a moment of tranquillity. Building on this work, we will attempt in the not-too-distant future to conduct a comparison using a different type of test, between stimulation with music familiar to the patient and stimulation with Ethhar's playlists, to compare whether the latter achieves better results than the former.

Furthermore, it is necessary to continue researching the emotional and behavioural improvements of patients with musical interventions. The extensive existing literature generally mentions the emotional aspect and perceives the results as positive, but research focusing on this point is needed to continue adding evidence about the valuable tool that musical interventions represent.

CONCLUSIONS

The first conclusion is that regardless of the degree of deterioration a patient has reached, one of the last abilities to be lost is the recognition of sounds. Therefore, it is still possible for them to recognise a melody and the emotions associated with it.

This characteristic, I believe, allows for the obtained results, based on the therapeutic objectives that were set:

- In all cases surveyed, post-intervention memories are better than or equal to pre-intervention.
- In some patients, pre-intervention values improved over a period of time, while in others, they could not be sustained, with results being unstable.
- In patients where there was a break in interventions, the pre-intervention value shows no defined trend; in one case it increased (Patient 2, between July 12th and 26th), and in another, it remained constant (Patient 3, between July 26th and August 9th).

Regarding the therapeutic objectives, the quality of memories has improved, both semantically and episodically. Another aspect I wish to analyse in detail is the emotional one, which aligns with the second specific therapeutic objective.

Generative AI Statement

The author declares that no Generative AI was used in the creation of this manuscript.

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