FUNDACIÓN QUERER

SCIENTIFIC PROJECT PROPOSAL

Impact of musical intervention in children with language disorders

GENERAL DATA

PROJECT NAME	Impact of musical intervention in children with language disorders
DATE OF SUBMISSION	October 2022
DURATION OF THE PROJECT	School year 2023-2024
PROJECT MANAGER	Eugenia Arribas earribas@fundacionquerer.org Fundación Querer

Content

1. SCOPE

1.1 Context

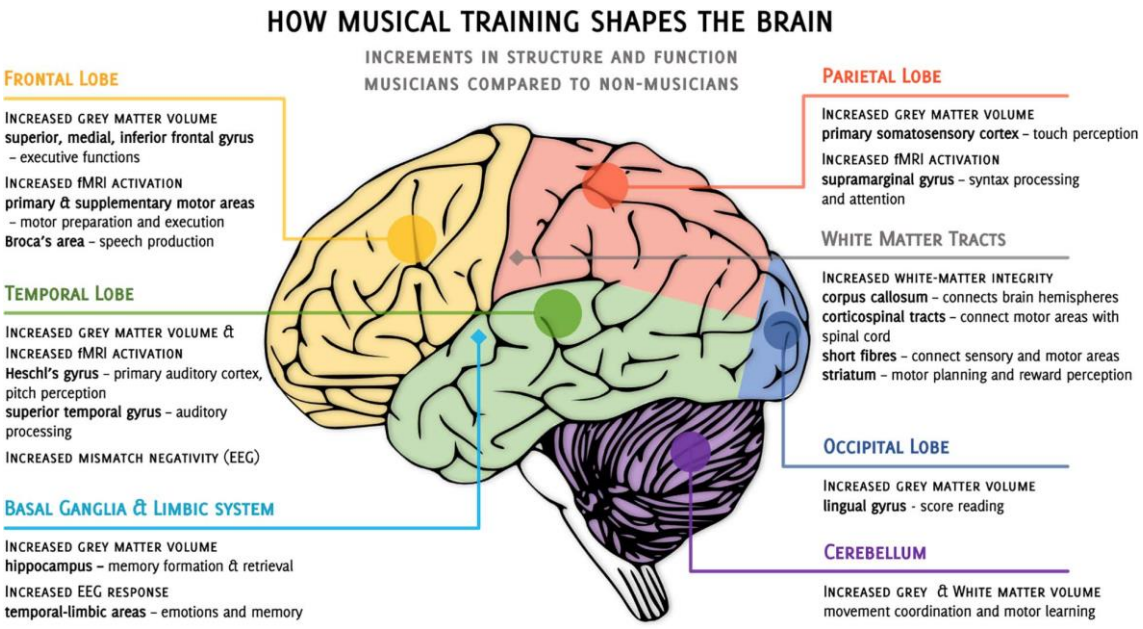
Neurological disorders are a heterogeneous group of complex neurodevelopmental disorders that share a series of common and characteristic symptoms related to deficits in social communication and restricted and repetitive sensory and/or motor behaviors. They are usually disorders of neurobiological origin of onset in childhood that present a chronic evolution, and different degrees of affectation and functional adaptation according to the case, the evolutionary moment, cognitive development and / or in the area of language (Lehn, 2015). A growing number of studies confirm the rehabilitative effects of music-based interventions on various neurological diseases (Sihvonen, 2022).

Neuroscience has demonstrated the effects that musical practice exerts on the anatomical-functional organization of the brain. Morphological differences, with functional implications, have been detected in the auditory brain areas (including heschl's gyrus and secondary auditory cortex), motor (central) and visuospatial (parietal) areas (Gaser et al., 2003; Schneider et al., 2002), as well as in the size of the corpus callosum and the planum temporale (Schlaug, 1995)

There are different scales of evaluation of musical skills (not based on the degree of musical formation) divided into multiple domains: tonal (melody, tone), qualitative (timbre, tuning), temporal (rhythm, rhythm to melody, accent, tempo) and dynamic (sonority) and that measure different aspects of musical perception such as incidental memory (Law and Zentner, 2012).

Musical training can lead to improvements in the perception of different sound parameters: timbre, height, duration, and intensity (Bigand, 2006). The correct processing of these parameters is fundamental for the development of prosodic skills since prosody is the rhythm and melody of language, and performs important linguistic functions, marking the divisions between words and syllables allowing the understanding of sentences. In addition, prosody encodes a wide range of communicative contents such as the type of statement (question, affirmation, request), the attitude towards the information we transmit (doubt, certainty), our emotional states (Patel, 2007).

In addition to the similarities between musical and language syntax, music and speech share a similar temporal structure, and connections have been identified between music processing and speech processing (Ding, 2017) (Fiveash, 2021). Phonological awareness, fundamental to reading and writing skills, is closely related to awareness of tone and musical experience (Dege and Schwarzer, 2011; Loui et al., 2011) and the neural and psychological resources of music and language processing overlap strongly Hoch et al. (2011). Therefore, musical training can help in the prevention and rehabilitation of a wide range of language, listening and learning impairments.



Overview of cross-sectional studies on the incremental differences observed when comparing musicians with non-musicians. -, cortical structures, subcortical structures, fMRI, functional magnetic resonance, EEG, electroencephalography (Olszewska, 2021).

1.2 Project proposal/ Hypothesis

The main hypothesis is that specific musical training can impact both cognitively and functionally in children with neurological disorders and that this impact has an effect on language development.

A previous study by this team observed morphometric and functional connectivity changes in the auditory cortex of 5 children with profound language disorders (Linke, 2021).

Therefore, this project consists of implementing a musical intervention aimed at promoting the development of neurocognitive skills related to sound processing (and consequently in prosorDecember processing), evaluating its effect on its linguistic development and correlating it, through functional magnetic resonance imaging before and after musical training, with possible structural changeis in the brain physiology of children with severe language impairment.

The place of implementation of the musical intervention will be at the specialized School of Celia and Pepe, a pioneering school for children with language disorders between 3 and 17 years old. The school that opened its doors in 2018, has an individualized curriculum and regulated by the Ministry of Education of the Community of Madrid adapted to the level of neurodevelopment of each child. This center is currently attended by 35 children with different pathologies such as TDL, ASD, Williams Syndrome, dyslexia and many rare diseases, whose common characteristic is a language disorder. The center is attended by a team of teachers specialized in neurodevelopmental disorders and a diverse range of accredited therapists.

During the 2021-2022 school year, a pilot music experiment was carried out to test the logistics of intervention, the viability of the musical training, the student´s reception of the training. It helped detect weaknesses, acquire experience and improve its design to guarantee its effectiveness and correct resolution.

The magnetic resonance images will be collected (at the beginning of the course and after the end of the musical training) by the radiological team of the Hospitales HN in Madrid and interpreted by researchers specialized in language members of the Grammar & Cognition research group of the Department of Translation and Language Sciences of the Pompeu Fabra University of Barcelona.

1.3 General objective

To assess the effectiveness of multimodal musical intervention in children with neurological disorders both at the cognitive level and at the level of brain functionality and specifically in children with severe language disorders.

1.4. Specific objectives

There are four types of specific objectives:

- To describe (phenotypate) the musical abilities of children with different language disorders and correlate them with their diseases, level of language development and neurological structural level.
- To develop a specific musical training for the different parameters of musical ability quantified in order to enhance them.
- To study the effects of musical intervention at the neuro-cognitive level through two indicators: Musical skills Prosody: levels of lexical awareness, accentual awareness and syllabic consciousness.
- To study the effects of musical intervention at the functional neurological level: through the study at the structural level in the CNS by functional MRI.

1.5. Expected results

There are, for this study, two levels of expected results:

- Cognitive level:
    - Musical perception: improvement of the child's musical skills.
    - Language: improvement of the child's prosodic skills.
    - Others: positive collateral impact of musical intervention on other parameters such as sleep, mood, safety,...

- Brain level: possible structural modification in neural networks related to the language area (auditory impact).

1.6 Beneficiaries

In the first place, the direct beneficiaries will be 24 students of "El Cole de Celia y Pepe" aged between 3 and 17 years and with language disorder due to heterogeneous neurological pathologies. The wide range of ages will allow us to study the effect of musical training at different stages of development in which musical perception undergoes important changes and, with this, we will be able to quantify and compare the result at different stages.

If results confirm the working hypothesis, this musical training can be extrapolated to other children with language disorder in search of new data and their personal improvement.

The field of music therapy would also benefit from these results by scientifically corroborating its efficacy and in such varied pathologies.

All children participating in this study will have the approval of the ethical committee of the health center and will have signed their corresponding informed consent.

2. TEAM AND INSTITUTIONS INVOLVED

Organization and title	Name and position in the project	Responsibility
University of Valladolid Neuroscientist	Manuela del Caño Principal Investigator	Monitoring of the project, implementation of the protocol and all activities. I write scientific articles.
Grammar & Cognition Lab. Barcelona Language researchers	Wolfram Hinzen Dominika Slusna Secondary researchers	Reading and interpretation of fMRI at both the beginning and the end. Radiological protocol. I write scientific articles.
Hospitals HN Madrid Radiological equipment	Dr. Alicia Duque Neuroradiologist	Realization of fMRI according to the protocol. Management for the approval of the ethics committee.
Music teacher / therapist To be confirmed	Implementation of the musical programm	Implementation of the musical program, monitoring during implementation.
Cole de Celia and Pepe Psychologist	Sara Serrano Child Psychologist	Neurocognitive evaluations. Coordinator of activities within the school. I write articles.
Cole de Celia and Pepe Linguist	Daniel de las Heras Language Advisor	Language assessments. Realization of musical program.
Querer Foundation Project Management	Eugenia Arribas Resp. of Scientific Projects	Coordination and management of the project.
Querer Foundation Comm. Director	Eva Revuelta Dir. Communication and PR	Communication, search for funding, image and publications.

3. DURATION, COMPONENTS AND ACTIVITIES

What		Who		Planning - (months)												
Component / Activities		Responsible	2022	2023						2024						
			jun-dic	jun	jul	sep	oct	nov	dic	ene	feb	mar	abr	may	jun	oct
PHASE 0: PROJECT PREPARATION AND FUNDING RESEARCH																
	Project preparation and funding research	I.P, GL, Resp. Project. and Querer Found.														
PHASE 1: INFORMATION AND INITIAL EVALUATION																
1.1	Introduction to parents	I.P, and Resp. projects														
1.2	Neuro-cognitive evaluations	Psychologist, linguist														
1.3	Functional MRI assessment	HN Hosp. and Grammar Lab.														
PHASE 2: THE MUSICAL PROGRAM																
2.1	Creation of the musical program	I.P, Music teacher and Linguist														
2.2	Musical intervention	Music professional					1	2	3	4	5	6	7	8	9	
PHASE 3: RE-EVALUATION AND RESULTS																
3.1	Neuro-cognitive reassessment	Psychologist and linguist														
3.2	Neurological evaluation with functional MRI	HN Hospitals and Grammar Lab.														
3.3	Data Analysis and reports	Full team														

4. COSTS AND BUDGET

Below is the cost ofthe project for an approximate number of 24 children.

ACTIVITY	COST
Principal Investigator, Monitoring and Reporting, Creation of the musical program	8.000 €
Secondary researchers, monitoring and reporting	6.000 €
Neuro-cognitive and musical assessments	2. 400 €
Program implementation and monitoring	16.000 €
Necessary materials	1. 500 €
Functional MRIs 12 children * 600 € * 2 times 12 children * 800 € * 2 times	 14. 400 € 19. 200 €
Data analysis, statistics, and publication	2.000 €
Logistic expenses	1.200 €
Project management and communication	4. 300 €
TOTAL	75.000 €

5. POTENTIAL THREATS AND SOLUTIONS

The biggest problem lies in finding the appropriate musical parameters that allow quantifying the effect of training on the improvement of musical skills in such a way that they allow the intervention to be correlated with the cognitive and physiological outcome. To ensure this correlation, we might include two control groups to be carried out in parallel. The first would be children from the center itself to whom the musical training will not be carried out and a sports training will be carried out. The second shall be formed by a group of children without pathologies who will perform the same musical training waiting for signs of expansion of their musical skills. This will make it possible to determine the expected effect (both in magnitude and in physical direction and location) in a non-pathological situation and compare it with the results obtained in children with language disorders.

6. COMMUNICATION STRATEGY

Once the project begins, press releases and visibility actions will be made on the social networks of the Querer Foundation, as well as progress and completion of the project.

Additional communication actions with the funding entities may be negotiated with the communication department.

The results will be presented at congresses in the area of interest and a dissemination plan will be carried out for schools.

7. MONITORING, REPPORTING, EVALUATION AND INDICATORS

The monitoring of the project will be carried out by the Querer Foundation through its department of scientific projects, with the help of Eugenia Arribas.

Each stage includes several documents that will serve for the monitoring and evaluation of the implementation of the project (signed consents, evaluation reports, follow-up of the musical intervention, etc.).

The project as a whole will measure its effectiveness by comparing through clear indicators, the results of the first neurocognitive and neurological evaluations with the results of the final evaluation. The indicators are the data that the tests can measure, as well as the neuroimaging tests and will be reflected in the final reports, both at the individual level (for each child), and at the general level.

There will be team meetings after the initial evaluations and after the re-evaluations. In turn, and throughout the entire musical intervention there will be monthly meetings with those responsible for the musical intervention (principal investigator, music teacher/therapist, and project coordinator) to have qualitative information about the intervention.

Finally, the team will:

- an individualized report for each family
- a scientific article for publication and
- an informative article.

8. IMPLEMENTATION

The implementation of the project will be carried out in three distinct stages:

STAGE 1: INFORMATION AND EVALUATION Jun-Sep 2023

- During the month of June 2023, we will inform the parents Celia and Pepe School about this project and its objectives, so that they can decide with the necessary information if they want their children to participate, signing an informed consent. This information will be provided by the project coordinator and the principal investigator.
- Once the number of participating children has been determined, the appropriate measurement indicators (through one or more standard tests) will be identified to measure neurocognitive objectives and evaluations will be scheduled. The tests to pass will be taken from:

    - Auditory test
    - Family musical environment test
    - Predisposition test: precision and asynchrony of pulsations as measures of motor performance (Bianco et al., 2019; Burgoyne et al., 2019).
    - Musical Skills: Adaptation of the Montreal Music Skills Assessment Battery (del Mar, 2014; Good, 2017) .
    - Blinking and eye movements: horizontal electrooculogram (EOG)
    - Prosody: The selected test, which will be used to define a baseline on which the evolution of the students' prosodic skills will be measured, will be the computerized version of the PEPS-C battery (Peppé and McCann, 2003). The PEPS-C is a test that examines receptive and expressive prosodic skills in adults and children at two different levels (functional and formal), for clinical and research purposes.
    - Sleep: For the evaluation of the impact of music on sleep, the Bruni Sleep Disturbance Scale (SDSC) will be used, consisting of 27 items valued according to a Likert scale, which allow the cluelessness of various sleep disorders. Evaluate the sleep of the last 6 months.
    - State of mind: Likewise, for the achievement of specific cognitive objectives, the validated scales of affectation of the social domain, language and behavior will be used.

These evaluations will be performed along September 2023, when school starts.

- At the same time, also in September, participating kids will go through the functional MRI evaluation. Some kids will need a light sedation for fMRI to make sure results are successful.

STAGE 2: THE MUSICAL PROGRAM AND IMPLEMENTATION Oct 2023 – Jun 2024

- The second stage, which overlaps with the first, begins with the **elaboration of a musical intervention** appropriate for the school children and adjustable to the different levels. This intervention will be designed by adapting the empirically validated methodology to the cognitive characteristics of the children participating. On the one hand, it is a multimodal intervention that allows to take advantage of the visual channel to compensate for the prosodic processing difficulties of these children. On the other hand, the active participation of the child is stimulated, where the teacher will apply the musical stimulus and the child will make use of his/her voice, his/her body and percussion to respond. This program will specifically be elaborated by the principal investigator.

- The musical intervention will be finished by September. Implementation will start in October 2023 and will last nine (9) months, until June 2024. The music teacher/therapist will be in charge of its implementation during the classes of the school following the next methodology:

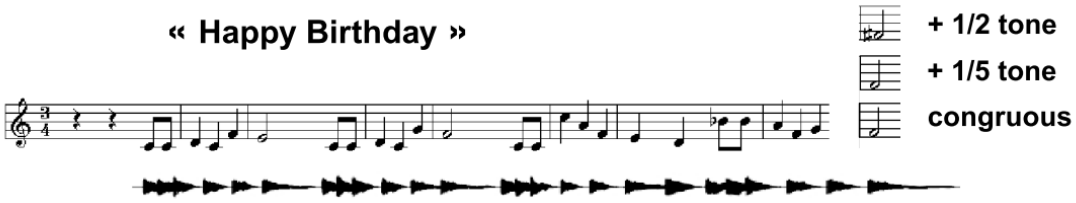
Methodology for the implementation of musical intervention

We have projected that the multimodal musical intervention based on songs will be implemented in the school during two weekly music classes, which last between 30 and 45 minutes. At the beginning of these sessions, 15 minutes will be allocated to the specific work of the selected musical parameter and the rest of the session to different musical activities that reinforce the work done. The selected musical activities will be grouped by:

Rhythm: auditory recognition of known rhythms, detection of specific rhythmic changes. Repetition of rhythms with instruments. Rhythm recognition in the face of speed changes. Recognition of rhythmic changes (binary/ternary) in known songs.

Melody: recognition of major and minor key changes of known and unknown melodies. Identification of known melodies in the face of tempo changes (slow or fast). Auditory detection of punctual changes of the melody. Recognition of coherent, semi-coherent or incoherent musical phrase (perfect cadence or semicadences) according to the rules of Western classical music. Amplitude recognition of ascending and descending intervals.

Timbre: recognition of changes of instruments or voices interpreting known melodies.



Example of exercise with 3 musical endings: coherent, semi-coherent or incoherent.

All these objectives will be based on musical games and children's, youth and current songs chosen by the students according to their musical tastes and subsequently validated by the professionals in charge of directing and administering such musical stimuli.

The musical stimulus will be presented in two different ways (visual and auditory) simultaneously. Depending on the strengths and weaknesses detected at the prosodic level in each group, the intervention will be carried out at a basic or medium level.

These stimuli will be presented during magnetic resonance imaging before and after the period of musical training to detect improvement in musical perceptual skills.

- During the months of implementation, follow-up tests will be carried out to monitor the acceptance of the intervention by children. In case of needing an adaptation, it will be modified according to the needs of the child and the criteria of the music teacher/therapist and the principal researcher.

STAGE 3: RE-EVALUATION AND RESULTS Jun – Oct 2024

Once the musical intervention is finished, the following activities will be carried out:

A. Neurological reevaluations: Measurements of evolution. RMI-f
Morphological (physiological) changes in brain communication structures will be evaluated.

B. Cognitive reassessment: Measurements of evolution.
An evaluation will be carried out again with the same initial measurement tests to measure the progress achieved and compare them with the initial baseline taken in stage 1.

C. Presenting results to parents
After the final evaluation of all the children, a specific report of each child will be made, on the one hand, which will be delivered and explained to the parents. On the other hand, a final report with the general results will be delivered to the funders.

D. Scientific paper and article to be published
Finally, data will be analyzed, and findings and results will be gathered into a scientific article to be published in a scientific journal. We will also present conclusions to the media.

9. EVALUATION AND CLOSURE

Project will be closed after the completion of the last stage and the results have been presented.

If the results have been positive for the children of the School of Celia and Pepe, the project would be an optimal candidate for its continuity in the school. There are very few published studies on the benefits of musical intervention in the population of atypical Spanish-speaking development, and therefore, it is of great interest to define a successfully tested intervention to be able to share it with the scientific and school community.

Likewise, it will be a candidate project to be presented at the neuroscientific conferences of the year 2023.

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