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NOVEL COMPOSITIONS FOR MUSIC THERAPY OF CHILDREN WITH COCHLEAR IMPLANTS: PRELIMINARY REPORT OF AN 'INSTRUMENTAL THEATRE'

Contributions:
A Study design/planning
B Data collection/entry
C Data analysis/statistics
D Data interpretation
E Preparation of manuscript
F Literature analysis/search
G Funds collection

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Abstract

Introduction: The aim of music therapy offered in the World Hearing Center is to accelerate rehabilitation and auditory development of people, including children, with hearing implants. The purpose of therapeutic musical activities is to shape and improve the patient's overall auditory and cognitive development.

Material and methods: The study was conducted on 5 children, aged 8–11, who had undergone cochlear implant surgery. The group was tested before the start of music therapy classes and after 3 months of classes involving novel music compositions called 'Instrumental Theatre'. The classes incorporated special Active Music Concerts (for participation) and Passive Music Concerts (for listening). Assessment were done with a questionnaire tool called Prima Volta.

Results: The results indicate that music therapy had a significant effect on the development of auditory functions, especially sound identification and auditory memory. Observations made with Prima Volta indicate that the children were much more engaged with music.

Conclusions:

1. Scarce academic literature and very few clinical resources indicate the need for further development of original music compositions for use in music therapy for children with cochlear implants.
2. For a more comprehensive assessment, the Instrumental Theatre program needs to be continued and the results assessed after 6 and 12 months of therapy.

Key words: music therapy • rehabilitation • cochlear implants • children

NOWATORSKIE KOMPOZYCJE DO MUZYKOTERAPII DLA DZIECI Z IMPLANTAMI ŚLIMAKOWYMI – WSTĘPNE WYNIKI „TEATRU INSTRUMENTALNEGO"

Streszczenie

Wstęp: Celem muzykoterapii prowadzonej w Światowym Centrum Słuchu jest przyspieszenie rehabilitacji oraz rozwoju słuchowego osób, w tym dzieci po wszczepieniu różnych implantów słuchowych. Zadaniem działań muzykoterapeutycznych jest kształtowanie i usprawnianie ogólnego rozwoju słuchowego oraz poznawczego.

Materiał i metody: Badania dotyczą grupy pięciorga dzieci w wieku 8-11 lat po wszczepieniu implantu ślimakowego. Grupa została przebadana przed rozpoczęciem programu muzykoterapii oraz po trzech miesiącach zajęć z wykorzystaniem nowatorskich kompozycji muzycznych pod nazwą „Teatr Instrumentalny". Terapia składała się z koncertów muzyki aktywnej (w których dzieci uczestniczyły) oraz koncertów muzyki pasywnej (których dzieci słuchały). Ocena została dokonana na podstawie kwestionariusza Prima Volta.

Wyniki: Otrzymane wyniki wskazują, że prowadzone zajęcia muzykoterapeutyczne istotnie wpłynęły na rozwój funkcji słuchowych, zwłaszcza identyfikację dźwięków i pamięć słuchową. Z obserwacji dokonanych na podstawie kwestionariusza Prima Volta wynika, że dzieci bardzo zaangażowały się w muzykę.

Wnioski:

1. Niewiele doniesień naukowych oraz bardzo mały materiał kliniczny wskazuje na potrzebę dalszego poszukiwania oryginalnych kompozycji muzycznych do wykorzystania w muzykoterapii pacjentów, w tym dzieci po wszczepieniu implantu ślimakowego.
2. W celu uzyskania pełniejszej oceny konieczna jest kontynuacja programu „Teatr Instrumentalny" i porównanie wyników po 6 i 12 miesiącach terapii.

Słowa kluczowe: muzykoterapia • rehabilitacja • implanty ślimakowe • dzieci

Introduction

Music has always been an important human need. It is a form of communication that allows us to exchange information, needs, desires, and emotions. The role of music has wide applications both in therapy and in everyday life. Through music, we can express many kinds of emotion that are difficult to describe or name. Music can arouse a whole spectrum of reactions and emotions – tears, laughter, affection [1].

There are many definitions of music therapy. In this study we use the one formulated by Bruscia: "Music therapy is a systematic process of intervention wherein the therapist helps the client to promote health using musical experiences and relationships that develop through them as dynamic forces of change" [2]. In the case of music therapy, the form and structure of a piece play an important role. Harmony is also important, which is why a strong emphasis is placed on harmonious instruments in compositions. Sounds used by a composer as building blocks are defined by pitch, duration, intensity, and timbre; it is also defined by emotionally charged characteristics that emerge from the other senses. Physically, sound reaches our ears in the form of periodic variations in atmospheric pressure, as a vibration, but emotionally it reaches our body, mind, and heart in an individual way. Everything we encounter leaves a mark on our feelings and mind. Each instrument, sound, or composition conveys some kind of information, evoking different kinds of feeling [3,4].

The use of music in medicine started through neurology. Clinical studies show that processes in the brain initiated by musical compositions can be generalized and transferred to non-musical functions, providing desirable and quantifiable therapeutic effects [5]. This is because the whole brain reacts to music, with each area reacting to the different musical elements of a work. For example, pitch is processed in the right temporal lobes of the cerebral cortex, an area which also governs speech prosody [6]. Processing of rhythm involves the prefrontal motor cortex, cerebellum, and other areas. The limbic areas connect with emotions, and are engaged in the processing of both rhythm and pitch [7]. The power of music derives from its flexibility, polysemy, variety of styles, and genres. It can reach a person without engaging attention, thereby acting in a passive way. But it can also actively engage a patient as well [1].

The literature describes two approaches to using music in therapy: analytical and synthetic. The analytical approach uses progressively more challenging exercises which target auditory functions directly, such as the discrimination of an instrument based on its timbre or pitch. The synthetic way of using music therapy affects not only auditory function, but also the overall development of cognitive functions such as attention, thinking, and memory. The types of exercises may consist of, for example, listening to complex compositions, training of attention, exercises in rhythm perception, changes in melody, etc. These two approaches are not mutually exclusive since they affect different spheres, and both can bring a range of benefits. An optimal therapeutic program should contain both analytical elements, which target core auditory functions, and synthetic elements, which help to compensate for difficulties in receiving sounds in acoustically challenging conditions [8].

The aim of this study is to present the preliminary results of music therapy classes conducted using instrumental and vocal compositions based on 3 months of observations of children with CIs at the World Hearing Center. The children took part in special classes involving an 'Instrumental Theatre' program which was developed by music therapists from the Center and that include specially composed musical sets designed for children to practice with. The classes were part of the Center's 'Music in Human Auditory Development' program.

Material and methods

The study group consisted of 5 children (4 girls and 1 boy), aged 8–11 years (average 8.6 years). All participants were native Polish speakers. Details of the children are presented in Table 1.

The 'Instrumental Theatre' was developed as a selection of novel music compositions designed to engage the whole auditory development process of the children. All children took part in these music therapy classes at the World Hearing Center which were conducted once a week for 3 months. The 1-hour classes consisted of Active Music Concerts intended for active rehabilitation and Passive Music Concerts, which contained instrumental and vocal music intended for passive listening and which the children were also encouraged to listen to at home. The concerts are described in Table 2.

Table 1. Characteristics of the participants (CI, cochlear implant; HA, hearing aid)

Child	Gender	Age	Type of hearing aid		Age at implant surgery		Regular school/ special school	Speech therapy classes
			LE	RE	LE	RE		
Child 1 D1	F	11	CI	CI	1 y.o.	5 y.o.	regular school	participates
Child 2 D2	M	8	CI	CI	3 y.o.	1 y.o.	regular school	participates
Child 3 D3	F	8	CI	CI	3 y.o.	1 y.o.	regular school	participates
Child 4 D4	F	8	CI	HA	6 y.o.	–	regular school	participates
Child 5 D5	F	8	CI	CI	3 y.o.	2 y.o.	regular school	participates

Table 2. Forms of music therapy included in the 'Instrumental Theatre': active concerts are for participation and passive concerts are for listening

Active music concerts (participation)	Specially composed music offered in sets of musical exercises intended for active rehabilitation; conducted by an expert during therapeutic classes. Active music exercises can be used for group or individual work, depending on the patient's needs
Passive music concerts (listening)	Specially composed instrumental and vocal music intended for listening at home or during residential rehabilitation without the constant supervision of an expert

All of the children had been diagnosed with bilateral sensorineural hearing loss and received cochlear implants in one or both ears. Participants D1, D2, and D3, due to early diagnosis of the hearing loss, had had implants since they were 1 year old. Patient D4 had been using two hearing aids, which brought only minimal benefit, since she was 1 year old. A decision was therefore made to insert a cochlear implant into the weaker ear (the left), but leave the hearing aid in the other. Although having only one implant, the child was admitted to the study because she was the right age and was willing to actively participate in music therapy. Parents of D5 came for an audiological consultation when their child was 22 months old, as they were worried by the child's lack of speech development. The hearing screening test at birth was normal, but probably a false positive, as the parents said that the child did not react to environmental sounds.

Inclusion criteria for the study were age 8–11, having at least one implant, and accepting the following conditions: 1) commitment to regular and active participation in music therapy and meetings with a psychologist and a speech therapist; 2) submit to assessment tests of the music therapy classes.

The 'Instrumental Theatre' consists of compositions developed by music therapists from the World Hearing Center. They were created under guidelines derived from various models of music therapy, and based on years of practice and experience in working with patients who had received a CI at the World Hearing Center. The compositions are instrumental works with a layer of musical sounds. They are enriched with a non-musical texture of everyday environmental sounds such as those of cars, the city, nature, and animals. Thus each composition is multi-layered.

As well as non-musical components, the 'Instrumental Theatre' includes diverse musical elements such as frequency, tempo, harmonies, and dynamics, and is designed for people with various hearing impairments, mainly cochlear implant users, to train their hearing. Each therapy session used audio tracks from the "Instrumental Theatre" consisting of two parts: an Active Music Concert and a Passive Music Concert. In the active part, the exercises are a set of specially prepared music therapy activities designed to strengthen sound identification, differentiation, and auditory memory (see Table 2). The music therapists combined the exercises with tests of perceptual ability, which are described in Table 3.

The examination procedure requires that both the initial examination, as well as the follow-up examination, are conducted by music therapists in a suitably adapted studio at the World Hearing Center. It is a room equipped with instruments (piano, guitar, guiro, thunder shaker, ocean drum, rainstick, maracas), audio equipment, and various accessories (metronome, images of teddy bears with different emotional expressions). Examinations were done for each child individually, without the parents present, and were conducted using an original tool called Prima Volta, which includes a set of questionnaires.

Prima Volta is the quality indicator for the 'Music in Human Auditory Development' program, and is a scale for assessing the quality of music perception in implant and hearing aid users. In children, it is a completed by a music therapist on the basis of instrumental and vocal tests with a child. It has three main components: a technical test of auditory development; test of speech and auditory development, and a test of emotional auditory development. The first area studied with the Prima Volta Quality Meter is set out in Table 3.

For the children in our study, only this first part is used; the other two parts were not used in this study. Table 3 shows that each music therapy activity had its own assignment of points. The number of musical examples and the level of difficulty of a given exercise affect the score. In our study, it took 30–40 minutes to perform all the tests on one child. As a control, the same tests were performed on normal-hearing children aged 8–11 in exactly the same way under the same acoustic conditions (same equipment, same room). The points scored were recorded on the appropriate questionnaire. Sessions were conducted in a similar way: they started with an introductory greeting song, and then the music therapist proposed actions within the scope of the set goals, which were later measured with the Prima Volta tool.

Results

The results indicated that the greatest difference was achieved in sound identification. Table 3 present the average scores for each test within the technical auditory development examination. Both the music therapy classes, as well as the examination itself, focused on particular auditory functions: detection (test A), discrimination (tests C1, E1, G, H, I, J, K), identification (B, C2, D), and auditory memory (E2, F).

Figure 1 presents the average scores obtained in the tests of individual auditory functions. The values indicate an improvement in results for all four tests. The highest difference was observed in the identification test, whereas the remaining three tests also show positive effects of music therapy application.

Figure 2 presents a comparison of the overall results of the Patient Examination Form. An improvement in the overall result was noted in all children regarding detection,

Table 3. Scores in the initial and control tests, based on individual samples as part of the technical auditory development study

Test issues	Maximum number of points obtainable	Average number of points obtained	
		Initial examination	Follow-up examination
A. Reaction to sound – detection of sounds (3 music examples)	3	2.8	3
B. Identification of sounds (sounds of the city, nature, animals, house, human, machinery)	24	13.4	17.2
C1. Recognition of the source of sound (similar sounds coming from different sources) – does the child hear the difference?	4	3.6	3.7
C2. Recognition of the source of sound – does the child recognise the source?	4	1.6	2.1
D. Identification of the sounds of instrument groups (5 music examples)	5	3.8	4.0
E1. Auditory discrimination of sounds based on pitch (2 music examples) – discrimination of low–high	2	2.0	2.0
E2. Auditory discrimination of sounds based on pitch (auditory memory, repeats a sequence)	1	0.4	1.0
F1. Auditory discrimination of sounds based on the number of sounds heard (scoring increased with increasing difficulty) – 1 sound	1	1.0	1.0
F2. Auditory discrimination of sounds based on the number of sounds heard – 3 sounds	2	2.0	2.0
F3. Auditory discrimination of sounds based on the number of sounds heard – 5 sounds	3	1.8	3.0
G. Auditory discrimination of sounds based on tempo and rhythm (3 musical examples)	3	2.0	2.0
H. Auditory discrimination of sounds based on key – minor and major (2 music examples)	2	1.9	2.0
I. Auditory discrimination of sounds based on interval sequence (2 musical examples)	2	0.0	0.5
J. Auditory discrimination of sounds based on musical scale	1	0.0	0.4
K. Auditory discrimination of sounds based on musical form	1	0.0	0.2
Total	58	36.3	44.1

discrimination, identification of sounds, and auditory memory.

After 3 months of therapy, the highest score difference was observed in the sound identification test which checks the ability to recognise the source of a sound, detect differences in sounds, and identify instrument groups. All 5 children obtained the maximum score on the test for reaction to sound (sound detection).

In the sound discrimination tests, auditory discrimination of sounds based on the musical scale test showed the largest improvement. A lower ranking, but still a positive score, was observed in the test for recognising the source of a sound, as well as auditory discrimination of sound based on key (minor and major). In the auditory memory test, the highest score difference was observed in auditory discrimination of sounds for 5 sounds heard (in the follow-up examination the group received the maximum score). In the auditory discrimination of sounds based on pitch, auditory memory, and repeating a sequence, the group also received the maximum score at the follow-up examination. The total score for all the tests after 3 months of music therapy increased by more than 7 points, which indicates the validity of continuing this form of rehabilitation for children with CIs.

Discussion

In a review of the international literature, only 6 papers on music therapy after cochlear implantation in children were found. In total, 103 children presented in these papers were subject to a similar form of rehabilitation. Few publications and very limited clinical resources indicate the need for additional original music compositions to be used in the rehabilitation of hearing and speech of both children and adult CI users.

In all the literature reviews, music therapy had a positive effect on the general development of children, and this form of rehabilitation made it possible to compensate for deficits and – at least to some extent – to minimise the difference between these children and those with normal hearing [9]. Authors have investigated the ability to recognise frequently heard melodies [10], recognise the outline of a melody [11], understand intonation and rhythm, maintain concentration [12], and discriminate sounds in terms of pitch [13] and timbre [14]. They have used various

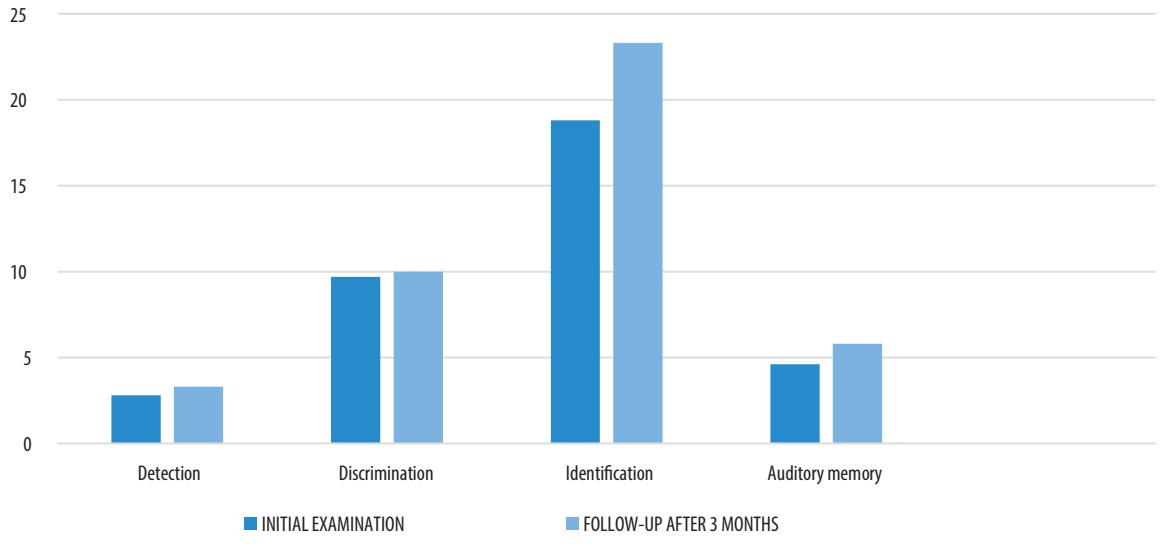

Figure 1. Comparison of average results for individual auditory functions after 3 months of music therapy for 4 selected components: detection (sample A), differentiation (sample C1, E1, G, H, I, J, K), identification (sample B, C2, D), and auditory memory (E2, F)

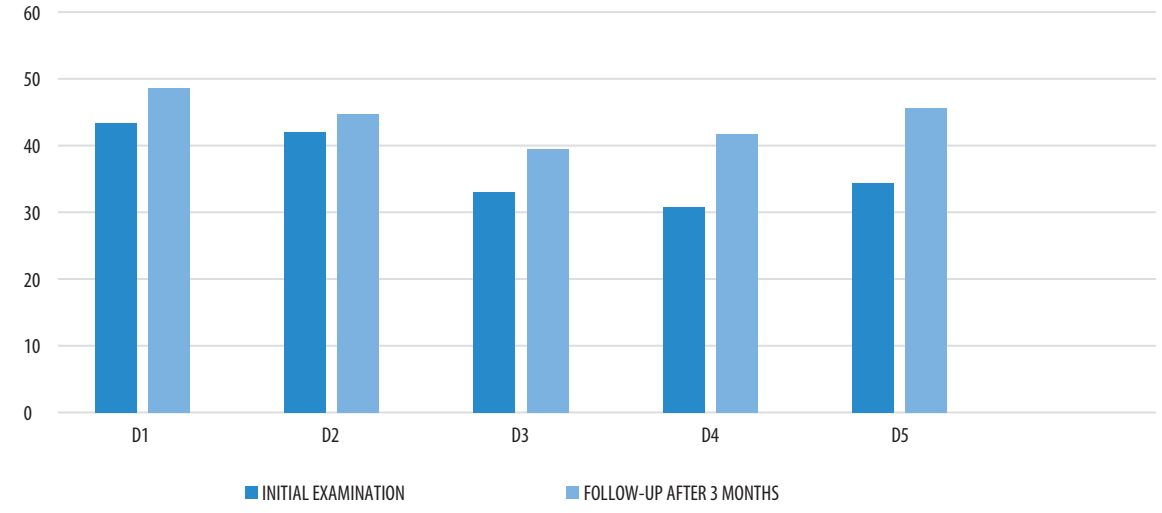

Figure 2. Comparison of the results of initial and follow-up examinations after 3 months of music therapy. D1 is Child 1, D2 is Child 2, D3 is Child 3, D4 is Child 4 and D5 is Child 5

therapeutic methods for their tests: from passive music listening only [10], to singing and playing instruments [13,14] and using eurhythmics [9]. Fu and co-authors created a computer program dedicated to conducting auditory training at home [11]. All of the above studies have brought expected, positive effects [11,13,14]. After music therapy, children should be able to better compensate for delayed speech development [9].

There are very few attempts to compose original pieces intended exclusively for the stimulation and auditory development of patients with hearing impairment, and especially for patients after implantation. One of the projects reported in the literature review is a multimedia composition created in 2007 for the Med-El company [15]. The author of the composition wanted to prove that numerous factors related to music perception (e.g. pitch perception or timbre identification) may have a significant impact on the musical experience of cochlear implant users. The instrumental and vocal music composed for this project is mainly based on wind and percussion instruments with a small contribution from a string instrument, the cello. It is based on the differentiation of rhythm and tempo, slight pitch differences, and on vertical intervals and small linear intervals [15]. In 2007, the Scottish composer Oliver Searle created special music, also commissioned by Med-El, for CI users. The concert 'Noise Carriers' was organized in 2008; patients and users of cochlear implants were invited and their level of satisfaction with listening to the compositions was evaluated [16]. After a few years the project was

extended. The aim of the project was to increase the number of compositions and provide a full measure of musical experiences for the implanted patients. A concert for patients with CIs was organised and each work was evaluated through a questionnaire. The concert was a collection of live instrumental sounds and electronic sounds generated with a synthesizer. The study showed that it was easier for patients to recognise rhythm and tempo, and as far as the sound of instruments was concerned, they preferred compositions which included percussion instruments (drums, vibraphone) with vocal elements.

Galvin et al. studied the ability to recognise the tone features of patients with CIs and compared it with the ability of people with normal hearing [17]. The study concluded that CI users are better at recognising clear rhythms in musical compositions, and much weaker when there are only melodic instruments without percussion. The authors suggest in their conclusions that composers creating music for patients with CIs should reduce the degree of complexity, thereby increasing listening pleasure [15,17]. All attempts to create compositions focused primarily on the ability to recognise rhythm and tempo.

The original 'Instrumental Theatre' project encourages the ability to read and listen to music in the broadest terms. The program is designed to develop listening skills far beyond rhythm and tempo to help CI users appreciate instrumental and vocal beauty in terms of tones, timbre, and pitch. Both Active (participatory) and Passive Music Concerts (for listening at home) are designed to focus on the whole spectrum of music. The idea is that patients with implants or hearing aids should be able to distinguish as many components of instrumental and vocal music as possible, enhancing the pleasure of listening to it.

The Prima Volta quality scale is designed to measure not only progress in the perception of rhythm and tempo, but also to monitor progress in pitch discrimination and timbre recognition, which are much more difficult areas. Introduction of the program to the World Hearing Center was based on years of observing patients who were involved in music, singing, and playing instruments. One highlight has been the 'Beats of Cochlea' International Music Festival for Children, Youths and Adults with Hearing Disorders, initiated several years ago by Prof. Henryk Skarżyński. He believed that the greater and closer contact people have with music, the easier it is to communicate with the outside world. The 'Instrumental Theatre' and the music therapy classes aim to assist in this process.

Conclusions

1. The use of the novel 'Instrumental Theatre' in music therapy classes significantly improves the development of a child's auditory functions.

2. Due to the structure and multi-layered quality of the 'Instrumental Theatre' works, the children participating in the study found great pleasure in listening to music, and this has improved their quality of life.

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