Music Therapy in the Treatment

of People with Hearing Deficits: A Review of Selected Strategies

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ABSTRACT

The paper deals with the question of music making in people with hearing deficits, showing the main advantages of such practice. It examines differences between 'hearing' in a medical sense and 'musical hearing' which is semantically much wider and involves different parts of the brain. Using various examples, the paper proves the possibility of music making even in the case of acute, bilateral or prelingual hearing impairment, but emphasises the necessity of Individualized Education Programme implementation to successfully face challenges posed by hearing deficits. The paper describes the main difficulties and challenges that deaf individuals face during the music learning process, and sums up strategies for musical pedagogy recommended in research studies since the second half of the twentieth century. Elements such as melodic patterns, rhythm and harmony are discussed. The teaching methodology presented in this paper focuses on multisensory approaches that may compensate for hearing loss, underlining such aspects as imagination, movement coordination, visual and haptic stimuli. Different types of hearing loss are presented, depending on their medical causes, hypoacusis level, onset time, and articulation ability in the context of music making. The article emphasises the beneficial role of active music-making for the patient's well-being, especially for memory training, developing the emotional sphere, improvement of prosodic elements in speech, and tinnitus relief.

Keywords: music therapy, hypoacusis, cochlear implants, ear training, hearing loss

A 'good hearing' is commonly believed to be one of the features that a musician should possess. Nonetheless, in the history of music there are multiple cases of musicians and composers who continued their activity despite hearing deficits. Noteworthy examples undoubtedly include Robert Franz (1815–1892), Bedřich Smetana (1824–1888) and Gabriel Fauré (1845–1924), but the most prominent example is Ludwig van Beethoven (1770–1827). His figure has attracted the interest of musicologists and physicians for years, since his deafness was not caused by natural, biological aging process of the outer hair cells and acoustic nerve fibre atrophy,[1] but was the effect of a pathological process that started in his youth and was characterised by violent periods of progression and remission. Scientists have tried to diagnose Beethoven's deafness by hypothesising otosclerosis, auditory nerve atrophy, post-typhoid meningitis, or even Paget's disease.[2]

In this article, I will describe the specificity of music learning in hypoacusis, indicate methods of coping with hearing loss through music practice (with reference to existing research studies), and prove the beneficial effects of music practice for patients with hearing deficits.

THE MULTISENSORY DIMENSION OF MUSIC PERCEPTION

First of all, 'musical hearing' is a term much wider than 'hearing' in the medical sense. While the latter refers to the mechanical process of a sound wave being captured from the air through the outer and middle into the inner ear where it gets converted into a nerve impulse, then conducted to the auditory cortex of the brain to be deciphered, 'musical hearing' is actually not a subcategory of a 'hearing' but a wider, multisensory concept. Conducting and deciphering sound waves is just one element of it. Others include a sense of rhythm, memory, creativity in performing and composing, audiation, coordination movements, and the emotional sphere.

Neurological tests such as functional magnetic resonance imaging (fMRI) prove the engagement of different brain parts in the process of music making. Apart from the auditory cortex (situated in the temporal cortex of the brain), which elaborates impulses sent from the cochlea and identifies sound frequencies (pitch) and their intensity, other brain parts are engaged while practicing music. The prefrontal cortex is responsible for planning and controlling musical execution. The motor cortex serves movement coordination, which is essential for the use of both hands while playing. The visual cortex is

1 Outer hair cells (OHC) are present in the organ of Corti (the spiral organ) in the cochlea. When the cilia of the inner and outer hair cells bend, the sensory cells get stimulated and mechanical sound wave is converted into a nerve impulse. More precisely, the inner hair cells (IHC) are mainly responsible for this process whereas OHC are the effector of the cochlear amplifier. Although the OHC are more numerous than IHC (12,000 vs 3500), they cannot regenerate. Their natural atrophy that can begin at the age of fifty is a physiological process that leads to sensorineural deafness. Another important structure that degenerates with age are the fibres of the vestibulocochlear nerve, the eighth cranial nerve colloquially called 'auditory nerve', which conducts the nerve impulse generated in the cochlea to the cerebellopontine angle in the brain. Cf. Roberto Albera and Giovanni Rossi, *Otorinolaringoiatria*, (Turin, 2021), 8–11, 82; Rudolf Probst, Gerhard Grevers, and Heinrich Iro, *Otolaryngologia*, tr. Henryk Skarżyński (2nd edn, Wrocław, 2019), 163, 164.

2 For more details, see: Richard A. Hoppmann, 'The Medical History of Great Composers: An Educational Aid', *Medical Problems of Performing Artists*, 12/2 (1997), 42–44.

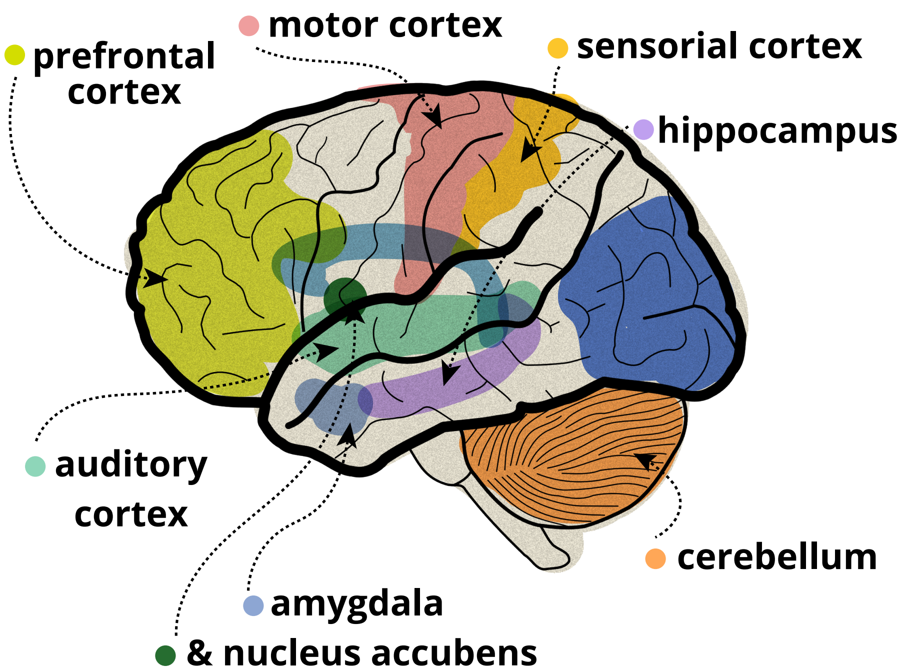

Figure 1. Brain structures involved in music elaboration. Graphics redrawn from: Collin, Catherine, and others, *Come funziona il cervello* (Milan, 2002), 76, 77. Graphic designer: Marta Gayczak.

involved in score reading and controlling finger position while playing an instrument. The sensorial cortex is indispensable for tactile sensations. Other structures involved in music performance are the cerebellum and elements of the limbic system: the amygdala, the nucleus accubens, and the hippocampus. The cerebellum plays a dual role: it supports the motor cortex in movement coordination and takes part in emotive reactions, like the amygdala and the nucleus accubens. The hippocampus places the sounds in the context of experience and memory.[3]

The multisensory dimension of music making finds ample confirmation in the practice of deaf musicians. One excellent example is the story described by painter August von Kloeber (1793–1864), who visited Ludwig van Beethoven and his nephew Karl in 1818 to sketch both men for an oil painting. He noted that, despite the serious difficulties the composer experienced with oral conversation due to his deafness, he was able to give his nephew piano lessons and detect his pupil's every error. What is significant, while teaching Beethoven carefully observed the hands of his students, and visual stimuli became a reference point for him.[4]

The example demonstrates that damage of the auditory cortex or ear structures such as the ossicular chain or the tympanic membrane does not rule out the functionality of other parts of the brain involved in music perception. Especially a well-developed audiation capacity, defined as the ability to hear music when the sound is not physically present, is crucial for musical activity.[5] For this reason, a person who has developed skills such as singing, playing an instrument, or composing music can continue these activities despite hearing loss, as was the case with Ludwig van Beethoven.

3 Donald A. Hodges, 'Implications of Music and Brain Research', *Music Educators Journal*, 87/2 (2000), 17–22; Michel Habib and Mireille Besson, 'What Do Music Training and Musical Experience Teach Us About Brain Plasticity?', *Music Perception: An Interdisciplinary* Journal, 26/3 (2009), 279–85.

4 George Thomas Ealy, 'Of Ear Trumpets and a Resonance Plate: Early Hearing Aids and Beethoven's Hearing Perception', *19th-Century Music*, 17/3 (1994), 262–273; Alexander W. Thayer, *Thayer's Life of Beethoven* (Princeton, 1964), 703.

5 The term 'audiation' was introduced in 1975 by Edwin Elias Gordon (1927-2015) and is an important element of his theory called Music Learning Theory.

EXAMPLES OF MUSIC THERAPY IN DEAF STUDENTS

In recent decades, music therapy has shown that it is not impossible to learn music and music theory even in the case of deafness from birth. For instance, in 1960 Elizabeth May conducted several- week-long series of meetings with a group of eight deaf children at Madison Elementary School in Santa Monica, California (USA).[6] During her classes, May introduced musical notation (both pitches and note values). The experiment results were partially successful: after the meetings, children were able to play from a score but only on the rhythmic level. They did not pay attention to the pitch of the sounds. In the end, none of the children achieved full speech capacity. It should be stressed that Elizabeth May's music therapy was one a pioneering one in that the main emphasis was placed on rhythmic issues as she focused on percussion instruments. Notably, however, she managed to develop in deaf children the concept of sound pitch by taking them to museums of musical instruments and churches with organs where they had an opportunity to touch them to feel the vibrations induced by the instruments and changes of their intensity correlated with pitch changes.

In the 1990s, Eugenia Bulawa Walczyk, music teacher at New York's Brewerton Elementary School, successfully introduced music theory to both deaf and non-deaf children. As she stated, all of them were able to recognise notes, draw and beat them and divide them into measures.[7] Such an approach aimed to achieve conceptual understanding of sound. During classes, deaf children had an interpreter and used amplifying devices. All of them played portable, electronic keyboards. Once deaf children became acquainted with the concept of sound and its pitch, they played some simple melodies. The keyboards were also used by a speech therapist to explain pitch changes in a speech). During lessons, the children reproduced rhythmic patterns on the keyboard pressing one key while alternating hands. After that, the first chords were introduced and, as the next step with the chords already learnt, pupils performed simple melodies harmonised in duet form. As a result, two students were able to play one keyboard at the same time, while the others learnt to play simultaneously melody and harmony.[8]

In 2009, Manuela Prause-Weber and Lyn Schraer-Joiner published a paper[9] summing up didactic techniques for children with cochlear implants.[10] The scientists focus on multisensory activities in their recommendations. They suggest manual communication based on stimulation of hearing through visual signals. They recommend amplifying sounds with stereo speakers that should ideally be placed on a wooden floor, as wood conducts vibrations that can be more easily perceived by deaf individuals. For maximum effect, they advise the children to take their shoes off so that the musical vibrations can be indirectly conducted through their bodies.

DIFFICULTIES IN LEARNING MUSIC IN THE CASE OF HEARING DEFICITS

Since there are different types of hearing impairments, the problems that patients face also vary. With regard to its cause, hearing loss is divided into conductive vs. sensorineural. Depending on the degree, hearing loss can be mild, moderate, or profound. With respect to the time of onset of the disease, hearing loss can be prelingual, interlingual, and postlingual. It is very important to assess whether hearing loss is the patient's only complaint or if it is accompanied by other malfunctions. An additional factor is whether the hypoacusis is uni- or bilateral, whether the patients' condition allows them to use hearing aids, and whether hearing can be improved by medical means. Nonetheless, there are some symptoms common to most people with hearing problems:

1. Indistinct speech (a person can hear the sounds but does not understand the meaning of words).

6 Elizabeth May, 'Music for Deaf Children', *Music Educators Journal*, 47/3 (1961), 39–40, 42.

7 May, 'Music for Deaf Children'.

8 Eugenia Bulawa Walczyk, 'Music Instruction and the Hearing Impaired', *Music Educators Journal*, 80/1 (1993), 42–44.

9 Manuela Prause-Weber and Lyn Schraer-Joiner, 'Strategies for Working with Children with Cochlear Implants', *Music Educators Journal*, 96/1 (2009), 48–55.

10 Cochlear implants (CI) are neuroprostheses surgically implanted in cases of moderate and profound sensorineural hearing loss. They are often used in children deaf from birth. Their main disadvantage is the low frequency discrimination of sounds. Moreover, they do not provide significant benefits in a noisy environment. Most patients who had heard sounds before the desease complain about unnatural, 'robotic' quality of sound. After CI implantation, most of them cannot recognise songs on the basis of their melodic lines even if these songs were very familiar to them before.

2. Difficulties with sound perception among noise.
3. Loss of otoacoustic emissions – sound becomes 'flat'.
4. Difficulty in understanding words (in music: lyrics) without visual stimuli (lip reading).
5. Difficulty producing the right pitch while singing (in profound hearing loss, especially prelingual one, even the concept of sound pitch may initially be unclear).
6. Difficulty in learning harmony due to the inability to hear selected frequency ranges.
7. Sound localisation disorders (a person does not recognise the direction and distance from the sound source).
8. Tinnitus.[11]

Moreover, otolaryngologists list problems characteristic of bilateral, prelingual hearing loss: altered voice quality, pronunciation errors, monotonous intonation, and poor knowledge of morpho-syntactic language rules.[12]

STRATEGIES FOR MUSIC EDUCATION IN DEAF STUDENTS

All the problems listed in the previous section are addressed in the music therapy process. Pupils can learn music (singing, dancing, or playing instruments) but they need Individualized Education Programmes (IEPs) that match their specific problems. Music therapy in hypoacusis is still *in statu nascendi*. Teachers or (better) therapists observe some problems their students deal with and then try to apply adequate solutions.

Eugenia Bulawa Walczyk, for instance, noticed the problems her students had with achieving the right pitch while singing.[13] This is why she decided to introduce the concept of sound pitch by using portable electronic keyboards. In her article, she justifies her choice with a quotation from Diane Merchant, music director at Gallaudet University for the deaf, who wrote to her in a letter that 'students do not have to correctly produce a pitch – the instrument does it; and the correct keys can be seen and felt'.[14] Frederick Lewis, in turn, noticed that deaf children learn speech by putting their hands on the throat of the teacher and observing their lip movements. He decided to apply this technique in teaching pitch in music. Moreover, with the help of an oboe, he managed to teach deaf children to sing musical intervals – with positive results in all twelve children in the test group.[15]

In several studies published since the second half of the nineteenth century,[16] conducted mostly on groups of several to a dozen or so deaf individuals, primarily children, mostly with moderate and profound sensorineural hearing loss, we find precious suggestions concerning the music education process. Some of them are repeated in different publications, while others are original and result from technological progress or from deeper reflection based on the experience in teaching deaf students and observations of individual and group needs. The main, universal methods for teaching deaf students are as follows:

1. Focus on feeling vibrations. Scientists recommend taking shoes off and using classrooms with wooden floors that conduct music vibrations to the feet without additional obstacles.
2. Gesticulation. Singing with signs that stimulate imagination.
3. Touching instruments as they are played. This practice allows children to feel changes in vibration frequency and is therefore useful for developing the concept of musical sound, especially in profound deafness.
4. Lip reading. Deaf people with developed speech function demonstrate a tendency to read words from the interlocutor's mouth movement. This process can

11 Modern tinnitus therapy is based on sound therapy. Therapists and audiologists help patients to choose music type and intensity as acoustic background to reduce the symptoms. For more details, see: E. Courtenay Wilson Ellis, Gottfried Schlaug, and Christo Pantev, 'Listening to Filtered Music as a Treatment Option for Tinnitus: A Review', *Music Perception: An Interdisciplinary Journal*, 27/4 (2010), 327–330.

12 Albera and Rossi, *Otorinolaringoiatria*, 79.

13 Scientists from Nagasaki Medical Centre observed the same problem. Comparing healthy children with those using cochlear implants, they noticed that both groups presented the same level in rhythm, but those with implants had much poorer results in producing the right pitch. Cf. Takayuki Nakata and others, 'Pitch and Timing in the Songs of Deaf Children with Cochlear Implants', *Music Perception: An Interdisciplinary Journal*, 24/2 (2006), 147–154.

14 Bulawa Walczyk, 'Music Instruction', 42–44.

15 Karl Wecker, 'Music for Deaf Children', *American Annals of the Deaf*, 84/2 (1939), 151–155; Karl Wecker, 'Music for Totally Deaf Children', *Music Educators Journal*, 25/6 (1939), 45, 47.

16 The first scientific publication on music education in deaf students dates back to 1848, the year when William Wolcott Turner (1800–1887) and David Ely Bartlett (1805–1879) published a paper entitled 'Music Among the Deaf and Dumb' (*American Annals of the Deaf and Dumb*), in which they provided teaching recommendations and described the history of a deaf woman who mastered the piano. Cf. Alice-Ann Darrow and George N. Heller, 'Early Advocates of Music Education for the Hearing Impaired: William Wolcott Turner and David Ely Bartlett', *Journal of Research in Music Education*, 33/4 (1985), 269–279.

sometimes be subconscious but in present-day speech therapies it is often taught. Lip reading is very useful for learning song lyrics. While words coming from electronic devices such as loudspeakers may be unclear, reading words from the teacher's mouth brings much more beneficial effects.

5. Transposing melodies into registers preferred by each student. In this individual approach, the didactic process focuses on residual hearing. Even where hearing loss is profound, it is often slightly less advanced at certain frequences. E.g. highly characteristic of senile deafness is high frequency hearing loss, while low frequency discrimination is impaired in conductive hearing loss (e.g. in otosclerosis).[17]
6. Where correct pitch production is our aim, performing melodies on fixed pitch instruments.
7. Using auxiliary devices: it appears that only about 2% of all deaf people are completely unable to discriminate any sound. Using the constantly advancing hearing prosthetic technology brings positive results.
8. Analysing pieces of music that focus on one element rather than on complex issues. Once students have become acquainted with one element (e.g. rhythm, meter, or the main melodic motif), it is recommended that they listen to the same piece again, focusing on and analysing successive elements of the composition.
9. The use of headphones. This point is the most controversial one. In case of conductive hearing loss caused by mechanical damage (interrupted sound conduction to the structures of the inner ear and the brain), amplifying the volume can indeed improve hearing quality. In many cases of sensorineural hearing loss, however, the problem is not impaired sound conduction but its elaboration and decipherment on the higher levels of the auditory pathway, such as the brainstem or auditory cortex. For this reason, amplification can blur the sound signals.[18] Moreover, earbuds can cause inflammation that worsens hearing condition (on the other hand, modern technology operates with solutions such as bone conduction headphones). Besides, headphones limit musical ambient soundscape and hinder sound source localisation – another very important element of ear training. Nevertheless, in most studies conducted so far, therapists apply such electronic solutions. The reason may be that children with profound hearing impairment, and sometimes with undeveloped speech function, are to be recruited for scientific research.
10. Encouraging students to take active part in music performance rather than limiting classes to just listening.
11. Repetition of both music performance and theoretical explanation. The teacher should try to explain the same musical issues using different words and examples. Some concepts may be unclear at the beginning, but understanding can be achieved through the use of different metaphors, references and examples.
12. Noise reduction. In many cases, deaf individuals find speech discrimination in noisy conditions difficult. This ability, known as 'sound masking' is often weaker and needs to be trained.[19] Sounds like construction work or street traffic may not disturb students with good hearing but can cause a serious inconvenience in case of hearing deficits.

Other methods used in a classical ear training at music schools are:

1. Indicating pitch change with hand movement. When practicing singing or instrumental performance, one should use gestures to show whether the next note should be higher or lower rather than say ambiguously that the sound is not correct.[20]
2. Introducing harmony exercises.
3. Combining listening with body movement. Methods proposed in Dalcroze eurhythmics can be particularly useful.
4. Acculturation to classical music repertoire, as well as vernacular one (e.g. local popular music).
5. Introducing musical notation for the subjects discussed.
6. Task-oriented listening.

17 On the other hand, Eugenia Bulawa Walczyk observes that even children with very similar audiometric test results are sensitive to different frequency ranges.

18 In sensorineural hearing loss, full understanding is frequently not achieved during speech audiometry. Speech discrimination may even decrease at higher volume levels. Cf. Probst, Grevers, and Iro, *Otolaryngologia*, 182.

19 As previously observed, especially cochlear implants are characterized by poor efficacy in noise.

20 Scientists from Nagasaki Medical Centre observed that implant users perceive pitch changes but they are unable to identify the direction in which the sound changed. Cf. Nakata and others, 'Pitch and Timing', 147–154.

CONCLUSIONS

People with hearing deficits can perform music just as well as others. Hearing is, in medical terms, only one component of the complex process of perceiving and performing music. In many cases, auditory deficiency can be compensated by other senses. Deaf individuals are more focused on visual stimuli while playing instruments than people with good hearing. Besides, they rely on vibrations and bone conduction – factors that are also present in non-deaf musicians, but are often secondary to their functioning.

Several studies show that while people with hearing deficits (especially those with profound sensorineural deafness) may have problems with pitch production, all of them have unimpeded rhythmic function. Other functions such as movement coordination, audiation processes, and the emotive function are not linked to hearing loss. This means that with an properly designed music therapy, deaf people can perform music in a satisfying way, which is beneficial in many ways. Music stimulates the limbic system responsible for the emotional sphere, trains memory and movement coordination, and it has cognitive functions. In (f)RMI the corpus callosum, which connects both hemispheres of the brain, is thicker in musicians than in people who only listen to music or have no musical experience. Moreover, as the example of Eugenia Bulawa Walczyk's classes showed, mastering the piano can be useful for explaining prosodic elements in speech. Furthermore, performing music trains sound discrimination (i.e. helps to separate meaningful sounds from noise), improves sound localisation, and brings relief in case of tinnitus.

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