Music and neurological diseases, how music can influence neurological disorders?

Key words: music, neurological disorders, rhythmic auditory stimulation, music rehabilitation, neurological music therapy, melodic intonational therapy

Ludwig van Beethoven said „Music is the mediator between the spiritual and the sensual life”. Music has been used by humans since ancient times at first for the religious celebrations, what we know only from the preserved drawings, until commercial use. In the past, music was accessible only for the persons with good education, like priests and priestesses or well-placed like the aristocracy. They could enjoy its sound, create it, practice it and use. Now the role of the music lost importance, it became something generally available for all people, it is everywhere and for everyone. What we are thinking about music? Is it only something which we use for pleasure, dancing, singing, recalling the past times or the people we met on our way years ago? Did you ever think about music like something which can cause side effects? Or that music can heal, restore efficiency?
I would like to present the positive and negative influence of music on the human health and life. Thanks to the development of PET and fMRI we can observe the activity of the brain and its possibility to reorganization the connections in the cerebral cortex and its neuroplasticity. The psychopatogenic symptoms, the coping strategy, the resilience and the effects of treatment are visible through the fMRI [9].

Negative music influences are: musician’s dystonia, musicogenic seizures and auditory hallucinations in schizophrenia.

Musician’s dystonia is not a frequent disorder which affects only 1% of musicians. Named also as focal dystonia the disease is a task-specific movement disorder, which manifests itself as a loss of voluntary motor control in extensively trained movements [1]. There are some possibilities how we can treat this disease. Pharmacologically we can use local injections with botulinum toxin and anticholinergic drugs. There are also some special therapies, not only physiotherapy but also several behavioral therapies like sensory-motor-returning therapy, sensory training therapy or learning based sensormotor training and pedagogical retraining. It is interesting that one of the available therapy – pedagogical retraining, is based on a workout with the instrument. It consists of correction of the movements and posture of the hand, muscle toning with the simple movements and finally retraining the basic technique. This type of therapy is attractive because of its non-invasive nature and it can be accompanied by the renewal of neuroplasticity of the brain [18].

According to International League Against Epilepsy official report, a practical definition of epilepsy is the brain disease defined by any of the conditions like: at least two unprovoked or reflex seizures occurring more than 24 hours apart, one unprovoked (or reflex) seizure and the probability of further seizures similar to the general recurrence risk (at least 60%) after two unprovoked seizures, occurring over the next 10 years and the diagnosis of an epilepsy syndrome.

But what are the musicogenic seizures? It is the rare disorder classified among the reflex seizures/complex stimuli which can be classified as focal seizures or generalized tonic-clonic seizures [3]. During the musical trigger seizures EEG and fMRI shown the signal change within the bilateral frontal and right temporal lobes [10]. In this case ictogenic mechanisms come from the external factors like the exogenous stimuli which are emotional aspect of music, specific melodic, rhythmic or harmony combinations. We think here about listening or playing various types of music. The latency between stimulus and the event (disclosed in EEG) can be long, that is why it can be unnoticed. After the induction the patient stopped the activity because of unpleasant feeling and refused to start it again [3]. In this case the successful treatment is the anteromesial temporal-lobe resection which give us the information that this seizures are of limbic epilepsy origin and not primary auditory cortex. Limbic system takes place in the in the affective experience of the music, as mentioned before, specific melody or rhythms but also musical theme and musical quality regardless instrument or voice. Cerebral processing of music includes both thematic and mechanic aspects, and clinical experience has shown that each may be integrated into epileptic dysfunctions [16].
There are not only negative impact of music on the neurological disease but also a lot of positive aspects. At first, I would like to introduce some perspective on music therapy. “Neurosciences and Music II” conference assumed five factors which contribute to the effects of music therapy. They are based on the modulations of attention, emotion, cognition, behavior and communication.

Limbic and paralimbic brain structures are responsible for emotional changes. From the neuroimaging studies we know that listening to music has an effect on this part of the brain in musicians and non-musicians. We can see also modulations of amygdala activity which taking place in inducting the “real” emotions. In response to pleasant and unpleasant music (consonant and dissonant music), we can see a positive signal in a central aspects of amygdala and negative in a dorsal part. It is interesting because normally unpleasant music increases signals in the amygdala, the hippocampus and parahippocampus gyrus and the temporal lobes. Pleasant music can lead to activity changes in the ventral stratum, the amygdalia and the hippocampus. We can use this changes for the treatment of dysfunctions of amygdale or reduction of hippocampal formations which can provoke affective disorders like depression, pathologic anxiety or post-traumatic stress disorders. Maybe it will be also possible to obtain beneficial effects in patients with the disorder of vegetative nervous system [8].

Emotional and behavioral disturbance we can observe often in some neurological disorders. Varied symptoms we can notice in multiple sclerosis, ALS, motor neuron disease and stroke, Parkinson’s disease or epilepsy. It is possible that depressive syndrome is a risk factor for certain neurological disorders. In this patients the music therapy is employed to change the mood, increase socialization and cognitive and neuromotor functions. Neurological Music Therapy (NMT) have the potentials to stimulate some areas in humans brain which can provide some therapeutic applications in a neurological disease. Music therapy it is a good adjunct to treatment while contributing to the functional recovery at the same time [8]. Among the positive affect of music we can emphasize the influence on memory - episodic memory and working memory, the development of creative thinking and troubleshooting. Music is important not only in the adolescence time when the teenagers use them for mood regulation, but also for adults and aging people. In this case, they tried to avoid the feelings of loneliness and isolation. They can feel to be independent and respected. Of course music can help us to relax or give us the energy, in other cases to remember or to forget. Noteworthy is a fact that verbal material used in a musical way like a song lyric remains longer in the memory and is easier to recall than the same text but in verbal form [14].

This special ability to easier recalling the phrases is using in therapy of the patients with aphasia. For those people singing familiar music or using an auditory model with singing to recall and repeat the words can improve their speech. The second possibility is a melodic intonational therapy - MIT. Here, the musical elements like melody and rhythm, influent the speech production. Thanks to this therapy, patients have bigger facility to spontaneous speech output, articulation and naming [14].
Ability of music to elicit memories and emotions is the important stimulus for persons with dementia. In Alzheimer’s disease (AD) the criteria are impaired memory and cognitive deficits. We can also distinguish Frontotemporal dementia with significant changes in social and emotional live. FTD has three variants like: 1) behavioral variant with disinhibition, 2) semantic dementia and 3) primary progressive aphasia. All this types finish with reduce of independence, isolation and bad functioning in the everyday live. In this disease we can use not only pharmacological treatment but also nonpharmacological. As a good response we can characterize listening to familiar music which gives smile and positive judgments, but this memory is typically impaired. Interesting that even in the severe stage of AD or primary progressive aphasia it is possible for musicians to recall or to produce music by singing or instrumental playing but the preserving of music memory in patients with AD is questioned, it exists but may be differentially impaired [4]. These deficits are not associated with perceptual difficulties. The semantic memory for melody may be preserved in normal aging and in AD but the explicit memory and episodic memory are changing [17]. Listening to the familiar music presented as auditory pieces the patients can judge if the piece is familiar or unfamiliar and from famous melodies they can recall the titles and lyrics and type of tune. It is possible for them to say if the part of two melodies are from the same piece of music or not. Also the recognition whether the song is old or new is good. But recall the last notes or name of composer is not possible, also even if they have the name of composer they can not give the title of the piece. Similarly from a given written text or its recitation they have the same negative result. Music have good response for the reducing of agitation and mood symptoms like depression and anxiety but in this case the therapy should be long, over 8 weeks. For me the most important part of the music therapy is the possibility to evoking the autobiographical memory, especially in the case of mild-to-moderate AD but this effect can be due to various types of auditory stimulations. Associations were more specific, quicker and emotional if the patient choose its selected music. This memory, we can say involuntary, was better than voluntary autobiographical memories to recall without the stimuli. This memories have more positive than negative context. Surprisingly that the musicians have better memory for the musical and technical structures than for the personal memories [4].

Also the possibility of developing dementia is lower for the people musically educated. The life span can change because of some factors and live style activities. We know that some factors like educational activity, bilingualism and psychical and leisure activities may retard the expression of brain pathologies because of functional reserves. They can change the brain plasticity and cognition. Because of livelong learning the humans and animals increase neurogenesis and the numbers of synapses in the brain. Unfortunately, it is hard to say what is the right age and the duration of these operations to stimulate the brain for optimal outcomes. Regarding the instrumental musical activities we can see the complex of stimuli which comes at the same time, they affect memory, converting speed and auditory, visuospatial, sensorimotor task. Brain organization differentiate in these cases depending on the years of practicing, age when they start the learning and years of acquisition [7]. Musicians has greater ability to maintain brain cognitive function like executive process.
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Achievement of music education is a very complex process which consists of motor functions, reading the notes, repetitive practice and the auditory functions, that is why we can see the effects in a number of brain regions and cognitive areas. The significant differences between musicians and non-musicians we can see in cognitive flexibility, visuomotor speed and sequencing and naming and nonverbal memory recall. We can see also the cognitive functioning in the advanced age which is changing linearly with a years of musical participation. However, there is not a significant difference in terms of high and low music activity for the cognitive performance. Also we can not accurately determine the critical limit when it comes to the age when we begin a musical adventure but we can suggest that the critical factor is the timing of cognitive stimulation during critical sensitive periods. It is not excluded that the individuals with higher intelligence may perform and remain in music for a longer period of time [6].

For children engaged in musical activity we can see prominence in nonverbal reasoning and verbal ability and for young adults more better visual design retention and enhanced visuospatial sequencing and advantages, also higher verbal IQ. It is not sure if music activities can increase IQ in general or simply it is more interesting for intelligent subjects to start the music activities [6]. We can noted also the awhile improvement of arithmetic performance in children with attention-deficit hyperactivity disorder [14].

The children with higher aptitude to music benefit more from the music lessons than the children with lower aptitude. They will also take this lessons more willing. This aptitude has positive effects for phonological awareness and after to perceive or product sounds from non-native language but also listening and speech-perceptions abilities. Music training children have likewise improvement with vocabulary and larger improvement for remembering and reproducing a complex line drawing (all spatial abilities) so we can not see the specific domains [15]. I think that is the same which we try to obtain after the musical rehabilitation of neurological disease.

When it comes to the impact of music on patients after stroke and with visual neglect, which is a common problem after stroke, we can see the deficit of realization the information for the controlateral side to the brain lesion. It is observed that listening to music everyday can change the early poststroke stage changing the structural in gray matters changes. Of course, we have also influence effect for the mood, auditory and verbal memory and for attention. We must also noted that the rehabilitation effects of music are discussed [14].

In hemiparetic stroke patient good rehabilitation is a rhythmic auditory stimulation using a special rhythms to propagate motor behavior of the weakened limbs. After stroke it is also important to help the patient to regain the possibility of social contacts and mood, using a different forms of active music therapy.

For the patients with visual neglect the rehabilitation is based on retraining to improve awareness and choice the neglect part of the body by the brain stimulation and pharmacological treatment by dopamine and noradrenergic agonists. It is interesting in the studies that we can see the significant effects with preferred music for the improvement of perceptual identification of contralesional items, which is oppo-
site to the unpreferred music or silence. This positive effect is the same as the answer for pleasant music appearing in the ipsilesional item.

Also worth noting is that the ordinary everyday listening to the music, selected by the patients, for a minimum of one hour per day lasting at least 2 months, have a good effect for the depression and confusion for the patients in early post-stroke stage. This daily activity can reduce depression and confusion, but also can improve verbal memory and concentration. Patients are more relaxed and willing to join the motor activity. Music also has a strong impact on patient contact and interaction with treating staff. The analysis of imaging studies show changes of volume in the grey matter in the right insula, the right IFG and the right percentral gyrus, that is why we can indicate good long-term neuroplasticity changes in the right hemisphere because of the long musical stimulus. Furthermore, the activity, which is everyday listening to music, is an easy leisure activity, which potentially have really good effect for emotional and psychological impact on patients in early post-stroke stage. Different rehabilitation is not easy in such state of the patient [14].

Next one important neurological disorder where we can use the music rehabilitation is Parkinson disease. Here, we can work against not only the mood disorders like anxiety and depression (non-motor symptoms) and the basic method which is used here is rhythmic stimulation to reduce the intensity of movement-related symptoms. This stimulation can increase the number of the connections between the motor and auditory systems, especially in cerebello-thalamico-cortical areas. It can be assumed that areas of the brain responsible for receiving rhythm are very close to those who are responsible for regulation of movement. Parkinson’s disease is the neurological disorder where there is a slow destruction of dopaminergic system in the substantia nigra. Because of this deficiency we can see four cardinal symptoms: tremor, rigidity, akinesia or bradykinesia and postural instability, we can also see the accompaniment of the gait impairments. The lack of dopaminergic stimulation can be compensate with the regular stimulation of the putamen activity which we can receive with regular rhythmic pulses. This stimulation can change the movements of the patients like facilitate the movement or sequential atomized process [2, 12]. How said Oliver Sacks in his book “Musicophilia; Tales of Music and the Brain” when the music is present, its pace and speed prevail over Parkinson allowing sick persons, by the time of music duration, to return to their own rhythm of movement, natural and obvious to them when they were healthy. It is important that this music has clear rhythm but not too loud or insistent, if not, it is too obtrusive and the patients are captured by it [11]. Good and effective method in improving gait in PD is Rhythmic Auditory Stimulation - RAS. Importantly this method is safe and inexpensive. The marching music or dance therapy is used to ameliorate the motor abnormality but also cognitive functions. Familiar song have better effect for the faster gait velocity than unfamiliar songs. In RAS, the most important element is beat which is the unit of rhythmic pulse. This rhythm can give the urge for the locomotion speed. Studies showed that in healthy adults, music and metronome could increase cadence but, oddly enough, only music could widely increase gait velocity and stride length. The opposite we can observe in the Huntington’s disease were the patient can move faster not with the music but with the metronome. [2]
Direct effects of dance and dance therapy can extremely affect confidence in their own strength and mobility of the patient with PD. A good example is the Argentine tango where close contact with the dance partner helps them maintain balance of the body and affects the way of its maintaining. Also improvisation in dance movements require greater focus and more precise movements. The same benefits can be achieved in patients with Huntington disease, which requires a regular rhythm and the kinetic melody [11].

I consider very interesting the examples that it is not only music elements which are really important but also musical instrument. We have a lot of possibilities for choice the suitable instrument for the rehabilitation. To improve tidal volume we can offer the patient the flute for playing, in case of limb muscle weakness the best solution will be instruments which cooperate with relevant parts of the body like percussion instruments. Very important instrument is also the human voice which we use in singing. I previously mentioned such rehabilitation in case of aphasia, but we can see also good influence in the case of multiple sclerosis where singing can give good effects for the memory of the patient [5].

As we can see on examples which I presented in this article, music therapy for neurological patients is very promising form of rehabilitation. At the present time, music surrounds us and is available for everyone. Unfortunately, we must remember that such rehabilitation must be conducted by persons adequately trained because it is easy to cause opposite effect than intended. But as Novalis said in the end of XVIII century:

“Every disease is a musical problem; every cure is a musical solution”. That is why it is so important to know possibilities which give us the music and to use them in the best way we can.

REFERENCES

ABSTRACT

At the present time, music surrounds us and is available for every one. We are thinking that music is used only for pleasure, dancing, singing, recalling the past times or the people we met on our way years ago. Nowadays we noticed the influence of the music for the neurological disorders. We can see the positive and negative influence of music for the human live. Negative sides of music are musician’s dystonia, musicogenic seizures and auditory hallucinations in schizophrenia. As the positive aspects – music rehabilitation is the promising form of rehabilitation for the patient with aphasia, dementia and after stroke. In case of diseases like Parkinson disease and Huntington disease the most hopeful procedure seems to be rhythmic auditory stimulation. Unfortunately, we must remember that such rehabilitation must be conducted by persons adequately trained because it is easy to cause opposite effect than intended.
STRESZCZENIE

W obecnych czasach dźwięki muzyki otaczają Nas i są dostępne dla każdego bez wyjątku. Na pewno wielu z Nas myśli że muzyka ma również moc przypominania Nam o osobach z którymi kiedyś mieliśmy styczność, a o których prawie zapomnialiśmy lub o niespodziewanych przygodach z naszego życia. Ale czy kiedykolwiek zastanawiało się nad niesamowitym wpływem muzyki na chorych? Szczególnie chorych neurologicznych, którym wydawać by się mogło nie da się pomóc? Muzykę wykorzystujemy do rehabilitacji pacjentów z afazją, demencją oraz po wylewach. Warto wspomnieć również o rytmicznej stymulacji słuchowej w przypadku pacjentów z chorobą Parkinsona lub Huntingtona. Poza pozytywnym wpływem mamy również co ciekawe, negatywny wpływ muzyki gdyż może wywoływać padaczkę muzykogenną, dystonię lub halucynacje w schizofrenii.

Artykuł zawiera 25364 znaki ze spacjami