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THE EFFECT OF SKILLS ACQUIRED DURING MUSICAL TRAINING ON BRAIN FUNCTIONS AND THE COURSE OF NEUROREHABILITATION

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SUMMARY

Background:

The effect of music on the emotional sphere has been studied by many specialists. The authors point out the benefits that accrue from acquiring the musical skills of a trained instrumentalist and vocalist.

Case studies

These skills played a major role in the neurorehabilitation of two patients under treatment at the Rehabilitation Clinic of the University Clinical Center in Gdansk, Poland, in 2010 and 2011.

Conclusions:

Many years of experience as a piano teacher have confirmed that this instrument, more than any other, stimulates both cerebral hemispheres, which has a positive effect on the child's intellectual development. For this reason music lessons should be available in general schools, not just music schools.

Key words: neurological rehabilitation, piano and vocal technique, brain

INTRODUCTION

The beneficial effects of music on the mental condition, cognitive capacity, and progress of persons in rehabilitation has been the object of research by specialists from many different fields. This is particularly true of music therapy, which has recently attracted a great deal of interest (Giannouli 2012). The advocates of these methods suggest that music could serve as a kind of universal medicine with no unpleasant side effects. Listening to music brings pleasure to almost everyone, while those who cannot abide music constitute a distinct minority. The counterindications for the application of music therapy include severe depressive episodes, psychotic states, and music-related epilepsy (Lewandowska, 1996).

Both instrumental play and song are effective in reducing muscle tension, which is known as “active comfort” (Brègy, 1974). Over the years, music lessons shape habits that allow musicians to practice their profession without occupational illnesses (provided that the training is correct). The voice that all of us use is a “living instrument.” The formation of the voice and speech is a neurophysiological activity. The vocal apparatus consists of central and peripheral elements, which, thanks to neural networks, form a whole system with a central analyzer and peripheral effectors. The cortical analyzers involved in listening to music are located primarily in the right temporal lobes, while the brain systems responsible for speaking or singing are in the left motor and premotor cortex, located in the frontal lobes. The center that controls breathing in voice production is found in the first and third frontal convolutions, while the innervation of the larynx itself originates from the medulla oblongata. The kinesthetic and acoustic analyzers control the interaction of the brain centers responsible for the production of the voice and speech (Jordan 1990). Normal voice emission begins with breath support, as shown by research on the coordination of the bioelectrical activity of the respiratory musculature, conducted by Edward Bronowicki in 1980 (Bronowicki, 1980). The key to proper voice production is the coordination of the phonatory system with the articulatory system, and voice timbre can be improved by using the properties of the hard and soft resonators, with the highest possible elevation of the soft palate and a low position of the larynx. Exercises that have been developed by generations of vocalists make it possible to achieve a sometimes very impressive condition of the vocal apparatus, which can be maintained even to an advanced age (Brown and Pachalska 2003). Vocal activity, such as singing in a choir twice a week, significantly improves such voice parameters as average phonation time and the size of the voice field (Sulter, 1996; Mielnik, 2012).

CASE STUDIES

Case 1

Musical skills significantly aided speech therapy for a 36-year-old right-handed female patient, initials M.C., who was admitted to the Rehabilitation Clinic at the University Clinical Center in Gdansk, Poland, in 2010, after an ischemic stroke

of unknown etiology and right hemiplegia. The motor symptoms were accompanied by dysarthria, which was the reason for recommending speech therapy exercises. The patient had previously worked as a teacher, but she had completed secondary school in a violin class, and for several years had been singing intensively in a choir. Thanks to her instrumental skills, she was easily able to cope with activities of daily living using the left hand. Her problems with speech articulation affected primarily vowels, which were excessively prolonged or truncated. The patient also complained that her voice had become lower. Articulatory and vocal exercises were used, and improvement was attained in a very short time. Therapy was facilitated by the patient's knowledge on the subject of proper voice emission, which she had acquired during her musical training in secondary school and her work with the choir. In her case the instrumental and vocal skills at her disposal significantly accelerated the process of motor rehabilitation.

Case 2

In December of 2011, a 39-year-old right-handed female patient, initials M.T., was admitted to the Rehabilitation Clinic at the University Clinical Center after excision of a tumor in the vermis of the cerebellum. She presented with symptoms of multi-focal damage in the posterior cranial cavity, disturbances of equilibrium, and nystagmus. A speech therapist was brought in due to cerebellar dysarthria. The motor dysfunctions were explicable as articulatory disturbances: her speech was characterized by an uneven tempo of speech, a truncated exhalation phase, pauses, and problems with the duration of vowels. M.T. held a degree in music education, though she had spent her professional life in the banking industry. As in the previous cases, her musical skills significantly facilitated her rehabilitation. Speech therapy for dysarthria went very well, but the tremor in the left arm persisted. The speech therapist also had musical training, so she proposed playing on the keyboard. The patient was forced to use both hands; she attempted to practice scales and passages, as well as short simplified works for the piano (from a collection entitled "In the land of melody"). However, she was still unable to control the tremor in the left hand. After consultation with physiotherapists, she was advised to put a specially designed roll under her wrist, which enabled her to play a scale rapidly and smoothly. In this case, instrumental play also facilitated motor rehabilitation.

Occasionally, when the capacity for speaking, writing and reading have been compromised by aphasia, pianists are still able to play on their instrument. This occurred in the case of Maurice Ravel (1875-1937), who suffered a stroke of uncertain etiology (Jaynes, 1994).

DISCUSSION

These cases confirm the significance of musical training for the development of brain functions. Researchers from the Norwegian Research Council for Science and Humanities emphasize the favorable impact of this art form on success

in school: participation in music lessons improves imagination and self-esteem, while participation in a school choir or orchestra teaches cooperation (Micke, 2011; Neville, 2011). Other research has shown that musical performance develops the intellect. Tedd Judd, in a paper delivered during a conference entitled “The Biology of Music-Making,” stated that “an involvement in music involves many parts of the interconnected brain. Children without access to an arts program are actually damaging their brain” (Micke, 2011). Music lessons require the concentration of attention, abstract thinking, and the intellectual predisposition known as “executive control” (Neville, 2011).

The second author’s many years of experience as a piano teacher at the Lycée Française la Pèrouse in San Francisco has indicated that the piano, more than any other instrument, requires the work of both cerebral hemispheres, with the cooperation of the acoustic, kinesthetic, and visual analyzers (reading notes). Both hands are equally important, and they must also perform different tasks at the same time. Moreover, each finger must be controlled (Jaynes, 1994). If the piano were played with the fingers alone, each sound would be different. Pianists take years to develop a free and natural coordination of the work of the muscles of the fingers, so that the specific “weight” of the stroke can give the proper significance to each note in a particular context. This also pertains to other instruments, but the independent work of each hand, and especially the fingers, can create a multi-layered “polyphonic” thinking, of which perhaps the best example is the performance of a fugue by J.S. Bach. Many outstanding composers (such as Mozart, Beethoven, Schumann, or Rachmaninov) and conductors (such as Bernstein, Barenboim, or Schiff) have performed and still perform as concert pianists. It is not without reason that the piano is a supplementary instrument in music schools for those studying other instruments, including solo singers. In San Francisco, learning to play the piano is a supplementary subject in general schools. In Poland, this is left to music schools, which train children and youth with musical talent, with a view towards achieving the level of virtuoso, which is attained by only a few graduates. There is also a mistaken opinion that only people with a musical gift can learn to play instruments. By practice and experience it is possible to develop a good musical ear or musical memory. Such lessons should be available for all children, for the sake of their future development (Micke, 2011; Neville, 2012). Not everyone is gifted mathematically, but mathematics is a required subject for all students. Music, though it has a strong effect on the emotional sphere, requires strict logical thinking. Pythagoras (ca. 570 - 500 BCE) found in acoustics the mathematical proportions that define the intervals of a musical scale. In his view, the structure of the world can only be understood through numbers (King 2004).

CONCLUSIONS

1. The technical skills acquired in the course of learning to play the piano have a favorable impact on the work of both cerebral hemispheres, which takes

- place under the control of the kinesthetic, acoustic, and visual analyzers.
2. These skills support neurorehabilitation.
 3. Familiarity with the basic of voice emission facilitates therapy of voice disorders in patients with dysarthria.
 4. Music lessons stimulate the child's intellectual and emotional development.
 5. An optimal solution would be to enable all children in general schools to learn to play the piano.

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