Brain evoked potential Analysis of Effects of Popular Music Training on Adolescents' Cognitive Neurobehavioral Plasticity

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ABSTRACT

In order to study the impact of pop music on cognitive neurobehavioral plasticity through the use of ERP technology, this study selected adolescents as the research target group, and studied the impact of music training on multiple cognitive functions, influence characteristics, brain structure and brain functional connection in different stages of popular music training through experimental analysis. The results indicated that pop music training not only enabled adolescents to acquire corresponding musical skill and music knowledge reserve, but also exerted a profound effect on adolescents' cerebral neural development. Meanwhile, the brain plasticity could also be improved, including the neural connection and information communication in the nervous system, making it possible for young people to exercise and develop multiple brain regions. The research results of this paper bear important reference significance for the application of pop music in adolescent education.

Key Words: Pop Music Training, Cognitive Function Transmission, Brain Plasticity

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Introduction

Music, as an important form of artistic expression, has always belonged to the category of artistic research. However, with the rapid development of brain imaging techniques such as ERP, EEG and MEG, music has gradually been included in the research field of cognitive neuroscience, which is because music itself is represented by the sound state and the silent state and its components are related to timbre, rhythm, harmony, tune, and melody. The individual needs the extensive involvement, perception, and information processing of the motor cortex, auditory cortex and visual cortex of the brain when engaged in various musical activities (Mcewen, 2016). The brain is a complex dynamic system, which can be reconstructed due to changes in internal factors and external environment such as learning, brain development, and pathological changes in terms of morphological structure, functional activities and chemical substances. This is called brain "plasticity". Therefore, music, as a basic cognitive model of the human brain, provides plasticity for the development of the human brain in the process of cognitive process of the human brain (Karbach, 2015). Therefore, many researchers are seeking to find a point of convergence between brain plasticity and music training in order to better evaluate and detect the changes in active areas and activation levels of the brain under the influence of music training and stimulus. Then, it can be further proved whether music training can help us improve other cognitive abilities through external stimulus and integrating the structures and neural activation patterns of internal related brain regions (Tierney *et al.*, 2015).

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Event-related potentials technology (ERPs), is a special type of brain evoked potentials. It refers to the bioelectric reaction that is specifically generated, detectable, and has relatively fixed time interval and specific phase to the stimulus of the brain or nervous system brain (Schellenberg, 2015). It can reflect the brain nerve electrophysiological changes in the cognitive process from cerebral evoked potentials of the skull with the help of addition average technique. The event-related potentials are closely related to cognitive processes, so they are considered to be the "window" to "peep" psychological activities. The development of neuro-electrophysiological technique has provided new methods for the study of the cognitive process in the brain (Szumlinski, 2016). ERPs have a better potential and advantage for studying these cognitive processes because of its time resolution of millisecond. If electroencephalogram can be included in the experimental process, the difference of brain waveforms of the subjects under compatible tasks and incompatible tasks can be detected through ERPs technique, thus revealing the analytical mechanism of plasticity effect of different popular music on the cognitive neurobehavior of adolescents from the perspective of neurophysiology (Rutherford *et al*., 2016).

This paper studied the effect of multiple music trainings on the cognitive functions and brain function networks of adolescents and revealed that popular music training enabled students to obtain certain playing and singing skills and musical experience through event-related potentials (ERPs), behavioral experiment and functional magnetic resonance imaging, studied the, revealing that (Sherwood *et al*., 2017). Through multiple sensory channels, multiple regions of the cerebral cortex, including auditory regions, visual regions, sports regions and regions of different emotions and somatosensory sensations, could participate in the processing and integration of musical cognition in different forms, which promoted the network connection and comprehensive development of brain, changes in the structure and function of the brain and obtained the plasticity development of the brain. Meanwhile, pop music training also promoted the changes in other cognitive functions of the individual. The plasticity of the brain referred to the ability of neurons to respond to stimuli and make changes (Dunlap, 2016). In addition, the requirements for each type of training were different, so the areas and levels of activation were also different in the training (François *et al*., 2016). Therefore, long-term popular music training had a strengthening effect on specific brain regions (Jain e*t al*., 2016).

Methods

Impact of Pop Music Training on Adolescents' Academic Performance

As it is known to all, music is an acoustic art that shapes an artistic image through sound. The auditory cortex in the individual's brain plays an important role in monitoring and identification role whether in the listening and feeling of various factors such as pitch, timbre, rhythm, harmony, and melody, or integrating these elements into a complete piece of music to play. Therefore, it involves complex brain activities such as sound analysis, auditory memory, and auditory scene analysis. Studies have shown that there is a critical period in the development of the basic functions such as hearing, intelligence, and vision, so there is a critical period for the development of hearing and the auditory plasticity decreases with age. The brain mechanism of children and adults are different. In the initial stage of childhood, the brain has a high degree of plasticity, and learning is mainly through a bottom-up mechanism. With the increase of age, more top-down ("supervised learning") mechanisms are involved. In the transition from childhood learning to adult learning, the difference lies mainly in the reliance on experience. Therefore, there exists a significant difference in the different experience of the auditory system in the adolescent stage and the ability to learn and control in adulthood even if the differences in the auditory system at birth are completely excluded.

In the experiment, if the training of pop music is beneficial to the academic performance of adolescents, it should at least benefit the development of musical ability. In our analysis using a multi-level model, the pop music scores and training time of adolescents were taken as repeated measures, and music adolescents and non-music adolescents were used as intergroup variables. The results showed a significant interaction effect between time (namely, semester) and music scores, as is shown in Figure 1, indicating that the differences in scores between music and non-music adolescents was related to music training experience.

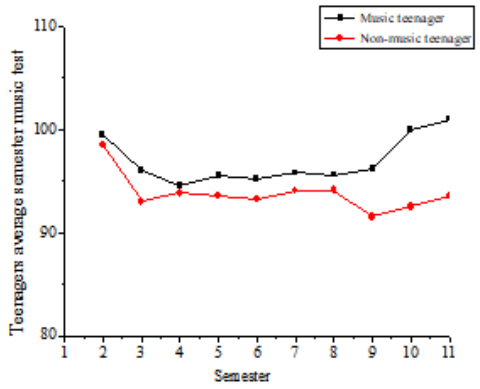

Figure 1. Teenager's music score development

In judging the correlation between music training and academic performance improvement, three independent multi-level models were used to analyze the children's Chinese, English and mathematics scores. Time, namely semester, was taken as repeated measure and group (music and non-music adolescents) was taken as intergroup subject variables. Figure 2 was the results of English scores and the results indicated that there was only a significant interaction effect between English scores and x group, revealing that the English scores of adolescents were related to music training. Therefore, the results showed that in this study, music training was related to the improvement of English performance.

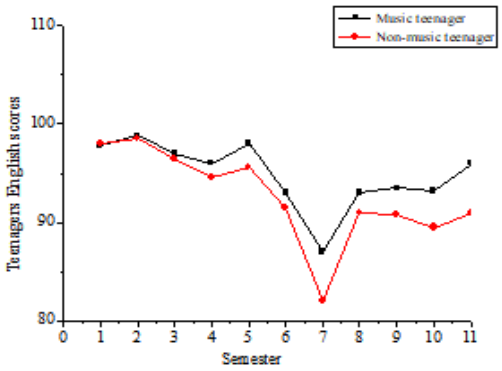

Figure 2. Teenager's English (second language) grades development

Impact of Popular Music Training on Adolescents' Memory Ability

As it is known to all, music shapes artistic images through sounds. We calculated the correct rate of memory tasks for adolescents, as is shown in Figure 3, and the reaction time was shown in Figure 4. After performing variance analysis on the results, there was no significant difference between the groups for music adolescents; and there was also no significant difference between the groups for non-music adolescents. For the reaction time, after analyzing the variance of the results, it was found that there was significant difference between the groups of music adolescents.

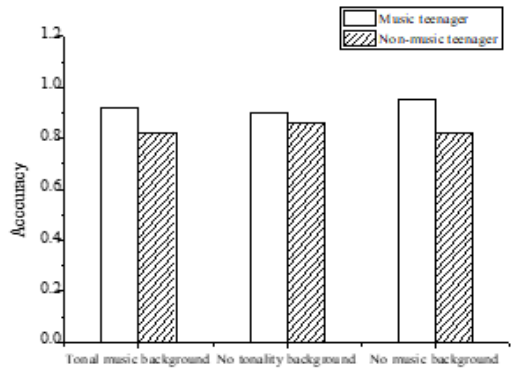

Figure 3. Comparison of the correct rates of music teenagers and non-music teenagers

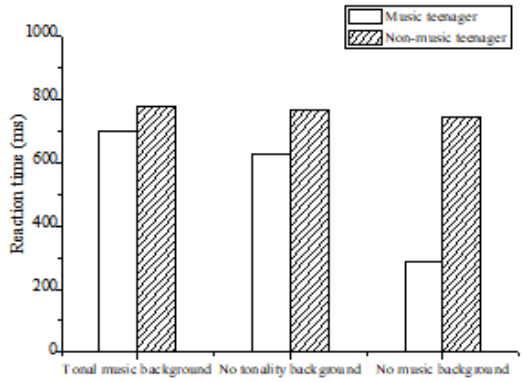

Figure 4. Comparison of the reaction time of music teenagers and non-music teenagers

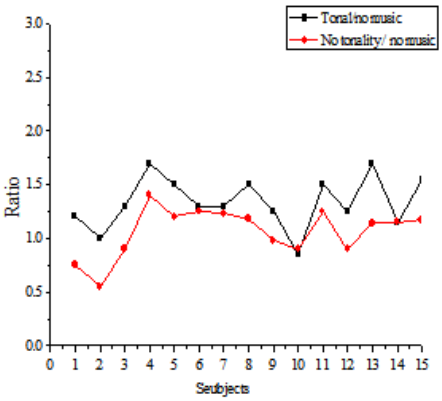

Figure 5. The ratio of tonal music / atonal tune to non-tonal response time in teens

To be more specific, the reaction time in the tonal music background was the longest and

the and the reaction time in no music background was the shortest. There was no significant difference in the reaction time between non-music adolescents in each group. In order to reflect the difference in the reaction time of music adolescents under the tonal music background and no tonality background more directly, the proportion of the two subjects was plotted in Figure 5. The normalized experiment was conducted on the results of groups under the tonal music background and no tonality background. The results showed that music adolescents had a significantly longer reaction time for memory tasks under the tonal background music while non-music adolescents had no significant difference in this aspect. In conclusion, it is believed that there was significant difference between tonal music background and no tonality background for music adolescents.

Impact of Music Training on Brain Motor Cortex

Chinese researchers took Chinese musicians as subjects and used functional magnetic resonance imaging technique to explore the differences in brain function between musicians and non-musicians. The main performance of musician subjects was the advantage in activation of the left temporal region and wide and strong activation of other brain regions, especially in the cuneate, precuneus, medial frontal and left occipital area; while non-musicians showed a right activation advantage and the activation of other brain regions were less and weaker, as is shown in Figure 6.

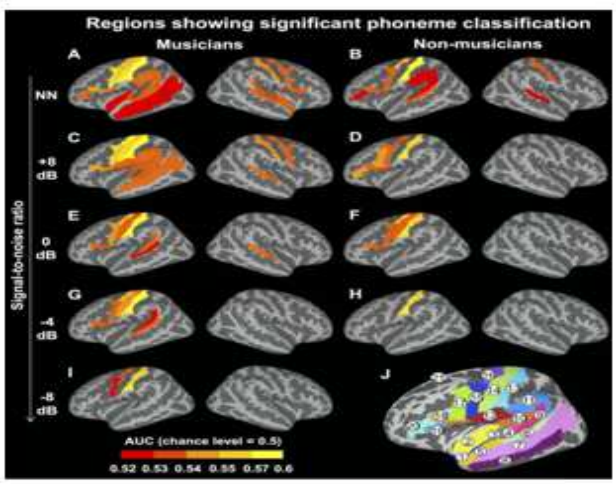

Figure 6. When listening to music, ordinary people and musician teen brain activation

The researchers also found that the brain's motor cortex was also one of the cortexes with strong plasticity and was located in the posterior part of the frontal lobe, including the primary motor cortex, anterior motor cortex and auxiliary motor cortex. Many studies have confirmed that a certain period of sensory stimulation or the acquisition of new motor skills could lead to changes in the structure and function of the motor cortex, producing certain reward mechanisms for different regions of the human brain.

Results and discussion

This study analyzed the first language, second language, and math scores of 250 young people and studied the relationship between long-term popular music training and academic performance. It was found that music adolescents were significantly better than non-musical adolescents in musical performance and second language. In addition, although music training seemed to be related to first language, second language and math achievement, it did not act independently on first language and mathematics. This study explained the impact of pop music training of adolescents on academic performance and transmission effect of non-music cognitive function.

In addition, through a comparative study of the memory abilities of adolescents who have received pop music training and those who have not received pop music training, it was found that there was no significant difference in the evaluation of distinction between tone and atonality among music adolescents, and that there was significant difference in the evaluation of distinction between these two types of music among non-music adolescents, which indicated that long-term music training might lead to a higher threshold for auditory perception of music adolescents, and thus they might be less sensitive to the differences between tone and atonal music; for learning and memory tasks, music adolescents achieved better performance within a shorter period of time, indicating that music training played a positive role in the improvement of learning and memory ability. In the future, more experiments are needed to assess the brain plasticity of tonal and atonal music, including neural mechanism and working memory.

Conclusions and Prospects

The outstanding effect of music training in the development of human brains and the promotion of intellectual development have been gradually confirmed and popular music also has a positive

effect on the cognitive neurobehavioral plasticity of adolescents. Therefore, how to use pop music education to explore and develop the structure and function of adolescents' brain has become an unavoidable new topic. We should clearly realize that the pop music education has extensive impact on adolescents' brain cognition and great value and function in brain development. We need to strive to find the best combination of brain plasticity and music education. To this end, under the premise of fully understanding and recognizing the advanced functions of the brain such as cognitive functions, emotional functions, and self-awareness, we need to implement popular music education according to the rules of brain development and cognitive activities. We need to explore what kind of content, at what moment and what kind of behavioral participation should be adopted in pop music education to match the brain development of adolescents and build a pop music education system that is based on, suitable for and beneficial for brain. Thus, we can provide a more solid and scientific foundation for the implementation of music education and explore a more scientific, effective and enjoyable music learning path for children and adolescents.

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