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# Influence of Ethnic Mminorities' Musical Experience on Their Inhibitory Control Function

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***Abstract:*** *Music is the product of human consciousness activities, which exists in different ethnic groups and different cultural groups. The ethnic minorities in our country are especially good at singing and dancing, and their musical experience should be more abundant. There is substantial evidence that musical experience not only improves music-related abilities, but also has positive effects on a wide range of cognitive activities. However, we still do not know the internal mechanism of the transfer effect of music experience, which makes us lack scientific guidance in music education and music therapy. In recent years, some theories suggest that the influence of musical experience on cognitive ability is mediated by inhibitory control functions. Inhibitory control function is closely related to individual academic achievement, intelligence level and mental health, and childhood is an important period for the development of executive function. However, until now, there is still a lack of systematic research on the relationship between musical experience and executive function.*

***Keywords:*** *ethnic minorities; musical experience; inhibitory control*

## 1. Introduction

Music is the crystallization of the development of human history and exists in all ethnic groups and various cultural groups. In my country, ethnic minorities are especially good at singing and dancing, and music and dancing exist in their blood. The variety and complexity of music is unique to humans. A piece of music needs to play each note in the right order, for the right duration, in the right space and time. This process requires the involvement of sensory and motor systems and integrated brain regions, and involves higher cognitive processes. Music-related exercises can greatly promote the cognitive function of the brain related to music. Musical experience refers to the experience gained during a long period of systematic musical practice, including but not limited to instrumental and vocal practice.

## 2. Musical experience and brain plasticity

### *2.1 The influence of musical experience on cognitive ability*

Previous studies have found that musical experience can improve music-related cognitive abilities, that is, musicians tend to have better pitch perception, rhythm perception, beat perception and melody perception[1-2]. Moreover, musical experience has also been widely transferred to other non-musical cognitive activities[3]. Ability[4], mathematical ability[5], academic achievement[6], and general intelligence[7].

### *2.2 Effects of musical experience on brain function and structure*

The human brain has plasticity, and brain development, experience acquisition, environmental stimuli, etc. all affect brain structure (such as connections between neurons) and functions (such as functional separation and integration of brain regions)[8-9]. With the technological innovation of cognitive neuroscience, scholars pay more attention to the dynamic changes of brain structure and function brought about by experience. fMRI studies have found that musical experience not only affects individual behavior, but also affects the structure and function of the brain.To a certain extent, music learning promotes brain development and contributes to the development of brain plasticity [10].

Existing functional magnetic resonance imaging (fMRI) studies have shown that the gray matter of musicians and non-musicians differs in auditory cortex, visual cortex, motor-related brain regions, and frontal lobes. For example, in the auditory cortex, the study found that adults and children with musical

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experience had significantly greater activation in the temporal lobe of the auditory cortex than the control group when judging irregular chords[11]. At the same time, Bermudez and Zatorre (2005) found that the gray matter density of the superior temporal gyrus and transverse temporal gyrus of musicians is greater[12], and this area is an important brain area for pitch processing; in the visual cortex, fMRI results found that non-musician's letter processing performance The left hemisphere was lateralized, while the music group showed bilateralization in word and music processing, that is, activation of the fusiform gyrus and infraoccipital gyrus of the left and right hemispheres simultaneously [13].

## 3. Inhibit control function

As the total regulatory mechanism of human cognition, executive function coordinates various cognitive processes, allocates and regulates attentional resources, and ensures that the cognitive system achieves its goals in a flexible and optimized manner. Diamond and Miyake et al proved that executive function belongs to a multidimensional structure, including inhibitory control, working memory and cognitive flexibility, and the components are relatively independent[15]. Studies have found that executive function plays an important role in the facilitation mechanism of music training, and music training directly affects executive function.

Inhibitory control refers to the ability to effectively complete the expected task goals by inhibiting internal and external interference, regulating our attention, emotions, behaviors, etc. [14-15]. Inhibitory function is an important component of executive function and is involved in almost all executive function tasks. Many researchers even equate executive function with inhibitory control. Tasks that measure inhibitory control include the Stroop task, the Simon task, the delayed gratification task, the Go/No-go task, and the signal-stop task[15].

Previous studies have found that inhibitory control can be further divided into response inhibition and interference control, and the two have different cognitive neural mechanisms[15-17]. Functional magnetic resonance (f MRI) studies of the Go/No-go task identified the inferior frontal gyrus (IFG) and supplementary motor area (SMA/preSMA) as important brain regions for response inhibition [16,18-19], while fMRI studies on the Stroop task found that the anterior cingulate cortex (ACC) and dorsolateral prefrontal cortex (dlPFC) It is the main brain area for interference control[20]. And the hybrid Go/No-go--flanker task found that response inhibition and interference control are separable and distinct inhibitory processes[21]. Developmental studies have found that it is more difficult for young children to inhibit the interference of irrelevant information, and the ability of inhibitory control continues to develop during adolescence, and does not fully mature until adulthood[15].

## 4. Research on the relationship between music experience and executive function

In recent years, some researchers believe that music training is one of the ideal methods to improve executive function[14]. For example, playing an instrument requires a message that suppresses internal and external disturbances (e.g., suppression of melodic or harmonic disturbances played by other musicians in an ensemble) [22]. It is not difficult to find that musical experience involves a variety of cognitive functions. Moreno's multidimensional model of the effect of musical training suggests that the ability to transfer from musical experience to executive functions may be due to similar cognitive processes between the two[23].

### *4.1 Behavioral research on the influence of music experience on inhibitory control function*

When individuals engage in musical activities with others, they need inhibitory control to resolve conflicts and adjust their own and others' singing; when processing multi-melody music, they need more inhibitory control participation. People with musical experience were more dominant in inhibitory control, and this dominant effect was demonstrated across different age groups. Travis, Harung, and Lagrosen found that compared to amateur music lovers, musicians had less interference effect of color words and better inhibitory control ability[24]. Using the auditory Stroop task and the visual Simon task, Bialystok and DePape found that musicians responded shorter than non-musicians in both the agreement condition and the conflict condition[25]. Moreno, Wodniecka, Tays, Alain, and Bialystok used the stop-signal task, and D'Souza, Moradzadeh, and Wiseheart used the Flanker task, all finding an advantage in the inhibitory control ability of musicians. This shows that long-term music training promotes inhibitory control ability not only in the auditory field, but also in semantic

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interference and spatial position interference[26]. Moreno et al. conducted 4 weeks of high-intensity music training on 5-year-old children and found that training improved children's performance on the Go/No-go task, indicating that short-term music training can also improve children's inhibitory control ability. Seinfeld, Figueroa, Ortiz-Gil, and Sanchez Vives found that older adults who had 4 months of piano training had less interference effects on the Stroop task than older adults who were engaged in recreational sports training. Amer, Kalender, Hasher, Trehub, and Wong found that older musicians outperformed non-musicians on multiple cognitive control tasks.

Studies on the relationship between musical experience and inhibitory control have found that musical experience can improve inhibitory control in children and adults, but some studies have not found this result. For example, early cross-sections found that musicians had less Stroop interference, i.e. greater inhibitory control, than non-musicians [27]. This result was further confirmed by a follow-up study, finding that experts with more musical experience performed better on the Stroop task than amateurs with less musical experience, suggesting that rich musical experience is associated with improved inhibitory control. Similar results were found in children's studies, with children in the music group having an inhibitory control advantage compared to the control group, that is, shorter reaction times in the music group on the Simon task[28]. Longitudinal studies have also found that music experience of 1 year or more can promote the development of children's inhibitory control, as shown in that children in the music group have shorter response times in the signal-stop task after training compared with children in the art group[29]. However, some studies have found that music experience has nothing to do with inhibitory control. For example, Moradzadeh (2014) found that there was no significant difference in the performance of the music group and the control group on the signal stop task and the Stroop task, that is, the influence of music experience on inhibitory control may be stronger than that of the control group. Weak[30]. A study by Slevc et al. (2016) found that musical experience did not predict the development of inhibitory control[22]. Okada (2016) also found that subjects' musical experience was not related to inhibitory control ability[31].

### *4.2 The neural mechanism of the influence of musical experience on executive function*

The human brain has plasticity, and brain development, experience acquisition, environmental stimuli, etc. all affect brain structure (such as connections between neurons) and functions (such as functional separation and integration of brain regions). With the technological innovation of cognitive neuroscience, scholars pay more attention to the dynamic changes of brain structure and function brought about by experience[29]. fMRI studies have found that musical experience not only affects individual behavioral performance, but also changes the structure and function of the brain, that is, music learning promotes brain development to a certain extent and contributes to the development of brain plasticity.

Existing functional magnetic resonance imaging (fMRI) studies have shown that the gray matter of musicians and non-musicians differs in auditory cortex, visual cortex, motor-related brain regions, and frontal lobes. For example, in the auditory cortex, the study found that adults and children with musical experience had significantly greater activation in the temporal lobe of the auditory cortex than the control group when judging irregular chords[31]. At the same time, Bermudez and Zatorre found that the gray matter density of the superior temporal gyrus and transverse temporal gyrus of musicians is greater, and this area is an important brain area for pitch processing; in the visual cortex, fMRI results found that non-musician letter processing showed left Brain lateralization, while the music group showed bilateralization in word and music processing, that is, activation of the fusiform gyrus and suboccipital gyrus of the left and right hemispheres at the same time. The study shows that musical experience changes the neural mechanisms of visual and word processing in musicians; in the motor area, Gaser and Schlaug compared the brain structure of professional musicians, amateur music lovers and non-musicians, and found that professional musicians exercise The gray matter density was higher in the relevant brain regions, and this change in structural plasticity was closely related to the adaptation of motor function.

With the rise of cognitive neuroscience, researchers began to use ERP and fMRI techniques to study the cognitive neural mechanisms by which musical experience affects executive function. For example, previous studies have used ERP technology to examine the effect of music training on the inhibitory control of children aged 4-6 years. The results found that compared with children in the control group, children in the music group completed the Go/No-go task behavior after 4 weeks of training. With improved accuracy, the No-go condition evoked larger P2 amplitudes, which may reflect an advantage in early visual attention in children in the music group [27]. However, this study uses a computer-based simulated music training method, which lacks ecological validity and has a short training time, and the

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study did not find the effect of music training on the N2 and P3 components of the core indicators of response inhibition.

Existing studies on the relationship between music training and inhibitory and transfer abilities have been inconsistent. Some studies found that music training promotes inhibitory control[27]; others found that music training did not predict inhibitory control and switching[22].

## 5. Summary

Numerous studies have focused on the relationship between executive function and musical ability, but it is difficult to get a definitive answer. This is because most studies only focus on one component of executive function, and a small number of comprehensive studies rarely match visual tasks and auditory tasks, so it is difficult to determine whether the dominant effect of musicians only exists in auditory ability, or whether visual ability is also superior. Existing research is mainly based on Western music. Western music is an artificial language expression system formed by basic music theory, harmony, musical form, polyphony, etc., which is separated from everyday language. The style of Chinese folk music is accompanied by natural language or dialect, preserving the everyday language expression system of music. This interaction of language and music may also have implications for different components of executive function.

Musical ability has an important impact on life development. Gardner proposed that musical ability is an integral part of intelligence[32]. There are indeed differences among musicians in the field of music and cross-field cognition, but the main evidence comes from the study of Western music. Chinese folk music has a long history, with unique expressiveness and distinctive personality. Researchers have studied Chinese folk music from the perspectives of musicology, ethnology, and anthropology, but there are few studies from the cognitive perspective. Studying the effect of Chinese folk music training on executive function can provide evidence for the theory of the relationship between music and cognitive ability.

## References

*[1] Tervaniemi, M., Just, V., Koelsch, S., Widmann, A., & Schroger, E. (2005). Pitch discrimination accuracy in musicians vs nonmusicians: an event-related potential and behavioral study. Exp Brain Res, 161(1), 1-10.*

*[2] Wallentin, M., Nielsen, A. H., Friis-Olivarius, M., Vuust, C., & Vuust, P. (2010). The Musical Ear Test, a new reliable test for measuring musical competence. Learning and Individual Differences, 20(3), 188-196.*

*[3] Schellenberg, E. G., & W. Weiss, M. (2013). Music and Cognitive Abilities. 499-550.*

*[4] Patston, L. L., & Tippett, L. J. (2011). The effect of background music on cognitive performance in musicians and nonmusicians. Music Perception: An Interdisciplinary Journal, 29(2), 173-183.*

*[5] Rauscher, F. H., & Hinton, S. C. (2011). Music Instruction and its Diverse Extra-Musical Benefits. Music Perception, 29(2), 215-226.*

*[6] Southgate, D. E., & Roscigno, V. J. (2009). The Impact of Music on Childhood and Adolescent Achievement. Social Science Quarterly, 90(1), 4-21.*

*[7] Schellenberg, E. G. (2005). Music and cognitive abilities. Current Directions in Psychological Science, 14(6), 317-320.*

*[8] Jancke, L. (2009). The plastic human brain. Restorative Neurology and Neuroscience, 27(5), 521-538.*

*[9] Zatorre, R. J., Fields, R. D., & Johansen-Berg, H. (2012). Plasticity in gray and white: neuroimaging changes in brain structure during learning. Nature Neuroscience, 15(4), 528-536.*

*[10] Hyde, K. L., Lerch, J., Norton, A., Forgeard, M., Winner, E., Evans, A. C., & Schlaug, G. (2009). Musical Training Shapes Structural Brain Development. Journal of Neuroscience, 29(10), 3019-3025.*

*[11] Koelsch, S., Fritz, T., Schulze, K., Alsop, D., & Schlaug, G. (2005). Adults and children processing music: an fMRI study. NeuroImage, 25(4), 1068-1076.*

*[12] Bermudez, P., & Zatorre, R. J (2005). Differences in gray matter between musician and nonmusicians. In G. Avanzini, S. Koelsch, L. Lopez & M. Majno (Eds.), Neurosciences and Music Ii: From Perceptio to Performance (Vol. 1060, pp. 395-399).*

*[13] Proverbio, A. M., Manfredi, M., Zani, A., & Adorni, R. (2013). Musical expertise affects neural bases of letter recognition. Neuropsychologia, 51(3), 538-549.*

*[14] Chen J, & Liu Lei. (2017). Effects of music training on executive function. Advances in*

ISSN 2522-6398 Vol. 5, Issue 13: 118-122, DOI: 10.25236/FER.2022.051320

*Psychological Science, 25(11):1854-1864.*
*[15] Diamond, A. (2013). Executive functions. Annual Review of Psychology, 64(1), 135.*
*[16] Chambers, C. D., Garavan, H., & Bellgrove, M. A. (2009). Insights into the neural basis of response inhibition from cognitive and clinical neuroscience. Neurosci Biobehav Rev, 33(5), 631-646.*
*[17] Friedman, N. P., & Miyake, A. (2004). The Relations Among Inhibition and Interference Control Functions: A Latent-Variable Analysis. Journal of Experimental Psychology General, 133(1), 101-135.*
*[18] Swick, D., Ashley, V., & Turken, U. (2008). Left inferior frontal gyrus is critical for response inhibition. BMC neuroscience, 9, 11.*
*[19] Swick, D., Ashley, V., & Turken, U. (2011). Are the neural correlates of stopping and not going identical? Quantitative meta-analysis of two response inhibition tasks. NeuroImage, 56(3), 1655-1665.*
*[20] Laird, A. R., McMillan, K M., Lancaster, J. L., Kochunov, P., Turkeltaub, P. E. Pardo, J. V., & Fox, P. T. (2005). A comparison of label-based review and ALE meta-analysis in the stroop task. Human Brain Mapping, 25(1), 6-21.*
*[21] Brydges, C. R., Clunies-Ross, K., Clohessy, M., Lo, Z. L., Nguyen, A., Rousset, C. Fox, A. M. (2012). Dissociable Components of Cognitive Control: An Event-Related Potential (ERP) Study of Response Inhibition and Interference Suppression. PLOS ONE, 7(3), 5.*
*[22] Slevc, L. R., Davey, N. S., Buschkuehl, M., & Jaeggi, S. M. (2016). Tuning the mind: Exploring the connections between musical ability and executive functions. Cognition, 152, 199.*
*[23] Moreno S., & Farzan, F. (2015). Musi training and inhibitory control: a multidimensional model. Annals of the New York Academy of Sciences, 1337(1), 147-152.*
*[24]Travis, F., Harung, H. S., & Lagrosen, Y. (2011). Moral development, executive functioning, peak experiences and brain patterns in professional and amateur classical musicians:Interpreted in light of a Unified Theory of Performance. Consciousness and Cognition, 20(4), 1256–1264.*
*[25]Bialystok, E., & DePape, A. (2009). Musical expertise, bilingualism, and executive functioning. Journal of Experimental Psychology: Human Perception and Performance, 35(2), 565–574.*
*[26]Moreno, S., & Farzan, F. (2015). Music training and inhibitory control: a multidimensional model. Annals of the New York Academy of Sciences, 1337, 147–152.*
*[27] Sabir, S. M., Blakely, L., & Alfano, D. P. (2005). Early music training and executive function. Archives of Clinical Neuropsychology, 20(7), 835-835.*
*[28] Joret, M.-E., Germeys, F., & Gidron, Y. (2016). Cognitive inhibitory control in children following early childhood music education. Musicae Scientiae, 1029864916655477.*
*[29] Jaschke A. C., Honing, H., & Scherder, E. J. A. (2018). Longitudina Analysis of Music Education on Executive Functions in Primary School Children. Frontier in Neuroscience, 12, 11.*
*[30] Moreno, S., & Bidelman, G. M. (2014). Examining neural plasticity and cognitive benefit through the unique lens of musical training. Hear Res, 308, 84-97.*
*[31] Okada, B. M. (2016). Musical trainin and executive functions (Unpublised master's thesis). University of Maryland, College Park.*
*[32] Shen Zhilong, Howard Gardner. (2007).The present and future of multiple intelligences theory in China and the world. Global Education Perspectives, (1), 3-7*