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Cognitive and Musical Characteristics as Factors of Creative Development

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Abstract

The study is dedicated to examining cognitive and musical characteristics as factors in the creative development of children in primary school and adolescence. The sample consisted of 126 students of grades 2-3 and 6-7 from comprehensive schools in Moscow and Sochi. The following methods were used: Raven's test, Amthauer's Verbal Scale, Gold-MSI and Torrance test. The results of multiple regression analysis showed that the structure of creative perspective factors changes with age. In primary school, fluid intelligence is the leading factor, whereas active musical involvement comes to the fore in adolescence. A significant interaction effect between fluid intelligence and musical involvement was found. An increase in the role of crystallized intelligence in adolescence was revealed. Emotional responsiveness to music consistently contributes to developing creative potential in both age groups. The results of the study emphasize the importance of an integrated approach to the development of creative potential, taking into account both cognitive and musical factors. Practical implications for education and prospects for further research are discussed.

Keywords: Adolescence, Cognitive Characteristics, Creative Development, Crystallized Intelligence, Fluid Intelligence, Musical Characteristics, Musical Involvement, Primary School Age.

1. Introduction

Music plays a fundamental role in human development from the earliest stages of life. Research shows that musical sensitivity already manifests in the prenatal period and is closely linked to cognitive and emotional development (Kholikov, 2023). Modern cognitive neuroscience of music studies the relationship between brain activity and mental processes underlying music's perception, performance and composition, demonstrating that musical activity activates multiple brain areas associated with various cognitive functions.

Creativity, a critical factor in the evolution of humanity and socio-cultural systems (Fan, Sarfo, 2023; Fourie, Schlebusch, 2023), is closely related to musical activity (Portin et al., 2018). Neurobiological studies show that creative processes involve complex cerebral mechanisms, including the interaction of various cognitive processes and emotions (Mastnak, 2018). Musical activity significantly impacts neuroplasticity, activating brain areas associated with emotions, personality, sensory integration and executive functions (Groussard et al., 2014). In musical composition, creativity is considered the ability to transform an ill-structured problem into a well-

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structured task (Wiggins et al., 2001). Essential aspects of creativity in musical composition are the ability to simultaneously represent and process multiple characteristics of a musical piece and the ability to represent musical information hierarchically (Barbot B. et al., 2018). Some researchers believe that learning success is related to intelligence, working memory, and information processing speed (Morosanova et al., 2017).

Research shows that music is an effective tool for developing physical and mental abilities, as well as emotional sensitivity (Sizova, Kislova, 2022). It is important to note that the first six years of a child's life are important for laying the foundations of musical development since, during this period, children have a natural ability to perceive and distinguish musical tones and form an emotional attitude towards music.

Early adolescence is a critical period for identifying and developing various types of giftedness, including intellectual and artistic (Doniy, Shumakova, 2020). In this context, music is considered one of the most effective means of developing creative potential, influencing all aspects of personality (Gilmanov et al., 2010).

Research demonstrates the positive impact of music lessons on the development of verbal memory and intelligence (Ho et al., 2003; Schellenberg et al., 2006). In addition, the home musical environment and the frequency of joint parent-child musical activities at an early age are associated with a higher level of mathematical skills and self-regulation in preschool children (Williams et al., 2015). Self-regulation helps to overcome acute stress due to its high degree of reliability and highly developed processes of action programming (Morosanova et al., 2018). At present, we can talk about the existence of different levels of individual characteristics of the subject, manifested in conscious self-regulation. (Verbitskaya et. al,2020)

Recent studies have identified four key components of children's musicality: musical communication, enthusiasm and motivation, analytical understanding of music, and musical ability itself (Bayanova et al., 2021). This emphasizes the importance of a broad understanding of musical ability that goes beyond traditional tests and includes such aspects as emotional perception of music, as well as expressive and creative abilities.

Thus, cognitive and musical characteristics developed through active interaction with music can serve as important factors in the creative development of the individual. This emphasizes the need to include various forms of musical activity in the educational process to develop the creative potential of students. Despite extensive research into the influence of music on cognitive and emotional development, the question of how exactly cognitive and musical characteristics interact in forming an individual's creative potential remains understudied. In addition, most studies focus on individual aspects of musical influence without considering the complex interaction of various factors.

The purpose of this study is to examine cognitive and musical characteristics as factors of creative development in children of primary school age and adolescents. The study seeks to fill the existing gap in understanding how various aspects of musical experience and cognitive abilities interact in the process of forming creative potential. Our study also aims to identify the structure of factors of creative development in different age groups, which will allow us to understand the dynamics of creative abilities development better. The results of this study may have important practical implications for education, providing a basis for developing more effective strategies for developing the creative potential of children and adolescents through musical activities. In addition, it can contribute to the theoretical understanding of the nature of creativity and the role of music in its development.

2. Methods

Sample

The study involved 126 students from comprehensive schools in Moscow and Sochi (68 girls and 58 boys). The study was conducted in two age groups: younger students (2nd-3rd grades, average age 8.5 years, n = 63) and younger adolescents (6th-7th grades, average age 12.7 years, n = 63).

Instruments

1. Fluid intelligence was assessed using the Raven's Progressive Matrices test (short form). It is necessary to identify the logical sequence of elements and select one correct option from the proposed ones. The total score of correctly solved problems was used as an indicator of general intelligence.

2. The verbal scale of the R. Amthauer intelligence structure test was used to diagnose crystallized intelligence, including tasks for general awareness, verbal analogies and generalization.

The total score of correctly solved problems was used as an indicator (adapted by Valuev, Ushakov, 2010) (Gilmanov et al., 2010).

3. Musical characteristics were assessed using the Gold-MSI, v.1.0 method—this tool aimed at measuring various aspects of musical behavior. The Active Involvement and Emotions scales were used (adapted from the Russian version of the method) (Knyazeva, 2018; Knyazeva, 2018).

4. The Torrance Creativity Test (image battery, form A) was used to assess image creativity according to the indicators of fluency, flexibility, originality, and elaboration (Tunik, 1998).

Data Analysis

As part of the study of cognitive and musical characteristics as factors of creative development, data were analyzed using the multiple linear regression method with the SPSS 26.0 statistical package. According to the Torrance test, the dependent variable was the originality indicator, which is considered an indicator of creative development. The factors were the indicators of fluid and crystallized intelligence, as well as the scales of musical characteristics: active musical involvement and emotional responsiveness to music. We further conducted the regression analysis with a significance level of $p<0.05$.

3. Results

Regression analysis for a group of primary school students (grades 2-3) showed that the model explains 34% of the variance of the dependent variable ($R^2 = 0.34$, $F(4.58) = 7.46$, $p < 0.001$). Statistically significant predictors of originality of thinking were identified: fluid intelligence ($\beta = 0.30$, $t = 2.86$, $p < 0.01$), active musical involvement ($\beta = 0.27$, $t = 2.58$, $p < 0.01$), emotional responsiveness to music ($\beta = 0.21$, $t = 2.01$, $p < 0.05$) and crystallized intelligence ($\beta = 0.18$, $t = 1.72$, $p < 0.05$). Table 1 shows the identified statistically significant predictors of originality of thinking.

Table 1. Predictors of originality of thinking (groups of primary school students, grades 2-3)

Characteristics	**β**	**t**	**p**
Fluid intelligence	0.3	2.86	< 0.01
Crystallized Intelligence	0.18	1.72	< 0.05
Active musical involvement	0.27	2.58	< 0.01
Emotional responsiveness to music	0.21	2.01	< 0.05

These results indicate that in primary school age, cognitive and musical characteristics significantly contribute to predicting creative development. Moreover, fluid intelligence has the greatest influence, indicating the importance of general cognitive abilities in developing creative potential at this age stage.

For the group of younger adolescents (grades 6-7), the regression model explains 39% of the variance in the dependent variable ($R^2 = 0.39$, $F(4.58) = 9.28$, $p < 0.001$). The structure of factors changed as follows: active musical involvement ($\beta = 0.33$, $t = 3.15$, $p < 0.01$), crystallized intelligence ($\beta = 0.26$, $t = 2.48$, $p < 0.01$), fluid intelligence ($\beta = 0.24$, $t = 2.29$, $p < 0.05$), and emotional responsiveness to music ($\beta = 0.20$, $t = 1.91$, $p < 0.05$). Table 2 shows statistically significant predictors of originality of thinking.

Table 2. Predictors of originality of thinking (groups of younger adolescents, grades 6-7)

Characteristics	**β**	**t**	**p**
Fluid intelligence	0.24	2.29	< 0.05
Crystallized Intelligence	0.268	2.48	< 0.01
Active musical involvement	0.33	3.15	< 0.01
Emotional responsiveness to music	0.20	1.91	< 0.05

Adolescence shows a change in the hierarchy of factors: active musical involvement comes first, which may indicate an increasing role of purposeful creative activity in the development of

originality of thinking. Crystallized intelligence also becomes more significant, which may reflect the increasing role of accumulated knowledge and experience in the development of creative potential.

Additional analysis revealed a statistically significant interaction effect between fluid intelligence and active musical involvement in both age groups (younger group: $\beta = 0.18$, $t = 1.73$, $p < 0.05$; older group: $\beta = 0.22$, $t = 2.10$, $p < 0.05$) which is presented in Table 3.

Table 3. Interaction between fluid intelligence and active musical engagement

Characteristics	β	t	p
Junior group	0.18	1.73	< 0.05
Senior group	0.22	2.10	< 0.05

This result indicates that a high level of musical involvement enhances the positive effect of intelligence on originality of thinking, which emphasizes the importance of the interaction of cognitive and musical factors in creative development.

Comparative analysis of regression models for the two age groups revealed several significant differences. The explained variance of the dependent variable increased from 34 % in the younger group to 39 % in the older group, which may indicate an increase in the predictive power of the studied characteristics with age (see Figure 1).

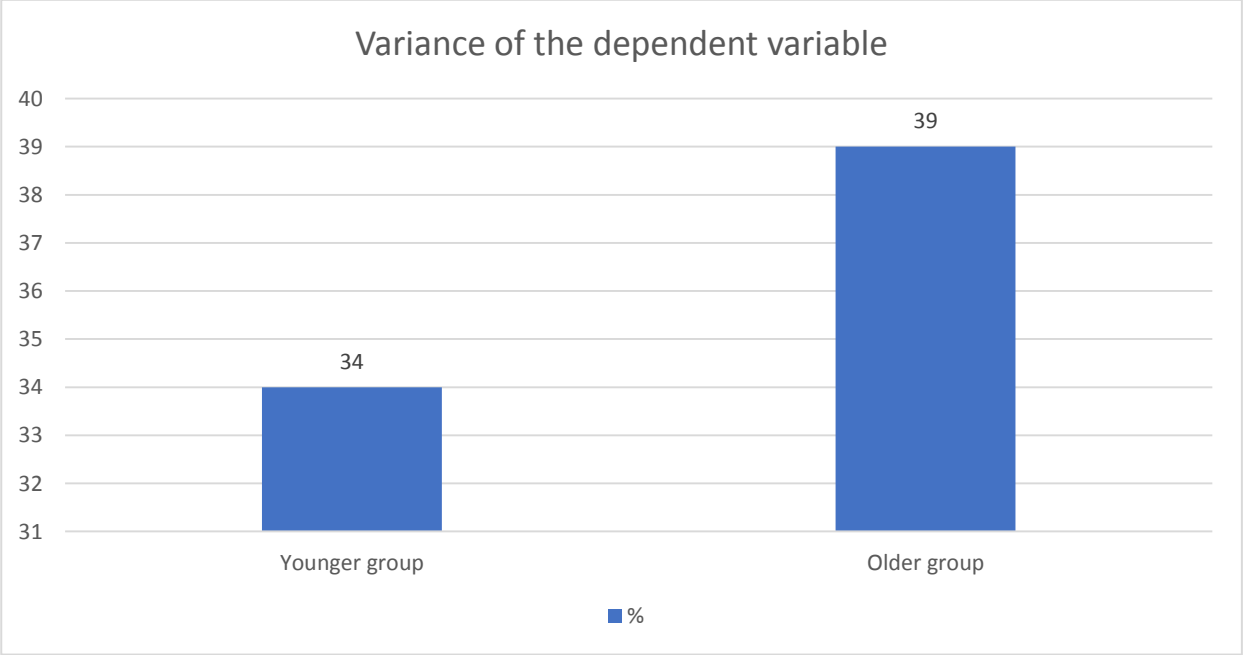

Fig. 1. Variance of the dependent variable

The change in the hierarchy of factors from the younger to the older group may reflect a shift in emphasis from general cognitive abilities to specific creative activity in the development process. The increasing role of crystallized intelligence and some decrease in the significance of fluid intelligence in the older group may be associated with the accumulation of knowledge and experience, which begin to play a more significant role in the creative process of adolescents. The strengthening of the effect of interaction between fluid intelligence and active musical involvement in the older group emphasizes the increasing importance of the synergy between cognitive abilities and creative activity in the formation of creative development.

The results indicate the dynamic nature of the relationship between cognitive and musical characteristics and their influence on creative development. They indicate the need to consider age-related characteristics when developing strategies for developing creative potential in children and

adolescents, emphasizing the importance of both intellectual development and active involvement in creative activity.

4. Discussion

Dolgikh suggests the existence of a relationship between musical abilities and regulatory function in children, which indicates the special value of music lessons in preschool age (Dolgikh et al., 2022). The conducted study of cognitive and musical characteristics as factors of creative development in children of primary school age and adolescence revealed some important patterns.

Firstly, the results confirm the complex nature of creative potential, which is influenced by both cognitive and musical factors. This is consistent with modern theories of creativity, emphasizing the multifactorial nature of this phenomenon (Lubart, 1996). Shishkina et al. (2020) also say in their work that musical and creative abilities are complex personal characteristics and special abilities necessary for studying music.

The study was devoted to intellectual activity in primary school and adolescence. The network correlation analysis method was used, making it possible to visualize and quantify the relationships between various factors. This made it possible to study in more detail the structure of relationships between intellectual, regulatory and cognitive characteristics measured by the "Creative Field" method. The results are consistent with our conclusions about the importance of both cognitive and musical factors in developing creative potential, emphasizing the complex nature of this phenomenon (Zhukova et al., 2019). The stability of the contribution of emotional responsiveness to music in both age groups confirms the importance of the emotional component in the creative process, which is consistent with studies on the role of emotions in creativity (Sizova, Kislova, 2022).

It is especially interesting to note that the study by Knyazeva also found an important role in musical involvement and emotional responsiveness to music. However, if, in our study, fluid intelligence plays a leading role in primary school age, the author of the study notes the absence of differences in general intelligence between the groups but reveals significant differences in crystallized intelligence. This may indicate age-related features of the development of intellectual abilities and their relationship with musical activity, which requires further study in longitudinal studies (Knyazeva, 2024).

The results obtained have important practical implications for education. They indicate the need for an integrated approach to developing creative potential, including cognitive development and involvement in creative activity. Particular attention should be paid to creating conditions for children's active participation in musical and other types of creative activities, especially in adolescence. Karataeva and Khan (2023), in their works, also paid special attention to the development of the intellectual and creative potential of primary school students, linking their development with children's imagination and creative thinking.

5. Conclusion

The conducted study of cognitive and musical characteristics as factors of creative development in children of primary school age and adolescence successfully achieved the set goal and allowed them to solve several important problems.

Firstly, the hypothesis about the complex nature of creative potential, influenced by cognitive and musical factors, was confirmed. The revealed differences in the structure of factors between age groups indicate the dynamic nature of the development of creative abilities, which corresponds to the set objectives of the study.

Secondly, the study showed the increasing role of active musical involvement and crystallized intelligence in adolescence, confirming the hypothesis about the importance of purposeful creative activity and accumulated knowledge in developing originality of thinking.

Thirdly, the discovered interaction effect between fluid intelligence and musical involvement confirms the hypothesis about the significance of the synergy of cognitive abilities and creative activity in forming creative development.

6. Limitations and Strengths

Limitations of this study include its cross-sectional nature, which does not allow for unambiguous conclusions about cause-and-effect relationships.

Future longitudinal studies could clarify the dynamics of creative potential development and the factors influencing it. Further research could also consider the influence of other types of creative activity, in addition to musical, on the development of originality of thinking and study the role of social factors and personality characteristics in shaping creative development.

Overall, the obtained results contribute to the understanding of the factors influencing the development of creative potential in childhood and adolescence and emphasize the importance of taking into account age-related characteristics when developing strategies for the development of creativity.

7. Implications of the Study

The obtained results can be widely used in various fields. Educators and educational program developers can use these data to create more effective strategies for developing the creative potential of children and adolescents that take into account age-related characteristics and the relationship between cognitive and musical factors. Psychologists and creativity researchers can rely on these results to further study the mechanisms of creative ability formation.

Prospects for further research in this area include several directions. Firstly, it is necessary to conduct longitudinal studies to study in more detail the dynamics of creative potential development and the factors influencing it over a long period. Secondly, the study should be expanded to include other types of creative activity in addition to music in order to determine the general and specific factors influencing the development of creativity. Thirdly, it is important to study the role of social factors and personal characteristics in forming creative development, which will provide a more complete picture of the formation of creativity. Finally, a promising direction is the study of neurophysiological correlates of the interaction of cognitive and musical factors in the process of creative activity.

8. Declarations

Ethics approval and consent to participate

The Sochi State University's Ethical Review Committee granted ethics approval for the study.

Consent for publication

All authors read and approved the final version of the manuscript for publication and agree to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Availability of data and materials

The data supporting this study will be made available upon reasonable request to the corresponding author (marina.voytikova@yandex.ru).

Conflict of interest statement

The authors do not have any personal or financial interest in this study.

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Authors' contributions

MAV, EVP, and ONR conceptualized the study. All authors designed the study, collected data from participants, analyzed and interpreted the data, drafted the initial manuscript, contributed to its revision and finalization, and read and approved the final version.

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