

Evaluating the Effects of Integrating Music and Painting Aesthetics in Children's Education: A Quantitative Study

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Abstract—The scope of aesthetics is often bound by the limits of sensory perception. In appreciating music and painting, information is typically processed through distinct perceptual channels. However, at the cerebral cortex and nervous system level, these modes of perception can interact and integrate, influenced by collected audiovisual information, thereby enriching the aesthetic experience and improving aesthetic efficiency. The domain of audio-visual interactive aesthetics holds significant potential in aesthetic education, yet current research in this area has made limited substantial advancements. This paper explores the functionality and impact of an audio-visual interactive aesthetic model, combining music and painting, within practical aesthetic education through a series of applied experiments. By incorporating Chinese traditional music and painting into children's regular curriculum, we conduct a quantitative evaluating and analysis of the benefits of audio-visual multi-sensory aesthetics over single-channel perception in enhancing children's emotional, aesthetic experiences, and cognitive abilities.

1. INTRODUCTION

Chinese traditional music and painting are pivotal art forms in China, deeply rooted in the nation's cultural heritage. These arts not only share aesthetic connotations, spatial awareness, and emotional expression but also exhibit isomorphism and a natural internal connection. However, the perception of aesthetics is constrained by sensory input. During the appreciation of music or painting, information is gathered through distinct perceptual channels. Yet, at the cerebral cortex and nervous system levels, these sensory modes interact and integrate, guided by the collected audio-visual information. Psychologically, survey results indicate that children exhibit a natural inclination towards the interactive aesthetics of music and painting[1].

Given this backdrop, leveraging the interactive nature of visual and auditory senses for multi-channel aesthetic education in music and painting emerges as a promising approach to enhance aesthetic experiences and efficiency. Currently, aesthetic education faces challenges such as a lack of systematic approach, evaluation mechanisms, and resources. Overcoming these challenges requires the effective utilization of information technology, the development of a scientific content system for aesthetic education, the establishment of resource platforms, and the creation of high-quality digital resources[2].

Aesthetic education significantly influences children's emotional states, which in turn drive cognition and intrinsic learning motivation. Positive emotional states enhance attention to new content and facilitate information processing[3-8]. They also aid in retrieving

information from long-term memory[9]. Learning motivation is an internal psychological state that stimulates, directs, and maintains individual activities, influenced by both intrinsic and extrinsic motivations. Intrinsic motivations are often more beneficial, and individuals require stimulation to maintain internal balance, avoiding cognitive and thinking disorders in the absence of environmental stimulation [10-11]. Conversely, anxiety, often accompanying cognitive tasks, can hinder learning by promoting avoidance behaviors [12-13]. This paper posits that the synergistic audio-visual system of music and painting can regulate emotions, bolster intrinsic motivation, and alleviate anxiety in the learning process.

To explore this, we have developed a database of Chinese traditional music and painting, annotated with aesthetic and emotional values[14]. This database serves as a shared resource for aesthetic education. We have conducted fuzzy matching experiments of audio-visual signals based on similar emotional compositions across different aesthetics, confirming the synergistic aesthetic effect. This paper will detail a series of applied experiments to validate the positive impact of this approach in actual educational settings.

2. EXPERIMENTAL DESIGN AND METHODS

2.1. Experiment content

This paper delves into the realms of children's cognitive and learning psychology, with a specific focus on the

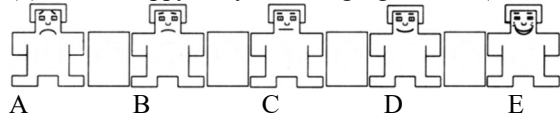
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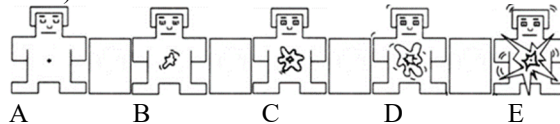
following two aspects. Firstly, it examines the participants' aesthetic experiences within the audio-visual interactive aesthetic mode, encompassing aspects such as emotional pleasure, arousal, dominance, and the development of aesthetic awareness. Secondly, the study investigates the impact of various audio-visual aesthetic education programs on the participants' cognitive abilities, learning interest, and overall engagement.

Given the age and cognitive development stage of the subjects, all experimental queries are framed as straightforward and comprehensible questions. The specific design of these questions is detailed below, with each one featuring a five-point scale ranging from negative to positive evaluations.

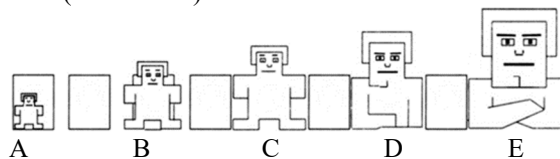
(1) How happy are you feeling right now? (Pleasure)



(2) How energetic do you feel at this moment? (Arousal)



(3) How well do you think you can arrange your studies? (Dominance)



(4) How much do you enjoy appreciating Chinese traditional music/painting? (Awareness and Experience of Aesthetic Feeling)

(5) Will this course help you be more willing to learn other subjects? (Improve the intrinsic motivation of learning)

(6) Do you believe this course will help you perform better in subsequent classes? (Self-efficacy)

(7) Will this course make you feel relaxed? (Anxious state)

(8) Would you like this course to be a regular part of your daily learning? (Demand for the Course)

2.2.Experimental signals

The Audio-visual data with significant synergistic effects in laboratory experiments were screened according to the proportions of different categories and gain rate distributions[14]. A total of 24 pairs of audio-visual signals were used as application experimental materials. The musical data contains four types instruments, namely wind instruments, plucked instruments, percussion instruments and string instruments. Audio files are all wav format files with bitrate 1411kbps, and all the music clips intercepted 30s signal with stable emotional state. The painting data includes landscape painting and flower-and-bird painting. Detailed information about these materials, including aesthetic-emotional values and audio-visual interaction gain rates, is presented in Table 1.

Additionally, select samples of the painting experimental signals are illustrated in Figure 1.

2.3.Subjects and experimental design

The subjects were children aged 8-14 and all had normal hearing and vision. Three groups of subjects were set up, each comprising 18 to 21 children matched in cognitive level and evenly split between males and females. Monitor one-week learning period and test the data differences in three groups on the evaluating questions above.

To minimize psychological stress and the burden of the experiments on the children, the study was designed to integrate aesthetic education courses within their regular curriculum. This approach aimed to blend the experimental setup seamlessly into their normal learning environment.

All experimental sessions were conducted in relatively enclosed classrooms equipped with multimedia audio-visual facilities, ensuring a controlled and conducive environment for the study.

3.EXPERIMENTAL RESULTS AND ANALYSIS

3.1.Reliability Test

The reliability of each subject's data was tested. Cronbach's α was used as a reliability parameter to eliminate unqualified subjects' data through statistical analysis of the internal consistency of all subjects' data. The number of people who passed the reliability test and the value of α coefficient are shown in Table 2.

TABLE 1. RELIABILITY TEST RESULTS

Group\ Parameter	Cronbach's Alpha	Number
Music Group	.646	18
Painting Group	.819	17
Audio-Visual Group	.894	21

3.2.Analysis of emotional changes

The study recorded the emotional states of participants in three groups both before and after exposure to audiovisual stimulation. Quantified values for pleasure (P), arousal (A), and dominance (D) were obtained using a 5-point bidirectional scale. Initially, the baseline emotional values for each group were standardized (*Music Group Pleasure*: $M_P = 3.93$, $SD = 0.99$; *Music Group Arousal*: $M_A = 3.42$, $SD = 1.16$; *Music Group Dominance*: $M_D = 3.84$, $SD = 1.00$). Following the application of the audiovisual signals, scores for each emotional dimension were recorded. This process facilitated a comparison of the emotional state changes in each group pre- and post-stimulation, thus evaluating the impact of different audio-visual channels on the participants' emotional responses. The results of these assessments are presented in Figure 2.

TABLE 2. EXPERIMENTAL SIGNALS AND LABELS

	Music						Painting						
No	Instrume	c	Aestheti	Pleasur	Arousal	Dominan	Author	c	Aesthet	Pleasur	Arousal	Dominanc	Aesthetic
1	Jinghu	Flexible	5.65	6.53	6.79	5.42	Yu Jigao	Vibrant	6.20	6.45	6.95	5.75	0.45
2	drum	Soaring	5.50	5.82	6.94	5.18	Li Zhaodong	Magnifi	5.50	4.40	5.05	3.55	0.44
3	erhu	Sad	5.65	2.67	2.78	4.33	Tango Yin	Bleak	3.70	4.40	4.85	3.90	0.59
4	erhu	Sad	5.65	2.22	4.39	3.17	Xiang	Bleak	3.70	5.00	4.95	4.85	0.45
5	guqin	Profoun	5.45	3.47	4.06	3.88	Zhu Da	Bleak	3.00	3.95	3.85	4.75	0.46
6	erhu	Sad	5.90	2.50	3.61	3.89	Li Di	Bleak	4.15	4.25	4.15	4.35	0.64
7	flute	Soft	5.90	5.06	5.59	4.82	Tang Yin	Elegant	4.10	4.55	4.25	4.90	0.32
8	guqin	Profoun	5.70	3.47	3.37	3.63	Han	Bleak	3.35	3.85	3.70	4.00	0.52
9	drum	Soaring	6.30	5.67	7.11	5.11	Huang Junbi	Magnifi	6.25	6.05	6.40	4.15	0.39
10	guqin	Profoun	6.20	3.50	4.17	4.56	Gu An	Bleak	3.55	3.95	4.05	4.00	0.46
11	konghou	Soft	7.20	5.35	4.40	5.05	Chen Baodi	Elegant	5.85	5.15	4.85	5.85	0.38
12	erhu	Sad	5.95	2.32	2.89	3.37	Li Shixing	Bleak	4.15	3.25	3.70	4.00	0.39
13	zheng	Soft	6.20	6.69	6.06	5.19	Chen	Elegant	4.55	5.30	5.20	5.35	0.27
14	flute	Flexible	5.70	7.71	7.35	6.47	Chen Zhifo	Vibrant	6.60	6.50	6.65	5.40	0.35
15	guqin	Profoun	5.65	3.69	4.63	4.25	Shi Lu	Bleak	3.05	4.00	4.40	4.40	0.38
16	flute	Flexible	6.50	7.16	6.89	6.32	Dong Xiyuan	Vibrant	6.85	7.15	6.90	5.80	0.36
17	drum	Soaring	7.05	6.15	7.15	5.70	Dong Xiyuan	Magnifi	6.85	6.10	7.05	4.70	0.28
18	cucurbit	Flexible	6.50	7.30	6.75	5.70	Zheng	Vibrant	6.00	6.65	6.35	5.50	0.29
19	flute	Flexible	6.65	7.42	7.11	5.58	Sun Qifeng	Vibrant	7.10	6.85	6.80	6.00	0.28
20	erhu	Flexible	6.25	7.61	7.00	6.06	Zou Chuanan	Vibrant	6.45	6.85	6.65	6.00	0.26
21	sheng	Soft	7.00	6.94	5.83	6.28	Chen Baodi	Elegant	5.00	5.25	4.60	4.95	0.30
22	konghou	Soft	6.15	4.22	4.11	4.89	Xie Sun	Elegant	4.20	5.90	5.55	5.25	0.37
23	cucurbit	Flexible	5.90	7.56	6.56	6.19	Sun Qifeng	Vibrant	6.15	6.85	7.00	5.70	0.21
24	sheng	Soft	5.90	5.75	5.44	5.25	Liang Bin	Elegant	4.00	5.55	5.75	5.45	0.25



Figure 1. Upper left- Bamboo Begonia (Vibrant, $P=6.65$, $A=6.35$, $D=5.50$);
Upper right-Huangshan (Magnificent, $P=6.1$, $A=7.05$, $D=4.7$);
Lower left -Tang Yin Landscape Painting (Bleak, $P=4.4$, $A=4.85$, $D=3.9$);
Lower right- Lotus (Elegant, $P=5.9$, $A=5.55$, $D=5.25$);

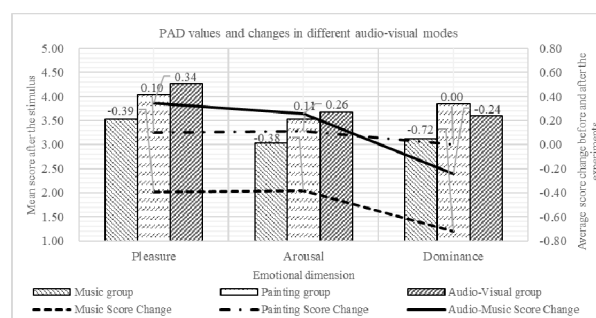


Figure 2. Comparison of PADValues and Their Variations Across Different Audio-Visual Modes

The histograms in Figure 2 represented the states of three emotional dimensions (Pleasure, Arousal, Dominance) of the subjects following stimulation with experimental signals. Within each cluster, the three bars denoted the statistical mean values for the music group, the painting group, and the audio-visual group, respectively. The secondary y-axis illustrated the average score changes observed before and after the signal stimulation. The results revealed that, following the audiovisual interactive aesthetic process involving music and painting, the subjects in the audio-visual group recorded higher scores in pleasure and arousal compared to those in the music and painting groups, while the dominance scores exhibited a relatively moderate state ($p < .05$). In terms of score changes, the music group experienced a decrease in all three dimensions; the painting group showed an increase in pleasure and arousal with no change in dominance; the audio-visual group exhibited an increase in pleasure and arousal but a decrease in dominance.

The data suggested that audiovisual stimulation through music and painting had a regulatory effect on the subjects' emotions. Emotional regulation, both an internal and external organizational system, modifies emotions to promote adaptive behaviors. It impacts thinking, memory, behavior, learning, and health. The study affirmed the widespread use of pleasure and arousal in classifying academic emotions. Dong Yan and Yu Guoliang categorized academic emotions into four types according to the two-dimensional theory of emotions: positive high arousal, positive low arousal, negative high arousal, and negative low arousal emotions.

From the data of the three groups, it was observed that the audio-visual group achieved higher levels of positive emotion and arousal following signal stimulation. Prior research has indicated that elevated positive emotions can enhance students' autonomy and controlled motivation, thereby improving academic achievement. Such emotions also bolster the sense of control over learning situations and the effectiveness of self-regulation, leading to better academic performance [15]. Additionally, studies have found a significant positive correlation between positive academic emotions and effective learning strategies, such as metacognitive strategies, effort, association, and organization. In contrast, negative academic emotions have a significant negative correlation with these learning strategies [16]. High arousal levels are conducive to optimal performance, and positive emotions with high arousal are more beneficial for memory retention [17].

3.3. Analysis of cognitive state

Figure 3 presents the results depicting changes in cognition-related levels among the three groups following exposure to different audiovisual stimuli.

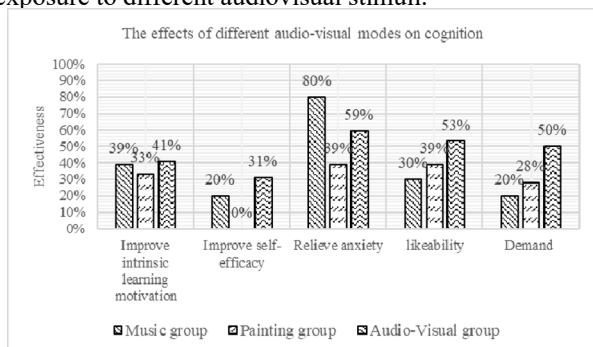


Figure3.Comparative Effects of Various Audio-Visual Modes on Cognitive Responses

Each histogram cluster in Figure 3 represents the efficacy of audiovisual stimuli on a specific cognitive level. Within each cluster, the three bars correspond to the outcomes for the music group, painting group, and audio-visual group, respectively. Across all cognitive test points, the results from the three groups indicated positive feedback. This suggests that both single-channel (music or painting) and dual-channel (audio-visual) multi-modal aesthetics positively influence children's cognitive enthusiasm.

Post a one-week period of audio-visual stimulation, the feedback from subjects was analyzed to determine its impact on their willingness to engage in other courses, essentially assessing the enhancement of intrinsic learning motivation following different audiovisual stimuli. The effectiveness in boosting intrinsic learning motivation was found to be 39% in the music group, 33% in the painting group, and 43% in the audio-visual group. Immersive aesthetic experiences, engaging more sensory nerves and emotions, appear to elevate arousal levels in children, thus effectively enhancing their intrinsic motivation for learning. Ugurodlu et al.'s meta-analysis, encompassing a wide range of studies with over 637,000 subjects from primary to high school, revealed a significant positive correlation between motivation and academic achievement in over 90% of the studies [18]. Furthermore, Liu Jiaxia et al.'s research on 398 middle school students in Beijing demonstrated a significant positive link between learning motivation and academic achievement, with motivation also indirectly impacting achievement through learning strategies [19].

In terms of subsequent course performance post-audiovisual stimulation, the subjects in the three groups showed varying degrees of improvement. The music group reported a 20% increase in performance, the painting group showed no significant effect, while the audio-visual group reported a 31% improvement. Learning psychology suggests that a higher sense of self-efficacy, the belief in one's ability to successfully complete a task, leads to more likely engagement in corresponding behaviors [20-22]. Thus, after audiovisual interactive aesthetic stimulation, children showed improved confidence in their competence for upcoming

learning activities and were more inclined to utilize effective cognitive strategies and actively participate in classroom activities.

Regarding the impact of audiovisual aesthetics on alleviating children's anxiety, music was found to be most effective, followed by audio-visual interaction and then painting. Specifically, the appreciation of music significantly reduced children's tension or anxiety.

Additionally, the study observed an increase in the subjects' preference for traditional Chinese art forms: a 30% increase for Chinese traditional music in the music group, a 39% increase for Chinese painting in the painting group, and a 53% increase in aesthetic preference in the audio-visual group. This indicates that, compared to single-channel aesthetics, the audio-visual synergistic matching pattern of Chinese traditional music and painting was more likely to be accepted and favored by the subjects. In terms of the subjects' demands for the three modes, there was a clear interest in integrating these aesthetic courses into their daily learning. Notably, the audio-visual interactive synergistic aesthetic mode of music and painting was the most preferred compared to single-channel aesthetics.

4. CONCLUSIONS

The present study demonstrates that in the realm of children's aesthetic education, the cross-modal interactive perception involving Chinese traditional music and painting significantly stimulates positive emotions with high arousal. This stimulation notably enhances students' autonomous and controllable learning motivation. It also amplifies their sense of control over learning situations, thereby reinforcing the benefits of self-regulation. Such an approach keeps children at their optimal performance level and proves beneficial for memory retention.

The synergistic interaction between music and painting has shown a distinctly positive influence on children's cognitive learning. When compared to single-channel audio or visual aesthetics, this interactive aesthetic model offers superior benefits in enhancing children's intrinsic cognitive motivation and self-efficacy. The boost in intrinsic motivation and self-efficacy encourages children to exert greater effort, persevere longer, employ more effective learning strategies, and delay gratification, particularly in situations where rewards for effort are not immediate. Additionally, there was a notable preference and demand among children for this interactive aesthetic mode, which effectively improved their aesthetic efficiency.

In sum, the findings suggest that the integration of music and painting in an interactive aesthetic model not only enhances children's enjoyment and engagement with aesthetic education but also positively impacts their cognitive and emotional development. This underscores the potential of cross-modal interactive aesthetic education as a powerful tool in fostering holistic educational outcomes.

ACKNOWLEDGMENT

We extend our sincere gratitude to all the participants for their invaluable contribution to this study. Their willingness to engage in our research has provided essential insights into the field of aesthetic education. Special thanks to the teaching staff and administrators at Taiyuan Xinghualing primary school, whose cooperation and support were pivotal in conducting the experiments and collecting data. Their dedication and enthusiasm greatly facilitated the smooth execution of this project.

Lastly, we thank the anonymous reviewers for their insightful comments and suggestions, which have greatly improved the quality of this paper."

National Social Science Foundation of art major project. (21ZD19)

REFERENCES

1. Yan Gao, Zihou Meng, "Investigation and Analysis of Influencing Factors of Audio-Visual Interaction in Children's Education," *Journal of Communication University of China (Natural Science Edition)*, 2018, 25(01): pp. 52-56+40.
2. Yong Sun, Guorui Fan, "The current situation, problems and countermeasures of school aesthetic education in China," *Educational Science Research*, 2018(10): pp. 70-75.
3. Linnenbrink, E.A., & Pintrich, P.R., "Role of affect in cognitive processing in academic contexts," In D. Y. Dai & R. J. Sterberg (Eds.), *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development*, 2004: pp. 57-87.
4. Pekrun, R., Goetz, T., Titz, W., & Perry, R. P., "Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research," *Educational Psychologist*, 2002, 37: pp. 91-105.
5. Bauml, K.-H., & Kuhbandner, C., "Remembering can cause forgetting-But not in negative moods," *Psychological Science*, 2007, 18: pp. 111-115.
6. Fredrickson, B., "Positivity: Groundbreaking research reveals how to embrace the hidden strength of positive emotions, overcome negativity, and thrive," New York: Crown Publishing, 2009.
7. Pekrun, R., "The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice," *Educational Psychology Review*, 2006,18: pp. 315-341.
8. Pekrun, R., Goetz, T., Daniels, L. M., Stupnisky, R.H., & Perry, R. P., "Boredom in achievement settings: Exploring control-value antecedents and performance outcomes of a neglected emotion," *Journal of Educational Psychology*, 2010, 102: pp. 531-549.
9. Oatley, K., & Nundy, S., "Rethinking the role of emotions in education," In D. R. Olson & N. Torrance(Eds.), *The handbook of education and human development: New models of learning, teaching, and schooling*, 1996: pp. 257-274.
10. Berlyne, D. E., "Conflict, arousal, and curiosity," New York: McGraw-Hill, 1960.
11. Hsee, C. K., Yang, A.X., & Wang, L., "Idleness aversion and the need for justifiable busyness," *Psychological Science*, 2010: 21, pp. 926-930.
12. Anderson, M.C., & Levy, B.J., "Suppressing unwanted memories," *Current Directions in Psychological Science*, 2009, 18: pp. 189-194.
13. Smith, S.M., & Moynan, S. C., "Forgetting and recovering the unforgettable," *Psychological Science*, 2008, 19: pp. 462-468.
14. Yan Gao, Ying Zhan, Xinyu Ma, Zihou Meng, "The synergistic effect of the interactive aesthetics of Chinese traditional music and Chinese painting," *Acta Acoustics*, 2020, 45(05): pp. 749-758.
15. Zhenli Jiang, "The influence of adolescents' academic emotions on academic performance and intervention suggestions," *Theory Research*, 2018, 12: pp. 229-230.
16. Wang, Z., Shakeshaft, N., Schofield, K., & Malanchini, M., "Anxiety is not enough to drive me away: A latent profile analysis on math anxiety and math motivation," *PloS one*, 2018, 13(2).
17. Yongyue Li, "The influence of emotion regulation strategies on the neutral memory material of junior high school students," *Tianjin Normal University*, 2018.
18. Uguroglu, M. E., & Walberg, H. J., "Motivation and achievement: a quantitative synthesis," *American Educational Research Journal*, 1979, 16(4): pp. 375-389.
19. Ji Xia Liu, Tao Xin, Gaoqing Huang, Jiliang Shen, "The relationship between learning motivation, learning strategies and academic performance of middle school students," *Educational Theory and Practice*, 2000(09).
20. Bandura, A., "Self-efficacy mechanism in human agency," *American Psychologist*, 1982, 37: pp. 122-147.
21. Bandura, A., "Human agency in social cognitive theory," *American Psychologist*, 1989, 44: pp. 1175-1184.
22. Bandura, A., "Toward a psychology of human agency," *Perspectives on Psychological Science*, 2008, 1: pp. 164-180.