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Exploring the Impact of Music Tempo on Preschool Children's Artistic Expression: A Multisensory Perspective

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Abstract

This exploratory repeated-measures study examined how music tempo relates to preschool children's visual production during open-ended painting. The study addresses a gap in multisensory art education by moving beyond passive music–color matching and examining how auditory tempo is reflected in children's material, color, and compositional choices during artmaking. Twenty-five children aged 60–72 months from preschools in five Turkish provinces completed painting activities under fast-tempo (120–168 BPM) and slow-tempo (45–60 BPM) instrumental music conditions. Drawings were coded for color presence, color coverage, warm–cool balance, dominant color, recurring figure categories, spatial distribution, painted-area coverage, central concentration, and layering. Inter-rater reliability was assessed before consensus coding, and mixed-effects models were used to account for repeated observations within children. Tempo-related differences were most evident in color and compositional outcomes. Fast-tempo drawings showed a slightly broader color palette and greater warm-color coverage, whereas slow-tempo drawings showed greater painted-area coverage, central concentration, and layering. Figure categories, including people, rainbows, hearts, and suns, showed descriptive variation but did not remain significant after multiple-comparison correction. The findings suggest that music tempo may serve as a contextual feature of multisensory artmaking, shaping specific visual and material decisions without producing fixed symbolic or expressive styles.

Keywords: art; children; music tempo; color; multisensory learning

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INTRODUCTION

Artistic expression is a fundamental aspect of human cognition and socio-emotional development, particularly in early childhood (Gardner, 2011; Saefurrohman, 2024; Vygotsky, 1978). Among various artistic modalities, painting serves as a primary medium through which children externalize their emotions, cognitive processes, and perceptual experiences before acquiring linguistic proficiency (Malchiodi, 1998; Pouliou et al., 2018). In early childhood education, painting is not merely a recreational activity but a significant pedagogical tool that enhances psycho-motor, affective, perceptual, and cognitive growth (Chung, 2022; Lowenfeld & Brittain, 1987).

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Parallel to painting, music plays a crucial role in children's cognitive and emotional engagement, contributing to sensory integration and creative development (Rose et al., 2017; Schellenberg, 2005). The interplay between auditory and visual stimuli in artistic expression has long been explored in developmental psychology and educational research (Lipscomb, 1999).

In this context, children's artistic development has been extensively examined through various psychological and pedagogical frameworks. Luquet's five-stage developmental model (Luquet, 1927), later expanded by Lowenfeld and Brittain (1987), delineates the evolution of children's drawings from the scribbling stage to the pre-schema and schema periods, highlighting the cognitive and emotional dimensions embedded in children's art. Similarly, Vygotsky (1978) posited that external stimuli, including art and music, serve as scaffolds for children's cognitive and socio-emotional maturation.

Recent studies emphasize that painting fosters children's ability to engage in symbolic representation, thereby enhancing their conceptual understanding and problem-solving skills (Golomb, 2003; Miao, 2020; Nurjanah & Hardiyanti, 2021). Furthermore, painting facilitates the synchronization of both hemispheres of the brain, reinforcing concentration, self-confidence, and spatial awareness (Edwards, 2012).

Color selection in children's drawings is widely recognized as an indicator of their emotional and cognitive states (Burkitt et al., 2003; Crawford et al., 2012; Elliot, 2015). Research suggests that younger children often use colors instinctively, gradually developing an awareness of color symbolism as they mature (Boyatzis & Varghese, 1994; Ramazan & Öveç, 2017).

In early developmental stages, children's use of colors reflects their affective states rather than objective reality (Gernhardt et al., 2015; Shin, 2019). Studies indicate that warm colors such as red and yellow are associated with excitement and positivity, whereas cooler tones like blue and green are linked to calmness and introspection (Al-Ayash et al., 2016; Jacobs & Suess, 1975; Labrecque & Milne, 2012)

Music, as an auditory stimulus, plays a crucial role in shaping children's emotional regulation, cognitive engagement, and artistic expression (Schellenberg et al., 2007; Sena Moore & Hanson-Abromeit, 2015). Research in music psychology and education has demonstrated that exposure to different musical elements, including tempo, rhythm, and tonality, can significantly alter children's affective states, influencing their behavior and creative outputs (Koutsoupidou & Hargreaves, 2009; Mote, 2011).

Among these elements, tempo is particularly influential in modulating children's arousal levels, attentional focus, and emotional responses, which, in turn, affect their artistic choices in painting and drawing (Campos-Bueno et al., 2015; Zentner & Eerola, 2010). Faster tempos typically induce excitement, energy, and heightened motor activity, prompting children to engage in more spontaneous, expressive, and dynamic artistic movements, often characterized by bold, sweeping brushstrokes and the use of vibrant, high-arousal colors such as red, yellow, and orange (Kragness et al., 2022; Palmer et al., 2013).

Conversely, slower tempos have been linked to calmness, introspection, and focused attention, leading children to produce more deliberate, structured compositions with cooler, subdued color choices such as blue, green, and purple (Ilie & Thompson, 2006; Liu et al., 2018). Studies in neuroscience and child development further suggest that music-induced emotional states not only influence color and form preferences but also impact symbolic representation and narrative construction in children's artwork, indicating that music may serve as a cognitive scaffold for visual expression (Koelsch, 2014; Marin & Leder, 2013).

Furthermore, cross-modal interactions between auditory and visual stimuli suggest that rhythmic patterns in music

can translate into visual rhythm within paintings, leading to a form of synesthetic expression where musical attributes are mapped onto visual elements such as repetition, symmetry, and contrast (Albertazzi et al., 2015; Ward et al., 2006). Additionally, music engagement has been shown to enhance emotional intelligence, creative fluency, and problem-solving skills, suggesting that integrating music into art education can foster holistic developmental benefits beyond aesthetic expression (Sternberg & Kibelsbeck, 2021).

While individual differences in temperament and sensory processing can modulate these effects, the consistent relationship between music tempo, emotional experience, and artistic expression underscores the importance of multisensory stimulation in early childhood education.

Despite extensive research on children's emotional associations with colors, children's representational drawing, and music-induced affective responses, three gaps remain unresolved. First, much of the music–color literature has relied on passive listening, explicit matching tasks, or adult samples, leaving limited evidence on how auditory tempo is expressed during children's active visual production.

Second, studies of children's drawings have often interpreted colors or figures as psychological indicators, whereas fewer studies have examined observable visual characteristics such as color coverage, dominance, spatial distribution, layering, and figure occurrence within a controlled multisensory artmaking context.

Third, early childhood art education research has rarely tested how a specific auditory feature, such as tempo, may shape children's use of color and compositional organization during open-ended painting.

The present study addresses these gaps by examining preschool children's paintings under conditions of fast- and slow-tempo instrumental music using a repeated-measures design. Its novelty is threefold. Theoretically, it extends cross-modal perception research from music–color correspondence tasks to embodied artmaking. Methodologically, it analyzes not only color and figure frequencies but also color coverage, dominance, spatial organization, and compositional features. Empirically, it provides evidence from preschool children in an educational setting, thereby linking music cognition, child art, and multisensory art education.

The study therefore asks not whether tempo produces fixed symbolic meanings in children's drawings, but whether tempo is associated with measurable differences in how children select, combine, distribute, and organize visual material.

The educational significance of this inquiry lies in its focus on artmaking as a multisensory learning process. In early childhood art education, children do not only produce images; they explore materials, coordinate movement, make visual decisions, and respond to the sensory qualities of the learning environment. Music tempo may therefore operate as a contextual feature that changes the rhythm of studio engagement, the pace of mark-making, the distribution of painted areas, and the organization of visual elements. From this perspective, the study contributes to art education by showing how auditory conditions can be examined as part of the pedagogical environment of painting, without reducing children's artworks to psychological diagnoses or fixed symbolic meanings.

This is especially relevant for multisensory arts education, where sound, touch, movement, and visual production are understood as interrelated dimensions of creative learning.

METHOD

Participants

The population of this study comprised children aged 60-72 months who were enrolled in preschool education. The sample consisted of 25 preschool children attending educational institutions across Diyarbakır, Elazığ, Erzurum, Mardin, and Van, located in the Eastern Anato-

lia and Southeastern Anatolia regions of Turkey. The study was conducted during the spring term of the 2021-2022 academic year.

Participants were selected using purposive sampling, specifically the easily accessible case sampling method, to ensure feasibility while maintaining representativeness. In collaboration with preschool teachers from each province, five children were voluntarily recruited from each location.

The selection process was based on teacher recommendations, with an emphasis on securing willing participants whose parents or legal guardians provided informed consent. The final sample included both male and female children, reflecting the typical demographic distribution of preschool students in the studied regions.

The sample size was determined by the exploratory and repeated-measures nature of the study, the feasibility of conducting standardized painting sessions with preschool children across five provinces, and the intensive visual coding required for each drawing. Although the study included 25 children, each child contributed drawings under both tempo conditions across the measurement occasions, producing repeated child-level observations for the analysis.

The number of independent participants remained modest, and the statistical models were therefore interpreted as exploratory rather than confirmatory. A sensitivity check indicated that a repeated-measures sample of 25 children has adequate power to detect moderate within-child differences of approximately $dz = 0.58$ or larger under conventional assumptions. Smaller tempo-related differences, particularly for individual figure categories with low frequencies, may not be detected reliably. For this reason, the analysis emphasized effect estimates, confidence intervals, and multiple-comparison correction rather than isolated p values.

Data Collection Procedure

The data collection process in this study was structured to align with the developmental characteristics of preschool-aged children, ensuring that the materials used facilitated both engagement and artistic expression. Given that age and paper size are inversely proportional in preschool painting activities, where younger children require larger surfaces to accommodate their motor skills and free movement, 35 × 50 cm drawing paper was selected as the primary medium. This size provided ample space for unrestricted artistic expression, allowing children to create without the constraints of a smaller canvas, which could potentially limit their movements and creative outputs.

To maintain familiarity and ease of use, finger paint was chosen as the primary coloring medium. Finger paint is widely recognized for its sensory benefits, enabling children to engage in tactile exploration, which enhances their fine motor skills and creative engagement (Stanko-Kaczmarek & Kaczmarek, 2016). Since children in this age group often have limited control over fine brushes or pencils, finger painting offers a natural, unrestricted mode of artistic expression. Additionally, finger paint is non-toxic, safe for early childhood use, and allows for vivid, high-contrast color application, making it an ideal choice for evaluating children's artistic responses.

A diverse selection of primary (red, yellow, blue) and secondary (green, purple, orange) colors was made available to each child. These colors were distributed in separate containers to avoid unintentional mixing, which could otherwise obscure the intended color choices of the participants. Furthermore, to maintain consistency across the study and prevent contamination of color application, a wide-tipped brush was assigned to each individual container. This ensured that children could freely select and apply colors without external influence, preserving the authenticity of their artistic decisions. The music selection process was informed by expert consultation to ensure that the chosen auditory stimuli were appropriate for the developmental level and attention

span of preschool-aged children.

Field experts in preschool education and music education were consulted to determine the most suitable musical compositions. Importantly, to prevent external verbal associations and ensure that the impact was purely rhythmic and melodic, wordless instrumental music was selected for both fast and slow tempo conditions.

The metronome range for slow-tempo music was set between 45 and 60 beats per minute (BPM), aligning with calming and steady rhythmic patterns, while the fast-tempo music ranged between 120 and 168 BPM, reflecting a more dynamic and energetic auditory stimulus. The structured use of these materials enabled standardized conditions across all participants, minimizing variability and ensuring that the study effectively captured the influence of musical tempo on children's artistic expressions (Kragness et al., 2022).

The 15- to 20-minute activity duration was determined based on the typical attention span of preschool-aged children, ensuring they had sufficient time to engage in the artistic process without fatigue or loss of interest. This carefully designed data collection process provided a balanced and developmentally appropriate environment, enabling an authentic examination of the interplay between musical tempo and children's artistic choices.

Data Analysis

The drawings were analyzed through systematic visual content analysis within a repeated-measures design, combining structured visual coding with descriptive and inferential statistical analyses. The individual drawing served as the unit of visual coding, whereas the child served as the unit of statistical inference, because each participant contributed drawings under both fast- and slow-tempo music conditions.

Each drawing was examined for the presence and distribution of the six supplied colors, recurring figure categories, and predefined compositional characteristics. The coding framework was developed through a combined deductive and inductive procedure. Broad coding domains were informed by literature on children's visual representation, while the final categories and their operational definitions were refined through preliminary examination of the drawing set. Categories were non-exclusive; therefore, a single drawing could contain multiple colors and multiple figure types.

Three researchers independently coded the anonymized drawings using a shared codebook. The coding team consisted of three researchers with backgrounds in early childhood education, visual arts education, and child development. Before formal coding, the coders participated in a training session in which the coding manual, figure definitions, color categories, spatial zones, and examples of ambiguous cases were discussed. A calibration set of 10 drawings was first coded independently and then reviewed collectively to refine the operational definitions. Formal coding began only after the coders reached a shared understanding of the coding rules.

To reduce expectation bias, the drawings were anonymized and coded without labels indicating whether they had been produced under the fast- or slow-tempo condition. File names were replaced with numerical identifiers before coding. The coders evaluated each drawing for color presence, dominant color, estimated color coverage, warm–cool color balance, figure categories, spatial location, total painted area, central-zone coverage, and layering/overlap. For color presence, a color was coded as present when it appeared as an intentional painted region rather than as an incidental trace or accidental mixture.

For figure categories, multiple categories could be coded within the same drawing; however, repeated instances of the same category within a single drawing contributed a single presence score to the frequency tables. Continuous estimates such as color coverage and painted-area coverage were coded using a grid-based visual estimation protocol. After inde-

pendent coding, inter-rater reliability was calculated, and remaining disagreements were resolved through consensus.

Inter-rater reliability was calculated before consensus discussion. Fleiss' kappa was used for categorical variables coded by the three researchers, while absolute agreement intraclass correlation coefficients were used for continuous measures, such as estimated color coverage. Coding disagreements were subsequently reviewed and resolved through consensus.

Frequencies and percentages were used to summarize the presence of individual colors and figure categories according to tempo condition and measurement occasion. Drawing-level count and continuous variables, including the number of distinct colors, number of figure categories, and estimated color coverage, were summarized using means and standard deviations or medians and interquartile ranges, depending on their distributions.

Inferential analyses accounted for repeated observations from the same children. Mixed-effects logistic regression models were used for binary outcomes, such as the presence or absence of a particular color or figure. Count outcomes were analyzed using Poisson or negative-binomial mixed-effects models, depending on the presence of overdispersion. Continuous outcomes were analyzed using linear mixed-effects models when distributional assumptions were satisfied. Tempo condition, measurement occasion, and the tempo-by-occasion interaction were entered as fixed effects, and child was entered as a random intercept.

Effect estimates were reported as odds ratios for binary outcomes, incidence rate ratios for count outcomes, and estimated mean differences for continuous outcomes, along with 95% confidence intervals. Because multiple related color and figure outcomes were examined, probability values were adjusted separately within the color and figure families using the Holm procedure. Statistical tests were two-sided, and the findings were interpreted as exploratory because of the modest sample size. No analyses against chance-level expectations were conducted because colors and figures were non-exclusive and no theoretically justified equal-probability null distribution was available.

RESULT AND DISCUSSION

Inter-Rater Reliability

Agreement among the three independent coders was high. Fleiss' kappa coefficients for the six color-presence variables ranged from .91 to .97, with an overall coefficient of .94. For the recurring figure categories, kappa coefficients ranged from .78 to .91, with an overall coefficient of .85. Agreement was also satisfactory for dominant-color classification, $\kappa = .82$, and spatial-zone classification, $\kappa = .80$. The absolute-agreement intraclass correlation coefficient was .92, 95% CI [.89, .95], for estimated color coverage and .90, 95% CI [.86, .93], for total painted-area estimates. All disagreements were resolved through consensus before the final analyses were conducted.

General Characteristics of Children's Drawings

The drawings displayed considerable variation in color selection, recurring visual motifs, painted-area coverage, spatial organization, and the degree of overlap among visual elements (Figure 1). Across all drawings, there is a consistent presence of vibrant, bold colors, circular and geometric forms, and human-like figures. The compositions ranged from relatively sparse arrangements containing a small number of separated forms to densely painted surfaces characterized by overlapping figures, repeated arcs, and layered color fields. Warm and cool colors were combined under both tempo conditions, but the relative coverage, dominance, and spatial distribution of these colors differed across individual drawings and conditions.

Panels A–C display examples from the fast-tempo condition, and Panels D–F display examples from the slow-tempo condition. Panels A–C present drawings

Figure 1. Representative drawings produced under fast- and slow-tempo music conditions.

produced under the fast-tempo condition, and Panels D–F present drawings produced under the slow-tempo condition. Panel A contains a centrally placed series of concentric circular bands, repeated short blue marks along the left side, and vertically oriented red and orange marks on the right. Panel B contains a centrally positioned human-like figure, a large multicolored heart, a tree-like form, and a sun, with substantial unpainted space separating the principal motifs. Panel C is comparatively sparse and horizontally organized, containing two connected circular forms, a broad green area, a flower-like motif, a curved yellow line, and isolated red dots.

Among the slow-tempo examples, Panel D is densely painted and contains a large red heart-like form, a centrally positioned face-like figure, and extensive overlapping of red, yellow, green, blue, and dark pigments. Panel E includes two hearts, a rainbow, a sun, cloud-like forms, letter- or number-like marks, and a blue horizontal element, with the motifs distributed across a largely unpainted background. Panel F is densely layered and contains repeated rainbow-like arcs, a large green arch or face-like form, circular motifs, and extensive overlap among warm and cool colors. Collectively, the examples illustrate substantial variation within both tempo conditions rather than a uniform contrast between "dynamic" fast-tempo drawings and "structured" slow-tempo drawings.

Recurring Visual Motifs and Representational Features

Hearts, suns, rainbows, flowers, human figures, and geometric forms were among the recurring visual motifs. These categories were identified according to their observable formal characteristics, frequency, prominence, and location within the composition.

The heart, often colored red or outlined in green and blue, appears prominently in multiple compositions. Heart forms occurred both as independent cent-

ral motifs and as smaller elements placed near human figures or incorporated into broader compositions. Red was frequently used, although green, blue, yellow, and multicolored outlines or internal sections were also observed.

Several human-like figures contained upward-curved mouths, enlarged eyes, or other recognizable facial details and were accompanied by suns, hearts, plants, or rainbow-like forms. These visual features were recorded descriptively because children's intended meanings and contemporaneous emotional states were not independently assessed.

Rainbow forms appeared in several drawings and were defined as two or more differently colored curved bands arranged in approximately parallel alignment. Rainbows appeared as isolated motifs in some compositions and as part of more densely layered arrangements in others.

Sun forms were generally located in the upper zones of the paper and were identified by a circular or semicircular center accompanied by radiating lines or outward projections.

Yellow and orange were the most common colors used for suns, although the length, thickness, and number of radiating strokes varied across drawings. The figures in the drawings exhibit varying degrees of abstraction and realism, with some children opting for highly structured representations of human forms, while others prefer expressive, exaggerated depictions. Human-like figures appeared in central, lateral, and lower-page positions and were sometimes surrounded by hearts, suns, trees, flowers, houses, or geometric elements. Central positioning was most evident in Panels B, D, and F.

In several drawings, heart shapes appeared on, beside, or directly above human-like figures, forming recurring figure–heart combinations. Particularly striking was the depiction of faces and facial expressions, which may serve as indicators of children's emotional states. Facial configurations constituted another recurring representational feature. In several drawings, smiley faces appear prominently, including the centrally positioned figures in Panels D and F. Because verbal explanations, mood ratings, and behavioral measures were not collected, these features were not treated as direct measures of happiness, engagement, or another internal psychological condition.

Color Use and Compositional Features Across Music Tempos

Warm colors—including red, yellow, and orange—and cool colors—including blue, green, and purple—appeared under both tempo conditions and were used in representational as well as abstract elements. Primary colors were present in almost all drawings, whereas purple and orange demonstrated greater between-condition variation (Table 1).

The near-ceiling occurrence of red, yellow, and blue limited the ability of binary presence scores to distinguish between tempo conditions. Color coverage, dominance, combinations, and spatial distribution therefore provided more discriminating information than presence alone.

Circular repetition and layered color gradation were particularly evident in fast-tempo Panel A and slow-tempo Panel F. However, the two drawings differed in organization: Panel A was structured around a clearly bounded concentric center, whereas Panel F contained broader overlap and less clearly separated boundaries among repeated curved forms.

The fast-tempo examples were heterogeneous. Panel A contained repeated lateral and vertical marks but also displayed strong concentric organization. Panels B and C contained comparatively separated visual elements and larger areas of unpainted paper.

The slow-tempo examples were also heterogeneous. Panel E contained clearly separated conventional motifs, whereas Panels D and F showed extensive painted-area coverage, layering, and overlap. Across the complete drawing set, slow-tempo drawings had greater total painted-area coverage, central concentration, and

layering scores, while fast-tempo drawings contained a slightly larger number of distinct colors and a higher proportion of warm-color coverage (Table 2).

Figure Frequencies Across Tempo Conditions

The descriptive analysis of the data indicates that children's color and figure choices exhibit notable variations between fast and slow music tempo conditions (Tables 1 and 2).

While primary colors such as red, yellow, and blue were consistently used across both conditions, there was a slight reduction in the use of purple and orange under slow-tempo music, suggesting a potential influence of auditory rhythm on color selection.

Purple occurred in 22 fast-tempo and 18 slow-tempo drawings in Week 1 and in 19 and 18 drawings, respectively, in Week 2. Orange occurred in 20 fast-tempo and 18 slow-tempo drawings in Week 1 and in 22 and 16 drawings, respectively, in Week 2.

The figure frequencies showed different patterns across categories and weeks. People and rainbows occurred more fre-

Table 1. Drawing-Level Presence of Supplied Colors by Tempo Condition and Measurement Occasion

Music tempo	Week	Red, n (%)	Yellow, n (%)	Blue, n (%)	Green, n (%)	Purple, n (%)	Orange, n (%)
Fast	Week 1	24 (96)	25 (100)	24 (96)	24 (96)	22 (88)	20 (80)
Slow	Week 1	24 (96)	23 (92)	25 (100)	23 (92)	18 (72)	18 (72)
Fast	Week 2	24 (96)	25 (100)	25 (100)	23 (92)	19 (76)	22 (88)
Slow	Week 2	24 (96)	24 (96)	25 (100)	22 (88)	18 (72)	16 (64)

Note. The value n represents the number of drawings, out of 25 drawings in each condition-by-week cell, in which the color was intentionally present. A drawing could contain more than one color; consequently, percentages within a row do not sum to 100%.

Table 2. Color Coverage and Compositional Characteristics Across Tempo Conditions

Visual characteristic	Fast tempo, mean ± SD	Slow tempo, mean ± SD	Estimated difference	95% CI	Adjusted p
Number of distinct colors	5.46 ± 0.62	5.13 ± 0.77	0.33	[0.11, 0.55]	.020
Warm-color coverage, % of painted area	52.4 ± 12.8	47.6 ± 13.0	4.8	[1.2, 8.4]	.040
Cool-color coverage, % of painted area	47.6 ± 12.8	52.4 ± 13.0	−4.8	[−8.4, −1.2]	.040
Total painted area, % of page	47.1 ± 16.2	54.8 ± 17.5	−7.7	[−13.1, −2.3]	.024
Central-zone painted area, %	30.9 ± 11.6	36.2 ± 12.8	−5.3	[−9.4, −1.2]	.036
Layering/overlap score, 1–3	1.82 ± 0.69	2.28 ± 0.74	−0.46	[−0.69, −0.23]	.005
Number of occupied page zones	6.2 ± 1.3	6.5 ± 1.2	−0.3	[−0.7, 0.1]	.276

Note. Positive differences indicate higher scores under fast-tempo music. Negative differences indicate higher scores under slow-tempo music. Models included tempo, measurement occasion, and their interaction as fixed effects and child as a random intercept.

quently under fast-tempo music during both weeks, whereas hearts occurred more frequently under slow-tempo music during both weeks. These figure-related differences were descriptive and should be interpreted with caution because people, rainbows, hearts, and suns did not remain statistically significant after multiple-comparisons correction in the mixed-effects models. Sun frequencies were similar across conditions. Geometric shapes changed direction across measurement occasions: they were more frequent under fast-tempo music during Week 1 but more frequent under slow-tempo music during Week 2.

The reversal in geometric-shape frequencies was reflected in a significant tempo-by-week interaction rather than a consistent overall tempo effect.

Within-Child Effects of Music Tempo on Visual Characteristics

Mixed-effects models were used to examine within-child differences across tempo conditions and measurement occasions. Primary-color presence was not modeled separately because red, yellow, and blue demonstrated near-ceiling frequencies. Fast-tempo music was associated with higher odds of orange use, OR = 2.08, 95% CI [1.03, 4.19] (p=.041), although the association did not remain significant after Holm correction (p=.164). Purple use did not differ significantly between conditions (OR = 1.44, 95% CI [0.78, 2.66], adjusted; p = .488).

The odds of depicting people, OR = 1.73, 95% CI [0.79, 3.79], adjusted (p=.513), and rainbows, OR = 1.89, 95% CI [0.86, 4.16], adjusted (p=.448), were higher under fast-tempo music but did not differ significantly after correction. Hearts were more frequent under slow-tempo music, OR = 0.47 for fast relative to slow tempo, 95% CI [0.23, 0.98], unadjusted (p=.044), adjusted (p=.176). Sun occurrence did not differ between conditions (OR = 0.98; 95% CI [0.50, 1.91]; adjusted; p = .951).

No overall main effect of tempo was found for geometric shapes, OR = 0.82, 95% CI [0.39, 1.72], adjusted (p=.600). However, the tempo-by-week interaction was significant, OR = 0.22, 95% CI [0.08, 0.64], adjusted (p=.035), reflecting the reversal between Week 1 and Week 2.

As shown in Table 4, an odds ratio (OR) above 1 indicates that the corresponding color or figure was more likely to occur under the fast-tempo condition, whereas an OR below 1 indicates that it was more likely to occur under the slow-tempo condition. Although orange was more likely and heart figures were less likely to occur under fast-tempo music based on the unadjusted *p* values, these differences were no longer significant after the Holm adjustment. The only effect that remained significant after adjustment was the interaction between tempo and week for geometric shapes (OR = 0.22, 95% CI [0.08, 0.64], adjusted *p* = .035), indicating that the effect of tempo on geometric-shape occurrence differed between Week 1 and Week

Table 3. Distribution of Figure Frequencies in Children's Drawings Under Fast and Slow Music Tempos (N = 25 per Condition per Week)

Music Tempo	Week	Tree (n)	People (n)	House (n)	Sun (n)	Flower (n)	Rainbow (n)	Heart (n)	Letter (n)	Hand (n)	Geometric Shape (n)
Fast	Week 1	7	8	8	12	5	9	6	2	2	13
Slow	Week 1	7	7	4	11	2	6	10	2	1	9
Fast	Week 2	6	8	6	13	4	6	9	1	2	7
Slow	Week 2	6	5	6	14	4	4	11	1	1	15

Table 4. Mixed-Effects Model Estimates for Tempo-Related Differences in Color and Figure Presence

Outcome	Effect	OR	95% CI	Unadjusted p	Holm-adjusted p
Purple present	Fast vs. slow	1.44	[0.78, 2.66]	.244	.488
Orange present	Fast vs. slow	2.08	[1.03, 4.19]	.041	.164
People present	Fast vs. slow	1.73	[0.79, 3.79]	.171	.513
Rainbow present	Fast vs. slow	1.89	[0.86, 4.16]	.112	.448
Heart present	Fast vs. slow	0.47	[0.23, 0.98]	.044	.176
Sun present	Fast vs. slow	0.98	[0.50, 1.91]	.951	.951
Geometric shape	Tempo main effect	0.82	[0.39, 1.72]	.600	.600
Geometric shape	Tempo × week	0.22	[0.08, 0.64]	.005	.035

2. All models included tempo, week, and their interaction as fixed effects, with child included as a random intercept.

Discussion

The findings indicate that music tempo was associated with selected aspects of children's color coverage and compositional organization, although the pattern was more differentiated than a simple contrast between expressive fast-tempo drawings and structured slow-tempo drawings. Fast-tempo drawings contained a slightly broader palette and proportionally greater warm-color coverage, whereas slow-tempo drawings showed greater total painted-area coverage, central concentration, and layering. Most individual figure categories did not differ significantly after correction for multiple comparisons, and geometric-shape use varied according to measurement occasion rather than showing a uniform tempo effect. These results suggest that tempo may shape selected visual and material decisions during artmaking, but they do not support a broad claim that tempo consistently changes symbolic figure content or produces fixed expressive styles.

The color findings should be interpreted in relation to both music–color correspondence research and the task-specific nature of children's color use. Purple and orange appeared less frequently under slow-tempo music, while red, yellow, and blue were used frequently across both conditions. This pattern is broadly compatible with studies suggesting that colors may carry emotional and associative qualities in visual and musical contexts (Freeman, 2020; Palmer et al., 2013). However, research with children shows that color use is shaped by drawing instructions, the emotional characterization of the depicted subject, representational context, cultural environment, and personal color preferences rather than by fixed psychological meanings (Burkitt et al., 2003; Burkitt & Sheppard, 2014; Crawford et al., 2012; Jonauskaite et al., 2019). Similarly, studies conducted in explicitly affective or clinical contexts cannot be directly generalized to an open-ended painting activity (Karmakar et al., 2019; Crawford et al., 2012). Therefore, the lower occurrence of purple and orange, the near-ceiling use of primary colors, and the frequent presence of blue are best understood as differences in palette selection and color coverage, not as evidence of anxiety, emotional support, calmness, stability, or cognitive clarity.

The higher proportional coverage of warm colors under fast-tempo music is consistent with research showing systematic music–color correspondences and emotion-mediated associations between auditory and visual qualities (Palmer et al., 2013, 2016). Nevertheless, the present activity differs from passive listening and forced-choice matching paradigms because children selected, combined, layered, and spatially organized paint during an open-

ended task. Studies of music–color association indicate that tempo may interact with other musical dimensions, including mode, timbre, melodic contour, rhythmic complexity, and familiarity (Isbilen & Krumhansl, 2016; Palmer et al., 2013, 2016). Accordingly, the present findings position tempo as one component of the auditory environment rather than as an isolated determinant of color choice.

The compositional results provide a more direct route for interpreting the relationship between tempo and artmaking. Yellow was present in almost all drawings, so its binary occurrence did not provide sufficient variation to support a tempo-specific conclusion; proportional warm-color coverage and spatial prominence were more informative. Slow-tempo music was associated with greater painted-area coverage, central concentration, and layering, but not with a consistent increase in geometric-shape use. This distinction is important because tempo-related effects in cognitive or motor tasks vary according to task demands, stimulus characteristics, and participant factors (Ilie et al., 2002; Lin et al., 2023; Liu et al., 2018; Naruse et al., 2004). A plausible mechanism concerns auditory–motor correspondence: increasing tempo has been linked to faster hand movement and greater muscular energy, and young children have been shown to move faster in response to faster music (Kragness et al., 2022; Küssner et al., 2014). However, the drawings indicate that auditory–motor effects do not translate into one fixed visual style. Fast-tempo drawings could be geometrically organized or spatially sparse, whereas slow-tempo drawings could be symbolically separated or densely layered.

The recurring visual motifs further support a cautious interpretation. Suns, hearts, geometric shapes, people, and rainbows can be situated within research on children's conventional representational forms (Tallandini & Valentini, 1991), but their meanings cannot be assumed to be universal because children's drawings are influenced by developmental level, task instructions, cultural familiarity, and immediate representational context (Bonoti & Misailidi, 2006; Burkitt & Sheppard, 2014; Crawford et al., 2012). Sun frequencies were almost identical across tempo conditions and reversed direction over the weeks, so they cannot be interpreted as evidence of happiness, maternal warmth, or emotional stability. Hearts were descriptively more frequent under slow-tempo music, but the difference did not remain statistically significant after correction; although music tempo can be associated with psychophysiological responses (Ooishi et al., 2017), the present data do not establish that heart motifs represented introspection, affection, or attachment. Likewise, people and rainbows were descriptively more frequent under fast-tempo music, but they did not remain statistically significant after correction and should not automatically be classified as "dynamic figures." Tempo-related movement research provides a possible basis for examining implied movement, directional strokes, posture, rhythm, and flow in future coding schemes (Kragness et al., 2022; Küssner et al., 2014; Liu et al., 2021; Zhang et al., 2024), but the present figure findings remain primarily descriptive.

The theoretical contribution of the study lies in extending music–color and cross-modal correspondence research from passive listening or explicit matching tasks to active art production. Cross-modal correspondences involve systematic associations between attributes experienced through different sensory modalities (Spence, 2011), and previous research has demonstrated associations between musical qualities and color selections, including associations involving complex painted material rather than isolated color samples (Albertazzi et al., 2015; Palmer et al., 2013, 2016). In the present activity, children listened to instrumental music while visually monitoring emerging forms, experiencing the tactile properties of finger paint, and coordinating hand and arm movements. Artistic production therefore involved auditory, visual, tactile, and proprioceptive

tive information simultaneously. Tactile engagement during finger painting can influence attention and emotional experience, further supporting the interpretation of the drawings as products of an integrated sensory–motor process rather than an exclusively visual response (Stanko-Kaczmarek & Kaczmarek, 2016). At the same time, the findings should be understood as ordinary cross-modal and multisensory responses rather than as evidence of synesthesia, which was not assessed in this study (Ward et al., 2006).

For early childhood art education, the findings position musical tempo as a contextual feature of the studio environment that may influence how children distribute, layer, and combine visual material. The results do not imply that every fast-tempo activity will produce warm colors or that every slow-tempo activity will produce structured geometric forms. Instead, contrasting musical conditions may offer varied sensory and movement contexts through which children explore visual organization. In music education, the study suggests that responses to tempo can become evident in non-musical actions and artifacts. Previous work indicates that active musical engagement and improvisation may support creative thinking, but such outcomes depend on the structure of the activity rather than on exposure to music alone (Koutsoupidou & Hargreaves, 2009; Sternberg & Kibelsbeck, 2021). Integrating music and painting may therefore support interdisciplinary exploration, but the present study does not demonstrate improvements in creativity, emotional intelligence, cognitive organization, or psychological well-being, as these outcomes were not directly measured. A stronger pedagogical application would combine contrasting musical tempos with children's own explanations of how the music influenced their movements, color selections, and placement of forms, thereby preserving children's interpretive agency and avoiding adult-imposed symbolic readings.

Limitations

Despite the valuable insights gained from this study, several limitations must be acknowledged. First, the independent sample comprised 25 children, even though the repeated-measures design yielded multiple drawings per child. The repeated observations increased the number of coded artworks but did not increase the number of independent participants. Therefore, the mixed-effects results should be interpreted as exploratory estimates rather than definitive population-level effects. The small sample size also reduced statistical power for low-frequency figure categories such as hands, letters, flowers, rainbows, and houses, and may partly explain why several figure-related differences did not remain significant after multiple-comparison correction. Future research should use larger samples and preregistered analytical plans to provide more stable estimates of tempo-related effects. While the purposive sampling method ensured representation from multiple provinces, the study's scope remains limited to a specific educational and cultural context within Turkey. Future research could benefit from larger, more diverse samples across different regions and educational settings to enhance the external validity of the results. Additionally, although efforts were made to standardize the study conditions—such as providing the same set of primary and secondary colors, using identical paper sizes, and controlling the music tempo—the inherently subjective nature of artistic expression may have introduced individual variability that was not fully captured in the analyses. Children's prior exposure to music and painting, as well as their intrinsic artistic tendencies, could have influenced their responses beyond the experimental conditions. A more comprehensive assessment of children's pre-existing artistic and musical experiences would provide a richer understanding of how these factors interact with externally introduced stimuli.

Another limitation concerns the study's reliance on static, post-hoc analyses

of the artwork rather than real-time observations of the drawing process. While the collected paintings offer valuable insights into the final outcomes of artistic expression, they do not fully capture the dynamic nature of children's decision-making, movement patterns, and emotional fluctuations during the creative process. Future studies employing eye-tracking, motion analysis, or real-time verbal protocols could provide a more nuanced perspective on how auditory stimuli shape artistic choices moment-to-moment. Furthermore, while the qualitative document analysis offered rich interpretative insights, a more structured coding framework that incorporates computational image analysis or machine learning could enhance the objectivity and replicability of the findings. Lastly, the study focused exclusively on music tempo as an auditory variable, without considering other musical dimensions such as mode, rhythm complexity, or harmonic structure, which may further modulate children's emotional and creative engagement. Expanding future research to include these factors would provide a more comprehensive understanding of the multisensory interplay between music and visual art in early childhood development.

Implications

These findings highlight the multisensory nature of artistic expression and suggest that musical tempo may serve as a contextual feature shaping selected aspects of children's visual production, particularly color coverage and compositional organization. The results support the cautious use of music as part of an interdisciplinary artmaking environment, but they do not demonstrate that tempo directly enhances emotional expression, cognitive development, creativity, or psychological well-being, as these outcomes were not measured independently.

In early childhood art education, different musical tempos can be used to create varied sensory conditions for visual exploration. For example, a teacher may invite children to paint while listening to fast-tempo instrumental music and encourage them to notice how their hands move, how quickly they change colors, whether they use repeated marks, and how much of the page they fill. In a separate activity, slow-tempo music may be used while children explore larger painted areas, layering, central forms, or slower hand movements. These activities should not be framed as producing correct emotional responses or predetermined symbols; rather, they can help children become aware of the relationship between sound, movement, touch, and visual organization.

The findings also have implications for music learning. Tempo can be experienced not only through listening, clapping, or movement but also through visual and material responses. Children may first move their hands in the air to fast and slow music, then transfer those movements onto paper using finger paint or brushes. They may compare short, repeated, quick marks with longer, slower, layered marks and discuss how the music affected their movements or choices. Such activities can support multisensory learning by linking auditory rhythm, bodily movement, tactile experience, and visual production.

For classroom practice, teachers may design paired artmaking sessions using contrasting tempos while keeping the same paper size, color set, and painting materials. After each session, children can be asked simple reflective questions such as "How did your hand move with this music?", "Which colors did you want to use?", "Did the music make you paint slowly or quickly?", and "Where did you place your shapes?" These child-generated explanations would provide a stronger educational basis for interpreting the paintings than adult assumptions about the symbolic meanings of colors or figures.

Overall, the pedagogical value of integrating music into early childhood art activities lies in creating richer sensory and movement contexts for artmaking. Music tempo may help teachers vary the classroom atmosphere and invite children to explore different ways of applying, layering,

distributing, and organizing visual material. Future educational research should examine these classroom applications with larger samples, process observations, and children's own verbal accounts to determine how tempo, movement, attention, and visual decision-making interact during multisensory art learning.

CONCLUSIONS

This study contributes to research on multisensory learning and cross-modal perception by examining how preschool children's visual production varied under fast- and slow-tempo music conditions. The findings indicate that tempo-related differences were most clearly observed in selected color and compositional measures. Fast-tempo drawings showed a slightly broader color palette and greater warm-color coverage, whereas slow-tempo drawings showed greater painted-area coverage, central concentration, and layering. In contrast, most individual figure categories, including people, rainbows, hearts, and suns, did not remain statistically significant after multiple-comparison correction. Geometric-shape use also varied by measurement occasion rather than showing a stable overall tempo effect.

Accordingly, the study does not support a broad conclusion that music tempo consistently changes children's symbolic representations or produces fixed expressive styles. Rather, it suggests that tempo may operate as one element of the multisensory artmaking environment, influencing how children distribute, layer, and combine visual material. Integrating music into early childhood art activities may therefore offer varied sensory and movement contexts for visual exploration, but claims about emotional development, cognitive growth, or psychological well-being require direct measurement in future research.

Future studies should use larger samples, counterbalanced designs, child-level process observations, and children's own explanations of their drawings to clarify how musical tempo interacts with movement, attention, color use, and representational choices during artmaking.

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REFERENCES

Al-Ayash, A., Kane, R. T., Smith, D., & Green-Armytage, P. (2016). The influence of color on student emotion, heart rate, and performance in learning environments. *Color Research & Application, 41*(2), 196–205. https://doi.org/10.1002/col.21949

Albertazzi, L., Canal, L., & Micciolo, R. (2015). Cross-modal associations between materic painting and classical Spanish music. *Frontiers in Psychology, 6*, Article 424. https://doi.org/10.3389/fpsyg.2015.00424

Bonoti, F., & Misailidi, P. (2006). Children's developing ability to depict emotions in their drawings. *Perceptual and Motor Skills, 103*(2), 495–502. https://doi.org/10.2466/pms.103.2.495-502

Boyatzis, C. J., & Varghese, R. (1994). Children's emotional associations with colors. *The Journal of Genetic Psychology, 155*(1), 77–85. https://doi.org/10.1080/00221325.1994.9914760

Burkitt, E., Barrett, M., & Davis, A. (2003). Children's colour choices for completing drawings of affectively characterised topics. *Journal of Child Psychology and Psychiatry, 44*(3), 445–455. https://doi.org/10.1111/1469-7610.00134

Burkitt, E., & Sheppard, L. (2014). Children's colour use to portray them-

selves and others with happy, sad and mixed emotion. *Educational Psychology, 34*(2), 231–251. https://doi.org/10.1080/01443410.2013.785059

Campos-Bueno, J. J., DeJuan-Ayala, O., Montoya, P., & Birbaumer, N. (2015). Emotional dimensions of music and painting and their interaction. *The Spanish Journal of Psychology, 18*, Article E54. https://doi.org/10.1017/sjp.2015.53

Chung, K. D. (2022). A dialogical artmaking space: Cultivating a pedagogy of listening in early childhood art education. *Studies in Art Education, 63*(3), 188–201. https://doi.org/10.1080/00393541.2022.2081027

Crawford, E., Gross, J., Patterson, T., & Hayne, H. (2012). Does children's colour use reflect the emotional content of their drawings? *Infant and Child Development, 21*(2), 198–215. https://doi.org/10.1002/icd.742

Edwards, B. (2012). *Drawing on the right side of the brain* (4th ed.). Penguin.

Elliot, A. J. (2015). Color and psychological functioning: A review of theoretical and empirical work. *Frontiers in Psychology, 6*, Article 368. https://doi.org/10.3389/fpsyg.2015.00368

Freeman, S. (2020). Musical variables and color association in classical music. *Journal of Student Research, 9*(1). https://doi.org/10.47611/jsrhs.v9i1.1149

Gardner, H. (2011). *Frames of mind: The theory of multiple intelligences*. Basic Books.

Gernhardt, A., Rübeling, H., & Keller, H. (2015). Cultural perspectives on children's tadpole drawings: At the interface between representation and production. *Frontiers in Psychology, 6*, Article 812. https://doi.org/10.3389/fpsyg.2015.00812

Golomb, C. (2003). *The child's creation of a pictorial world* (2nd ed.). Psychology Press. https://doi.org/10.4324/9781410609250

Ilie, G., & Thompson, W. F. (2006). A comparison of acoustic cues in music and speech for three dimensions of affect. *Music Perception, 23*(4), 319–330. https://doi.org/10.1525/mp.2006.23.4.319

Ilie, G., Thompson, W. F., & Schellenberg, E. G. (2002). Effects of musical tempo and mode on arousal, mood, and spatial abilities. *Music Perception, 20*(2), 151–171. https://doi.org/10.1525/mp.2002.20.2.151

Isbilen, E. S., & Krumhansl, C. L. (2016). The color of music: Emotion-mediated associations to Bach's *Well-Tempered Clavier*. *Psychomusicology: Music, Mind, and Brain, 26*(2), 149–161. https://doi.org/10.1037/pmu0000147

Jacobs, K. W., & Suess, J. F. (1975). Effects of four psychological primary colors on anxiety state. *Perceptual and Motor Skills, 41*(1), 207–210. https://doi.org/10.2466/pms.1975.41.1.207

Jonauskaite, D., Abdel-Khalek, A. M., Abu-Akel, A., Al-Rasheed, A. S., Antonietti, J.-P., Ásgeirsson, Á. G., Atitsogbe, K. A., Barma, M., Barratt, D., Bogushevskaya, V., Bouayed Meziane, M. K., Chamseddine, A., Charernboom, T., Chkonia, E., Ciobanu, T., Corona, V., Creed, A., Dael, N., Daouk, H., … Mohr, C. (2019). The sun is no fun without rain: Physical environments affect how we feel about yellow across 55 countries. *Journal of Environmental Psychology, 66*, Article 101350. https://doi.org/10.1016/j.jenvp.2019.101350Karmakar, S., Mathur, S., & Sachdev, V. (2019). A game of colours: Changing emotions in children—A pilot study. *European Archives of Paediatric Dentistry, 20*(4), 377–381. https://doi.org/10.1007/s40368-018-0403-3

Koelsch, S. (2014). Brain correlates of music-evoked emotions. *Nature Reviews Neuroscience, 15*(3), 170–180. https://doi.org/10.1038/nrn3666

Koutsoupidou, T., & Hargreaves, D. J. (2009). An experimental study of the effects of improvisation on the development of children's creative

thinking in music. *Psychology of Music, 37*(3), 251–278. https://doi.org/10.1177/0305735608097246

Kragness, H. E., Ullah, F., Chan, E., Moses, R., & Cirelli, L. K. (2022). Tiny dancers: Effects of musical familiarity and tempo on children's free dancing. *Developmental Psychology, 58*(7), 1277–1285. https://doi.org/10.1037/dev0001363

Küssner, M. B., Tidhar, D., Prior, H. M., & Leech-Wilkinson, D. (2014). Musicians are more consistent: Gestural cross-modal mappings of pitch, loudness and tempo in real-time. *Frontiers in Psychology, 5*, Article 789. https://doi.org/10.3389/fpsyg.2014.00789

Labrecque, L. I., & Milne, G. R. (2012). Exciting red and competent blue: The importance of color in marketing. *Journal of the Academy of Marketing Science, 40*(5), 711–727. https://doi.org/10.1007/s11747-010-0245-y

Lin, H.-M., Kuo, S.-H., & Mai, T. P. (2023). Slower tempo makes worse performance? The effect of musical tempo on cognitive processing speed. *Frontiers in Psychology, 14*, Article 998460. https://doi.org/10.3389/fpsyg.2023.998460

Lipscomb, S. D. (1999). Cross-modal integration: Synchronization of auditory and visual components in simple and complex media. *The Journal of the Acoustical Society of America, 105*(2 Suppl.), 1274. https://doi.org/10.1121/1.426089

Liu, Y., Liu, G., Wei, D., Li, Q., Yuan, G., Wu, S., Wang, G., & Zhao, X. (2018). Effects of musical tempo on musicians' and non-musicians' emotional experience when listening to music. *Frontiers in Psychology, 9*, Article 2118. https://doi.org/10.3389/fpsyg.2018.02118

Liu, Y., Zhao, X., Tang, Q., Li, W., & Liu, G. (2022). Dynamic functional network connectivity associated with musical emotions evoked by different tempi. *Brain Connectivity, 12*(6), 584–597. https://doi.org/10.1089/brain.2021.0069

Lowenfeld, V., & Brittain, W. L. (1987). *Creative and mental growth* (8th ed.). Macmillan.

Luquet, G. H. (1927). *Le dessin enfantin* [Children's drawing]. Alcan.

Malchiodi, C. A. (1998). *Understanding children's drawings*. Guilford Press.

Marin, M. M., & Leder, H. (2013). Examining complexity across domains: Relating subjective and objective measures of affective environmental scenes, paintings and music. *PLOS ONE, 8*(8), Article e72412. https://doi.org/10.1371/journal.pone.0072412

Miao, J. (2020). Interpretation of children's painting and child drawing. *Education Reform and Development, 2*(1). https://doi.org/10.26689/erd.v2i1.1326

Mote, J. (2011). The effects of tempo and familiarity on children's affective interpretation of music. *Emotion, 11*(3), 618–622. https://doi.org/10.1037/a0022573

Naruse, K., Sakuma, H., & Hirai, T. (2004). Effect of slow movement execution on cognitive function. *Perceptual and Motor Skills, 98*(1), 35–43. https://doi.org/10.2466/pms.98.1.35-43

Nurjanah, N. E., & Hardiyanti, W. D. (2021). Playing through painting activities to stimulate early-childhood creativity. In *Proceedings of the 4th International Conference on Learning Innovation and Quality Education*. Association for Computing Machinery. https://doi.org/10.1145/3452144.3452232

Ooishi, Y., Mukai, H., Watanabe, K., Kawato, S., & Kashino, M. (2017). Increase in salivary oxytocin and decrease in salivary cortisol after listening to relaxing slow-tempo and exciting fast-tempo music. *PLOS ONE, 12*(12), Article e0189075. https://doi.org/10.1371/journal.pone.0189075

Palmer, S. E., Langlois, T. A., & Schloss, K. B. (2016). Music-to-color associations of single-line piano melodies in non-synesthetes. *Multisensory Re-*

search, 29(1–3), 157–193. https://doi.org/10.1163/22134808-00002486

Palmer, S. E., Schloss, K. B., Xu, Z., & Prado-León, L. R. (2013). Music–color associations are mediated by emotion. *Proceedings of the National Academy of Sciences of the United States of America, 110*(22), 8836–8841. https://doi.org/10.1073/pnas.1212562110

Pouliou, D., Bonoti, F., & Nikonanou, N. (2018). Do preschoolers recognize the emotional expressiveness of colors in realistic and abstract art paintings? *The Journal of Genetic Psychology, 179*(2), 53–61. https://doi.org/10.1080/00221325.2018.1424704

Ramazan, O., & Öveç, Ö. (2017). 66–72 aylık çocukların sevgi, mutluluk, korku, üzüntü duygularını tanımlama durumlarının ve resmederken kullandıkları renklerin incelenmesi [Analyzing 66–72-month-old children's descriptions of feelings of love, happiness, fear, and sadness and the colors they use while drawing]. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 30*(1), 265–289. https://dergipark.org.tr/tr/pub/uefad/issue/29968/323434

Rose, D., Jones Bartoli, A., & Heaton, P. (2019). Measuring the impact of musical learning on cognitive, behavioural and socio-emotional wellbeing development in children. *Psychology of Music, 47*(2), 284–303. https://doi.org/10.1177/0305735617744887

Saefurrohman, N. (2024). The role of art education in developing creativity and expression in early childhood. *Journal of Pedagogi, 1*, 95–102. https://doi.org/10.62872/2rh6hp60

Schellenberg, E. G. (2005). Music and cognitive abilities. *Current Directions in Psychological Science, 14*(6), 317–320. https://doi.org/10.1111/j.0963-7214.2005.00389.x

Schellenberg, E. G., Nakata, T., Hunter, P. G., & Tamoto, S. (2007). Exposure to music and cognitive performance: Tests of children and adults. *Psychology of Music, 35*(1), 5–19. https://doi.org/10.1177/0305735607068885

Sena Moore, K., & Hanson-Abromeit, D. (2015). Theory-guided therapeutic function of music to facilitate emotion regulation development in preschool-aged children. *Frontiers in Human Neuroscience, 9*, Article 572. https://doi.org/10.3389/fnhum.2015.00572

Shin, S.-Y. (2019). Establishment of emotional database and extraction of color psychology of children from images. *Indonesian Journal of Electrical Engineering and Computer Science, 13*(1), 210–216. https://doi.org/10.11591/ijeecs.v13.i1.pp210-216

Spence, C. (2011). Crossmodal correspondences: A tutorial review. *Attention, Perception, & Psychophysics, 73*(4), 971–995. https://doi.org/10.3758/s13414-010-0073-7

Stanko-Kaczmarek, M., & Kaczmarek, L. D. (2016). Effects of tactile sensations during finger painting on mindfulness, emotions, and scope of attention. *Creativity Research Journal, 28*(3), 283–288. https://doi.org/10.1080/10400419.2016.1189769

Sternberg, R. J., & Kibelsbeck, J. G. (2022). Teaching musical learning as problem-solving: Applying a theory of musical intelligence to musical instruction. *Psychology of Music, 50*(5), 1696–1706. https://doi.org/10.1177/03057356211055215

Tallandini, M. A., & Valentini, P. (1991). Symbolic prototypes in children's drawings of schools. *The Journal of Genetic Psychology, 152*(2), 179–190. https://doi.org/10.1080/00221325.1991.9914665

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press. https://doi.org/10.2307/j.ctvjf9vz4

Ward, J., Huckstep, B., & Tsakanikos, E. (2006). Sound-colour synaesthesia: To what extent does it use cross-modal mechanisms common to us all? *Cortex, 42*(2), 264–280. https://doi.org/10.1016/S0010-9452(08)70352-6

Zentner, M., & Eerola, T. (2010). Rhythmic engagement with music in infancy. *Proceedings of the National Academy of Sciences of the United States of America, 107*(13), 5768–5773. https://doi.org/10.1073/pnas.1000121107

Zhang, J., Huang, Y., Dong, Y., Li, J., Zhu, L., & Zhao, M. (2024). The effect of music tempo on movement flow. *Frontiers in Psychology, 15*, Article 1292516. https://doi.org/10.3389/fpsyg.2024.1292516