

# International Journal of Education & the Arts

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<http://ijea.asu.edu>

ISBN 1529-8094

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Volume 5 Number 2

September 10, 2004

## Is Music “Colorful”? A Study of the Effects of Age and Musical Literacy on Children’s Notational Color Expressions

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Citation: Elkoshi, R. (2004, September 10). Is music “colorful”? A study of the effects of age and musical literacy on children’s notational color expressions. *International Journal of Education & the Arts*, 5(2). Retrieved [date] from <http://ijea.asu.edu/v5n2/>.

### Abstract

This eight-year study represents a pioneering effort to investigate color expression in children’s graphic notations at two stages of development: “Pre-literate” (age: 7.0-8.5), before students received school music instruction, and “Post-literate” (age: 14.0-15.5), three years after students acquired Standard Notation in school, and to consider the effects of age and musical literacy on notational color expressions. Two meetings with Israeli/Jewish schoolchildren were held along a course of eight years: The first meeting with 46 second-graders (1995); the second meeting with 33 ninth-graders (2003). Of these, 17 students participated in two meetings. All participants acquired Standard Notation in their sixth-grade. In each meeting, subjects performed a musical phrase called “Timbre”, represented it graphically and explained their notations. Seventy-nine notations were collected and analyzed by MSC (*Morphological, Structural, Conceptual*) method of interpretation (Elkoshi, 2000, 2002, 2004a). Based on MSC, notations were classified under four categories: A (*Association*), P (*Pictogram*), F (*Formal response*), and G (*Gestalt expression*). Results show that the *conceptual* sub-division of the musical phrase into fragments (G) is color related, whereas the *conceptual perception* of the chronological sequence (F) is shape rather than color related. *Associations* (including

Synesthesia) is probably age related. Post-literate notational color expressions were not affected by musical literacy.

## Theory

Color expressions are explored from diverse perspectives.<sup>1</sup> Painters devise color systems and place them in hierarchies.<sup>2</sup> Analysts measure the palette of works of art attempting to find rules of attaining color harmony.<sup>3</sup> The relation between colors and emotions underlie many philosophical views of man (Kreitler & Kreitler, 1972; Arnheim, 1974).<sup>4</sup> Poets and writers speak effusively about the deep-reaching symbolism of colors (e.g., Goethe, Kant cited in Kreitler & Kreitler, 1972; Hoffmann cited in Jewansky, 2003).<sup>5</sup> Anthropologists show that colors evoke associations of culturally shared meanings (e.g. Cage, 1995; Kreitler & Kreitler, 1972)<sup>6</sup>; Psychologists investigate the relation between colors and emotions (Staples & Walton, Wolberg, Aaronson, cited in Kreitler & Kreitler, 1972; Allen cited in Kreitler & Kreitler, 1972)<sup>7</sup> and scientists experiment with color vision.<sup>8</sup>

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<sup>1</sup> For reviews, see for example, Arnheim, 1974, pp330-371; Kreitler & Kreitler, 1972, pp 54-79; Trevor & Bourriau, 1995; Golomb, 1992, pp 133-294).

<sup>2</sup> An example of a color hierarchy would be the two-level hierarchy of colors, consisting of the three primary pure colors, red, yellow and blue, and three secondary mixtures (Arnheim, 1974, pp. 352-8; Poynter.org, 2003). Other scales of hues and color systems were devised by painters and analysts. For example, Paul Klee devised a "Canon of Color Totality"; Itten identified contrasts of colors (Itten, 1961).

<sup>3</sup> Holzel, for example, suggested that a painting attains harmony only when all its colors, introduced in the proper artistic variety and arrangement, add up to white (Holzel cited in Arnheim, 1974).

<sup>4</sup> For example, Philosophers study "aesthetic pleasure", trying to find out who is pleased or displeased by which colors (Arnheim, 1974).

<sup>5</sup> For example, Hoffmann (in Kapellmeister Kreisler) stated: "I find colors, notes and scents all coming together, not so much in a dream as in that state of delirium that precedes sleep, particularly when I have been listening to a great deal of music" (Hoffmann cited in Jewanski, 2003).

<sup>6</sup> Many problems, which are related to this issue, have not been resolved. For example, the controversy whether vocabulary gaps between "primitive" cultures and modern civilizations are related to biological evolution of the human retina (Cage, 1995, Segall, Campbell & Herskovits cited in Kreitler, 1972; Arnheim, 1974). While some investigators show that there is a universal order of color preference (Eysenk, Guilford, Shen, Schaie & Heiss, Alschuler, cited in Kreitler, 1972) others conclude that color preference is subject to great individual and group differences (e.g. Cage, 1995).

<sup>7</sup> Personality tests are based on the assumption that specific responses to particular colors reveal determinate personality types, associations and tendencies (e.g. Pressey, Valentine, in: Kreitler, 1972). Psychologists study the affective values of color and show, for example, that excitement is elicited by strong brightness and high saturation. Red is exciting because it reminds us of fire, blood, revolution. Green calls up the refreshing thought of nature. Blue is cooling like water (cited in Arnheim, 1974, p. 368).

Child Art psychologists during the last decades have increased their attempts to examine developmental aspects of color and color preference (e.g. Golomb, 1992; Kellogg cited in Read 1966; Alschuler, 1952; Rimerman, 1990; Amitay, 1985). Some researchers conclude that there is a universal order of color development. Young children, for example, have different color preferences than older children or adults (e.g. Gale, Granger, Staples & Walton cited in Kreitler & Kreitler, 1972; Rimerman, 1990; Amitay, 1985)<sup>9</sup>; adolescents attempt to vary the brightness value of a specific color; adults incline to create monochromatic drawings (Golomb, 1992). Others argue that laws with regard to color preference seem to turn up too many exceptions to the rules (e.g. Kreitler & Kreitler, 1972) and judgments of color preference are susceptible to changes by conditioning, mainly in children (e.g. Valentine, Staples & Walton cited in Kreitler & Kreitler, 1972).

Rules about color preferences are found to be fraught with contradicting conclusions. Werner, for example, suggests that schoolchildren turn increasingly to shape because “they are trained in practical skills, which rely on shape much more heavily than on color” (Werner cited in Arnheim, 1974, p 335), whereas Golomb concludes that the use of color (rather than shape) among children (age: 6-8) is being “elevated to the status of representational role” (Golomb, 1992, p 133).

The subject of color and music encompasses cosmological ideas which pervade the history of these relationships from antiquity to the 20th century. Theories of music have frequently been taken as the model for theories of color and color harmony.<sup>10</sup> Colors and sound analogies were accepted as scientific method until the late 18th century, and articles gave rise to animated arguments for and against the analogy of colors and notes (Jewansky, 2003).<sup>11</sup> Since the 18<sup>th</sup> century, composers have created color-light music (“Farblichtmusik”)<sup>12</sup> where colored lights are projected with the

<sup>8</sup> Scientists experiment with colored lights and color vision, attempting to prove anatomically the physiological mechanism operating in the nervous system. Newton is among the early pioneers of color theory. In 1672, he described colors as due to properties of the rays that compose light sources (in: Arnheim, 1974, pp. 340-7).

<sup>9</sup> For example, Israeli scholars found that children during the "Schematic age" (5-8), prefer the fundamental primaries: red, yellow, blue and green (Rimerman, 1990), and during the "Realistic stage" (13-15 and adults) use blue most frequently and red as second in frequency (Amitay, 1985).

<sup>10</sup> The ancient Greeks were the first to construct a scale of colors divided into seven parts, on the analogy of the seven musical notes and seven planets. Aristotle's theory, which is based on analogies of tonal intervals and a scale of colors, was considered valid into the 17th century and inspired authors to associate sound and color, usually in connection with further analogies, such as planets, phases of human life, the elements, degrees of knowledge, flavours.

<sup>11</sup> For example, 18th-century French writers, such as Diderot Rousseau and Voltaire, denied a direct relationship between color and notes but compared drawing and melody, color and pitch, and color and instrumental timbre (Jewanski, 2003).

<sup>12</sup> The term "Farblichtmusik" (color-light music) as defined by Alexander László in an article by that title (1925), refers to a category in the arts in which painting and music are linked to each other and are equally important. While music is performed, a changing play of colors

music, linking color and music as an artistic synthesis (Rimington cited in Jewansky, 2003). "Optical harpsichords" and "color-organs" are used, in which every key, when pressed, opens up a shaft through which colored light passes.<sup>13</sup> The 20<sup>th</sup> century idea of 'kinetic painting' (Diebold cited in Jewansky, 2003) is inspired by the effects of the color-organ and many color-organs are built with a view to creating kinetic art through plays of changing color (Goldschmidt cited in Jewansky, 2003).<sup>14</sup> Since 1920 color-light music has been a highly preferred genre by such composers as Bliss, Messiaen, Ligeti and many others.<sup>15</sup> Jazz musicians translate painting techniques into contemporary jazz<sup>16</sup>; motion picture artists explore the translation of music into

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and forms is cast on a screen by a projector. In a broader sense, this term is applied to all attempts at visualizing music (Jewanski, 2003).

<sup>13</sup> For example, an "optical harpsichord" was built by Louis-Bertrand Castel (1725). Johann Gottlob Krüger (1743) made the first recorded sketch of a color harpsichord "music to delight the eye". Moses Mendelssohn (1755) proposed the notion of expressing melodies in "various kinds of undulating and flame-like lines". D.D. Jameson (1844) propounded the concept of "color-music", the translation of music into a play of colors. Thomas Wilfred (from 1922) performed silent "Lumia" compositions on a "Clavilux" - a color-organ which produces an orchestral succession of colored lights which fill the whole visual scene (Jewanski, 2003).

<sup>14</sup> "The color-organ... is the logical development of all the modern researches in the art of color" (W.H. Wright, 1923 cited in Jewanski, 2003). Moholy Nagy, Dan Flavin, Francois Morellet, Takis and others create stable or moving colored-light paintings (Kreitler, 1972).

<sup>15</sup> In Bliss's "A Color Symphony" (1921–2), each of the four movements bears the name of a color: "Purple", "Red", "Blue" and "Green". Many of Olivier Messiaen's works employ his subjective association of colors with chords, forms and themes. Compositions, such as "Couleurs de la cite celeste" (1963) and "Sept Haïkai" (1962) are directly based upon writing specific notes to produce specific color sequences and blends ("Interpretation des Oeuvres d'Olivier Messiaen", 1988). In the preface to "Couleurs de la Cité Céleste" he explained: "The form of this work depends entirely on color". In the fifth movement of "Sept Haïkai" he wrote into the score the colors to be associated with the chords. György Ligeti described the process of harmonic transformation in his orchestral work "Lontano" (1967) as a kind of polyphony of light. Vishnegradsky, in his multimedia "Mosaïque lumineuse de la coupole du temple" (1942), aimed to project colors on the ceiling of a temple while music was played, awakening of a cosmic consciousness. Shchedrin in "Poetoria" (1968) illustrated the form of the music and the symbolism of the text by different colors. Xenakis linked light, color, music and architecture in "Polytope" (1967), "Persépolis" (1971), "Polytope de Cluny" (1972) and "Le diatope" (1978). Color is a basic rhythmic element in Gubaydulina's "Alleluja" for chorus, boy solo and orchestra, with color, organ ad libitum (1990). Stockhausen's seven-part operatic cycle "Licht" (1977) seeks to achieve a unity of music, light, words, movement and stage design. Luigi Veronesi's "Chromatische Visualisierung: J.S. Bach Kontrapunkt No.2 aus 'Kunst der Fuge'" (1971) was based on a physical parallel between color and music. In Jakob Weder's cycle of pictures "Orchestersuite 3 in D-Dur von J.S. Bach" (1980–81), each of the five movements of the suite is associated with a color that supposedly reflects its character and subject. In Michael Denhoff's cycle "Die blaue Vier – Musik zu Bildern von Jawlensky, Klee, Kandinsky und Feininger" (1977) there are "correspondences of gestus and sound to colors and forms" (Day, 1996; Jewanski, 2003).

<sup>16</sup> For example, the singer Lauren Newton and bassist Joëlle Léandre (1997) have translated painting techniques into contemporary jazz (Jewanski, 2003).

color;<sup>17</sup> artists, such as Paul Klee and Kandinsky, create artistic syntheses by blending methods from art and music in stage works,<sup>18</sup> and painters equate colors with individual musical parameters.<sup>19</sup>

Colors have been observed to appear as Synesthesia<sup>20</sup> to various stimuli as sounds, odors, tastes, and numbers (Hornbostel, Stevens cited in Kreidler & Kreidler, 1972). Synesthesia most frequently takes the form of "color-hearing", the involuntary perception of specific colors by someone hearing sounds (Jewansky, 2003), and Synesthetic metaphors, such as "dark", "bright" or "colorful" sounds, are highly common (Day, 1996).<sup>21</sup> Liszt, Rimsky-Korsakov, Sibelius, Bartok, Scriabin and Schoenberg are among the "Synesthetic composers", who explicitly associate sounds with specific colors (Day, 1996; Grove: Synesthesia).<sup>22</sup> Institutes are founded to carry

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<sup>17</sup> For example, the Walt Disney Company, Bach's D minor Toccata in "Phantasia".

<sup>18</sup> Paul Klee in his "polyphonic paintings", translated elements of music into pictorial equivalents. Kandinsky tried to achieve an artistic synthesis by using methods from each art in his stage work "Der gelbe Klang" (1912). Writing in "Der blaue Reiter", he gave detailed instructions for the colors and some indications of the music (Jewanski, 2003).

<sup>19</sup> For example, in a series of works by the painter Hans Werner Berretz and a group of composers (1993), primary colors illustrate the musical parameters: red for pitch and duration, blue for rhythm, yellow for melody, green for harmony. Carl Ludwig Junker compared the drawing, coloring and expression of a painting with the melody, harmony and expression of a musical composition (Jewanski, 2003).

<sup>20</sup> The term "Synesthesia" literally refers to the fact that a stimulus in one sense modality involuntarily elicits a sensation/experience in another sense modality. The word comes from the Greek (syn-) "union", and (aesthesia) "sensation", thus meaning "a union of the senses". Itten, for example, has designated the complementary pair of red-orange and blue-green as the temperature poles of "warm" and "cold" colors, respectively (Itten, 1961). The distinction between "warm" and "cold" colors, which is common among artists and in books on the theory of color, appears as a synesthetic response (Day, 1996).

<sup>21</sup> The language includes a great many metaphoric references, which link music to color: a musical composition may sound "superbly vital and colorful..." (Wigmore, 1986 about Dvorak's Slavonic Dances); Chords may sound dark and create the blues; Avant-garde composers employ "white noise" etc.

<sup>22</sup> Rimsky-Korsakov synchronized stage lighting with use of color words and a pattern of keys in the music in his opera "Mlada" (1889). Bela Bartók, in his opera "Bluebeard's Castle" (1911), integrated the colored light of the seven rooms with prevailing keys. Seeking to synthesize all sensations, Alexander Scriabin associated colors and sounds in "Prométhée" (1908–10) for orchestra, chorus and tastiera per luce (color organ). In "Die glückliche Hand" (1913), Schoenberg wanted the emotions arising from the action to be expressed by means other than music alone: "It should be evident that movements, colors and light are to be treated in the same way as notes are usually handled... Figures and structures are to be formed... from various light values and shades of color..." (Schoenberg cited in Jewanski, 2003). Granville Bantock advocated the use of colored light in the concert hall for performances of his "Atlanta in Calydon" (1911); The heraldic significance of the colors (green for instance, being associated with emeralds, hope, youth, joy, spring and victory) is reflected in the character of the music. Alexander László gave Farblightmusik concerts

out research about the Synesthesia phenomenon,<sup>23</sup> and international conferences devote to color and music.<sup>24</sup>

Nonetheless, the notion of Synesthesia is controversial. Some scholars tend to attribute Synesthesia to an innate global reactivity of the organism (e.g. London, Goldstein, Werner cited in Kreitler & Kreitler, 1972). While others, with a nativistic approach, maintain that a symbolic meaning of a color is a quality of the color itself (e.g. Hornbostel cited in Kreitler & Kreitler, 1972, p. 70) or a product of learning (e.g. Ellson, Howells cited in Kreitler & Kreitler, 1972, p. 72).<sup>25</sup>

Furthermore, research of color as related to music is fraught with obstacles. The works of composers, such as Messiaen and Scriabin, involve Synesthetic phenomena in the process of composition, but they are not necessarily perceived as Synesthetic by listeners. The precise nature of a stimulus provided by colors may not be evident if listeners have been given no indications. Without a prior knowledge of a programme, it is impossible to link colors and music. Because music and color images vary from one person to another, problems arise when a uniform perception is fundamental to the understanding of the phenomenon. The concrete associations between color and sounds cannot be reconstructed in detail because the character of individual colors is variable; the term “blue”, for instance, does not define the color exactly. Arnheim speaks of perceptual uncertainties regarding the nature of color: “In no reliable sense can we speak of a color as it really is... it is always determined by its context” (Arnheim, 1974, p. 345).

The relationship between color and music as part of the complex consisting of music and the visual arts has not yet been systematically investigated (Jewansky, 2003). It appears that the field of music psychology has supplied us with a collection of data on children’s invented notations (c.f. Hargreaves, 1992; Sloboda, 1985). However, the developmental aspects of notational color expressions and the way they are affected or unaffected by musical literacy has not yet been systematically investigated.

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(1925–7) which were typical avant-garde experiments of its time (Day, 1996; Jewanski, 2003).

<sup>23</sup> The Prometheus Studio (founded in 1962) at the Technical University of Kazan in the former Soviet Union; The Medizinische Hochschule, Hanover; The International Synaesthesia Association with its headquarters in the UK (Day, 1996).

<sup>24</sup> For example, four congresses, which devoted to color and music, were held in Germany (1927-1936) directed by Georg Anshütz.

<sup>25</sup> Howells (1944) succeeded in developing a synesthetic response by presenting 5000 times a low tone with red light and a high tone with green light. When later he showed his subjects a pale greenish-reddish color and sounded a high tone they saw the color as red, but when he sounded a low tone they saw the color as green. Ellson found that after pairing of a light with a tone, the presentation of the light alone produces a faint hearing of the tone.

## Purpose

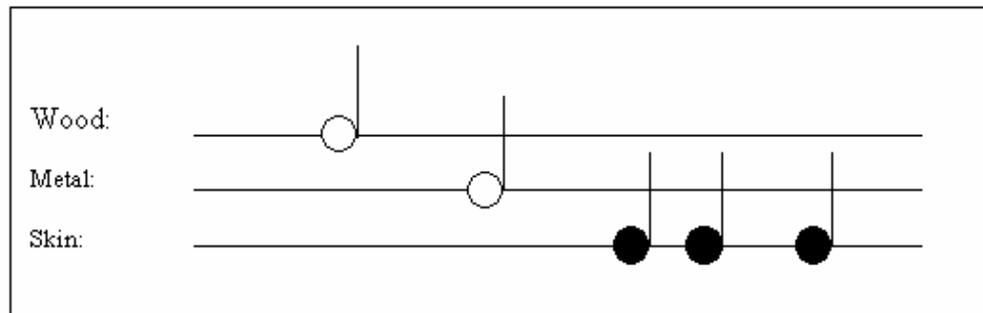
This eight-year study represents a pioneering effort to investigate color expression in schoolchildren's graphic notations at two stages of development: "Pre-literate" (age: 7.0-8.5), before students received school music instruction, and "Post-literate" (age: 14.0-15.5), three years after students acquired Standard Notation in school, and to consider the effects of age and musical literacy on notational color expressions.

## Procedure

Students from two classes in one Israeli/Jewish school (age: 7.0-15.5) participated in the study. Along a course of eight years, two meetings were held: (1) A "Pre-literate" meeting with 46 second-grade students, age: 7.0-8.5 (1995), before students received school music instruction; (2) A "Post-literate" meeting with 32 ninth-grade students, age 14.0-15.5 (2003), three years after students acquired Standard Notation in school.<sup>26</sup> Of these, 17 students participated in two meetings.

In each meeting, students performed by imitation a short musical phrase called "Timbre", which consists of two minims and three crotchets. The sounds are distributed among three percussion instruments made of different materials: the first sound is played on a wooden instrument (e.g. a wooden-block), the second – on a metallic instrument (e.g. a cowbell) and three strokes - on a skinned drum (e.g. an Arab drum), thus creating the following pattern: "Wood, Metal, Skin Skin Skin":

**Figure 1**



After students successfully performed the phrase, they were provided with paper and colored pencils and crayons and were asked to create a representation of the musical phrase: "create in any way you like a representation of the musical phrase that you played". Students explained their notation in private interviews, which were recorded. A total of 79 notations were collected: 46 - by second-graders and 33 - by ninth-graders. Of these, 17 students, who participated in two meetings, created 34 notations.

<sup>26</sup> During the sixth grade, students learned SN, which included rhythm (quarter notes, half notes, eight-notes, rest) and pitch (treble clef staff notation).

## Method of Analysis

Color expressions and the function of colors and shapes in the students’ notations was analyzed by a method titled “MSC”, which had been developed and implemented in former studies (Elkoshi, 2000, 2002) and has been used in previous research contexts (Elkoshi, 2004a; 2004b; Murphy & Elkoshi, 2004).<sup>27</sup> The “MSC” method is based on a procedure progressing consistently in three phases: 1. The *Morphological Analysis* (M), which engages in material descriptions of visual phenomenon, such as predominant colors and shapes; 2. The *Structural Analysis* (S), which focuses on the examination of the drawing grasped as a whole and the description of the interrelationships between its parts (e.g. directionality, repetitions, color contrasts, placement of colors); 3. The *Conceptual* interpretation (C), which defines the content of the notation and the final evaluation of the child’s reaction. The final interpretation of a notation is supported by the child’s verbal explanation of his or her notation. Based on the Conceptual Interpretation (C) each notation is classified under one or more of the following categories:

### Categorization of Conceptual Interpretation

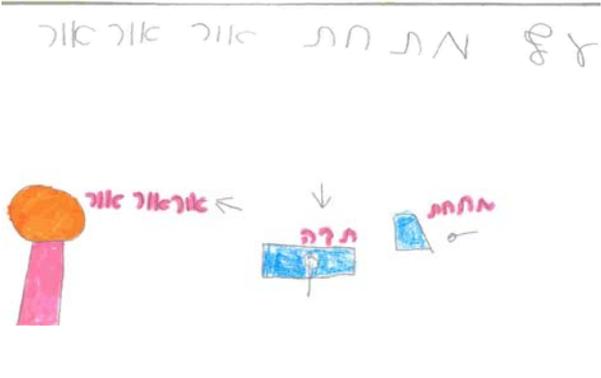
**Table 1**  
**Example of Data Sources**

(1)	(2)	(3)	(4)
<b>Category A</b> (Association)	<b>Category P</b> (Pictogram)	<b>Category F</b> (Formal response)	<b>Category G</b> (Gestalt)
When the notation includes associative images, metaphors (including Synesthetic metaphors) or story factors.	When the notation yields any musical instrument that took part in the performance of the musical stimulus.	When the notation embodies a chronological sequence of sound-events.	When the notation yields structural features of the musical stimulus, as for example grouping and division of the musical phrase into units.

A Pre-literate and Post-literate notation by four students: Shlomit, Nufar, Ilan and Gideon, will demonstrate the use of the “MSC” method for data analysis and drawings classification. Shlomit and Nufar never learned music outside school. Ilan learned guitar (for 2 years) and Gideon - piano (for 5 years).

<sup>27</sup> Notations, which had been created by kindergarten children (Elkoshi, 2004a; Murphy & Elkoshi, 2004) and schoolchildren of various ages (Elkoshi, 2000; 2002; 2004; 2004a, 2004b), were analyzed by the MSC method of interpretation.

**Shlomit**

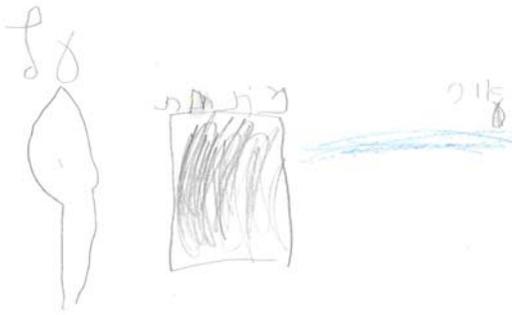
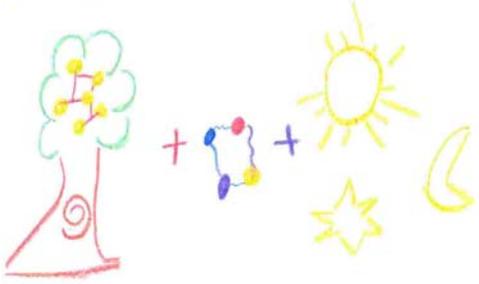
<p>1a Pre-literate</p>  <p>The pre-literate notation consists of two parts. The top part shows the Hebrew words 'אור אור אור' (Aur Aur Aur) and 'מת מת מת' (Met Met Met) written in grey ink. Below this is a colorful pictogram. On the left is a drum with a brown head and a purple body. In the center is a wooden block with a blue body and a grey mallet. On the right is a cowbell with a blue body and a grey mallet. Arrows indicate a circular flow from the drum to the wooden block and then to the cowbell.</p>	<p>1b Post-literate</p>  <p>The post-literate notation consists of three colored circles arranged horizontally from right to left. The rightmost circle is brown, the middle one is grey, and the leftmost one is blue.</p>
<p>Category PFG (Pictogram/Formal response/Gestalt)</p>	<p>Category A (Association)</p>

1a: **Shlomit's** Pre-literate notation includes Hebrew words: "wood, metal", and three times "skin" (misspelled), which represent the sequence of sounds (Category F). A labeled pictogram appears below (Category P) in a circular flow (center-right-left). By applying different colors, Shlomit emphasizes parts of the instruments involved. The drum's head and resonance-body on the left are separated by distinctive colors, brown and purple, respectively; The wooden-block and cowbell are shaded blue, but their mallets stand out in grey. The division of the phrase into 2+3 strokes is expressed by the placement of blue-grey against brown-purple objects, respectively. Shlomit pointed to the drum and said, "Drum-strokes go together..." (Category G). The drawing falls under category PFG (Pictogram/Formal response/Gestalt).

1b: Shlomit's Post-literate notation consists of three colored circles shaded brown, grey and black, moving right-to-left, respectively. Shlomit explained: "I used three colors: brown for wood, because this is the color of wood, grey for metal because grey is usually the color of metal and blue for the drum... I used colors that reminded me of things [objects]. Blue is the color of the sound of the drum. This is what it reminds me of when I hear these sounds". Shlomit's Post-literate notation falls under category A (*Association*).

Both of Shlomit's notations are colorful. However, colors in her Pre-literate notation express formal aspects of the musical stimulus, namely, parts of the instruments involved (Pictogram) and a division of the phrase into two units (Gestalt), whereas colors in her Post-literate notation express associative ideas: "I used colors that reminded me of things." Some of Shlomit's Post-literate metaphors are Synesthetic: "blue is the color of the sound of the drum". Although both notations employ blue and brown, the function of these colors is opposite; Blue and brown represent wood and drum in the Pre-literate notation although drum and wood in the Post-literate notation.

## Nufar

<p>2a Pre-literate</p> 	<p>2b Post-literate</p> 
<p>Category A (Association)</p>	<p>Category AFG (Association/Formal response/Gestalt)</p>

2a: **Nufar’s** Pre-literate notation includes three labeled items moving left-to-right: “a tree, a large piece of grey metal and blue skies”. Nufar explained, “A tree reminds me of things which are made of wood” (category A). I asked Nufar, “What do you mean by ‘blue skies’?” she replied, “There is light in the sky”. By “light” Nufar represents “skin” because of a linguistic connection; The Hebrew word “OR” means both skin and light, although spelled differently. Nufar’s drawing represents pictorial and linguistic associations, which places it in category A (*Association*).

2b: Nufar’s colorful Post-literate notation includes five items, which represent five sounds (category F): “an orange tree” with a red trunk, green treetop and golden apples “which stand for wood”; plus a colorful piece of jewelry, “...I drew a piece of jewelry, a bracelet. I was looking for something that is made of metal, ok?”; plus “three yellow sources of light: sun, moon and star for OR (skin\light). I drew three sources of light... (Category A) I clustered them in a circle, not in a row, because they form one unit” (Category G). By applying multi-colored objects for “wood” and “metal” against a cluster of yellow objects for “skin”, Nufar expresses the division of the phrase into 2+3 strokes, respectively. The drawing falls under category AFG (*Association/Formal response/Gestalt*).

Both of Nufar’s notations yield similar associations and linguistic connections in the same left-to-right direction: a tree always stands for “wood”, metallic objects for “metal” and skylights (OR) for skin. Yet, as Nufar matures, her early Pre-literate associations integrate into formal aspects of the musical stimulus; Furthermore, her Pre-literate two-color sketchy design becomes a Post-literate detailed multi-color picture, in which color placement functions as a means of expressing notational organization.

## Ilan

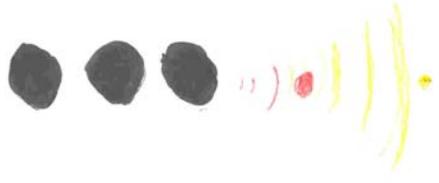
<p>3a Pre-literate</p> 	<p>3b Post-literate</p> 
<p>Category FG (Formal response/Gestalt)</p>	<p>Category AFG (Association/Formal response/Gestalt)</p>

3a: **Ilan's** Pre-literate notation includes Hebrew words (right-to-left) written in pencil: “wood metal” and three times “skin”, thus representing five sounds (category F). Large and small letters in this notation represent the division of the phrase into 2+3 sounds, respectively, according to dynamic changes (category G). Ilan explained while performing the musical phrase, “Wood is loud... metal is big [loud], like whoooo!! Drums have a small [soft] sound”. This notation falls under category FG (Formal response/Gestalt).

3b: Ilan's Post-literate staff notation includes five descending note-heads moving conventionally left-to-right, thus representing five sounds, respectively (Category F). Notes are differently shaded: brown, black and grey, respectively. A dictionary (on the right) equates instrumental Timbre and respective colors: “brown - wood; black - metal; grey – skin.” Ilan explained, “I use colors because the wood sounds pretty high like C. Wood is brown. The metal sounds black... it sounds different. It should not be purple, though... Drums sound like grey to me... (Category A). Three drum strokes are beamed because they go together” (Category G). Ilan's Post-literate notation falls under category AFG (*Association/Formal response/Gestalt*).

Both of Ilan's notations yield formal representations. However, during the Pre-Literate stage, when the teaching of reading and writing Hebrew plays an enormous role in school, Ilan uses a pure alphabetic representation written in pencil. Whereas, during the Post-literate stage, (as he continues to engage in Standard Notation in private guitar lessons), Standard Notation symbols prevail. This suggests that intensive learning of a standardized system (written language and Standard Notation, respectively) may have had bearing on Ilan's notational conventions. Yet, as Ilan matures, his early monochromatic formal statement becomes an integrated formal/associative representation, which embodies color associations, including noticeable synesthetic metaphors: “drums sound like grey to me... the metal sounds black (not purple)”.

## Gideon

<p>4a: Pre-literate</p> 	<p>4b: Post-literate</p> 
<p>Category APF (Association/Pictogram/Formal response)</p>	<p>Category AFG (Association/Formal response/Gestalt)</p>

4a: **Gideon’s** Pre-literate notation drawn in pencil includes five musical instruments (category P) moving left-to-right in a row: a wooden-block, a cowbell and three drums, thus representing five sounds respectively (Category F). The wooden-block is displayed in collage with a tree “...because a wooden-block is made of wood” (category A). Gideon’s notation falls under category APF (*Association/Pictogram/Formal response*).

4b: Gideon’s colorful Post-literate notation consists of “circles that represent sounds... and vertical lines that represent sound-waves.” Thus, five circles (right-to-left) represent five sounds (category F). Gideon explained, “The wooden-block sounds bright, like yellow, and the colors become darker and darker with the drum-beats. Metallic instruments sound red, whereas the drum sounds the darkest. Therefore, I made the circles ever bigger and darker (category A). The sounds of the wood and the metal influence each other, they intermingle as a mixture, but the drum stands out as a separate black unit with distinct sounds and it brings the phrase into its end” (category G). The division of the phrase into 1+1+3 sounds is thus expressed by changing the size of forms and by colors: yellow, red and black, respectively. Gideon’s notation falls under category APF (*Association/Pictogram/Formal response*).

Gideon, who turns to shape in his Pre-literate stage, turns to color rather than shape in his mature stage; he abandons the monochromatic concrete pictogram drawing in favor of a three-color nonfigurative notation. The function of color in Gideon’s Post-literate notation is twofold: color appears as a means of expressing notational organization (e.g., “...the drum stands out as a separate black unit...”) and as a means of expressing Synesthetic metaphors; yellow, red and black are akin to the Timbre of wooden, metallic and drum instruments, respectively.

**Summary:** The following table summarizes the categorizations of the above notations. Categories, which involve color expressions, are printed in red.

**Table 2**  
**Categorizations of notations**

Subjects	Pre-literate Notations	Post-literate Notations
Shlomit	<b>PFG</b> (Pictogram/Formal response/Gestalt)	<b>A</b> (Association)
Nufar	<b>A</b> (Association)	<b>AFG</b> (Association/Formal response/Gestalt)
Ilan	<b>FG</b> (Formal response/Gestalt)	<b>AFG</b> (Association/Formal response/Gestalt)
Gideon	<b>APF</b> (Association/Pictogram/Formal response)	<b>AFG</b> (Association/Formal response/Gestalt)

Colors have been observed to appear as a means of notational organization (category G) in both Pre-literate and Post-literate notations [1a, 2b, 3b, 4b]. Different colors represent respective musical sub-units, when areas of contrasting colors are pitted against each other as a representation of changing Timbre.

Associations are established between individual Timbre and particular colors (category A) in both Pre-literate and Post-literate notations [2a, 1b, 2b, 3b, 4b]. Color is a means of representing associations related to particular objects. Thus, green stands for a tree [2b], yellow for light objects [2b] and blue for sky [2a]. Color is a means of representing Synesthetic metaphors related to Timbre. Synesthetic metaphors do not appear in Pre-literate notations but appear in three of four Post-literate notations [1b, 3b, 4b]. Analogies, however, vary from one child to another: brown or yellow represent the sound of a wooden percussion instrument; grey, black or red represent a metallic sound; and blue, grey or black are akin to the sound of skinned drums.

Pictograms (category P) appear in two Pre-literate notations [1a, 4a], one of which is expressed in color [1a]. In this drawing, different colors distinguish between different parts of musical instruments (P) (such as, mallet, drumhead and resonance body). Pictograms are absent in Post-literate notations.

A sequence of sounds (category F), in both Pre-literate and Post-literate notations, is represented by a sequence of objects and/or words, either monochromatic [4a] or in color [2b].

Standard Notation symbols do not appear in Pre-literate notations. One Post-literate notation is a three-color Standard Notation representation [3b].

## Results

*Morphological analysis:* Standard Notation never appeared in Pre-literate notations and was rarely employed in Post-literate notations (3%); always involving color. 41% of the second-grade notations were colorful. The amount of colorful notations increased slightly among ninth-grade students (42.5%). Green and yellow were the most preferred colors in both Pre-literate and Post-literate notations. Red was the least preferred color in Pre-literate notations but second in frequency in Post-literate notations. Brown and grey were second in frequency in Pre-literate notations.

Mixed colors, appeared occasionally in Post-literate notations only. The following table summarizes the frequency (in percentage) of primary and secondary colors, respectively, which were used in Pre-literate and Post-literate notations.

**Table 3**  
**Frequency of colors in the notations**

	Pre-literate notations	Post-literate notations
Green	17%	13%
Yellow	16%	13%
Brown	14%	8%
Grey	13%	10%
Blue	9%	10%
Orange	9%	10%
Purple / pink	9%	7%
Black	9%	8%
Red	3%	11%
Mixed hues	---	7%

*Structural analysis:* more than half of the notations in every stage consisted of linear recurring shapes (78% and 57%, respectively), which were more often monochromatic (45% and 30%, respectively) than multi-color. Contrasting colors and spatial distributions of color typically represented changes in instrumental Timbre.

*Conceptual analysis:* The expression of G (*Gestalt*) in both Pre-literate and Post-literate notations was highly associated with the use of multi-colors. Notations, which were categorized under G, were more colorful than non-G-notations. For the Pre-literate children, the mean number of colors per drawing (+/- SD) in the G-group (27 children) and non-G-group (19 children) were 3.22 +/- 2.65 and 1.52 +/- 1.26, respectively. This difference is statistically significant by a student t-test at 0.05 level of significance. For the ninth-grade, statistical analysis was not performed due to the small number of children in the non-G-group (12 children).

No statistically significant difference (at the 0.05 level of significance) was observed between the A (*Association*) group (23 children) and the non-A group (24 children) or between the P (*Pictogram*) group (23 children) and the non-P group (24 children) in the Pre-literate stage in relation to the mean number of colors per drawing. Due to the small number of students with either P or A responses among the ninth-graders, statistics was not assessed. Synesthesia, which is A-related, was absent among the second grade children but found in 12% of the Post-literate notations. This research sorted out the synesthetic correspondences. Brown and yellow were akin to the Timbre of a wooden instrument; Black, red and grey were akin to the Timbre of a metallic instrument; Black, grey, green, turquoise and blue were akin to the Timbre of a drum.

All the notations that fell under F (*Formal response*) as a single category (7 Pre-literate, and 2 Post-literate notations) were monochromatic. In other words, there was no “pure” F presentation, which was colorful.

It is tempting to assume that the *conceptual* sub-division of the musical phrase into fragments (*Gestalt*) is color related, whereas the *conceptual perception* of the

chronological sequence (Formal response) is shape rather than color related. Synesthesia is probably age related.

## **Conclusions and Discussion**

### **A. The effects of age on notational color expressions**

The amount of colorful notations slightly increased as children matured (41% and 42.5%, respectively). This finding refutes Werner's assertion that schoolchildren turn increasingly to shape rather than to color (Werner cited Arnheim, 1974).

Green and yellow were the most preferred colors by both Pre-literate and Post-literate students. It means that color preference was not affected by age. This refutes the rule that young children have different color preferences than older children or adults (e.g. Gale, Granger, Staples & Walton in: Kreidler & Kreidler, 1972). It also demonstrates the difficulty of investigators (ibid) to have us believe that in spite of variability there is a universal order of color preference.

Ninth-graders occasionally introduced various hues attempting to emphasize the variations of a specific color. This accords with former findings of Child Art research (e.g. Golomb, 1992:133-4; Arnheim, 1974; Rimerman, 1990); Some objects in mature drawings are colored schematically as before, while a more realistic attitude to color is evident in the introduction of various hues and the emphasis of the variations of a specific color.

G- notations were significantly more colorful than non-G- notations across stages. This means that the graphic expression of musical units is highly associated with color. It unexpectedly shows that children use color as a notational device; as a means of expressing formal aspects of a musical stimulus.

Synesthesia was absent in Pre-literate notations but appeared occasionally (12%) in Post-literate notations. This shows that color and sound analogies are affected by age and that young children do not associate instrumental Timbre with specific colors. However, as children mature, they may explicitly associate instrumental Timbre with specific colors although no uniform perception exists with regard to such analogies, which are voicing a personal impression.

Pure F presentations were monochromatic across stages. This means that a description of a chronological succession of sounds (category F) is unrelated to color. This also means that both Pre-literate and literate children turn to shape rather than to color when they choose to represent a sequence of sounds.

### **B. The effects of musical literacy on notational color expressions**

Standard Notation was absent in Pre-literate notations and uncommon in Post-literate notations despite the fact that during the sixth grade students acquired Standard Notation. This shows that formal teaching and learning of Standard Notation symbols does not affect color as well as shape expressions. It is obvious that children will not employ Standard Notation symbols in a pre-literate musical stage, since they were not exposed to it yet. However, the fact that the students almost abandoned Standard Notation in the Post-literate stage, suggests that Standard Notation must be used regularly in order to appear in their representations: a language may be forgotten when not used.

Associative reactions (category A) were always integrated into Standard Notation representations. This implies that Standard Notation neither suppresses nor replaces associative thinking<sup>28</sup>.

### Educational Implications

Music educators are accustomed to regard shapes (such as, staff-lines, note-heads, beams) as the main carriers of notational meaning. However, “forms are merely a result of the existence of colors... It is through differences in colors that forms are created at all in our visual field” (Kreitler & Kreitler, 1972, p. 33). Color cannot be separated from shape any more than Timbre can be separated from tone. It is therefore, both shape and color, as they are phenomenologically seen in a notation, with which music teachers should deal.

The use of color should be part of teaching and learning Standard Notation, not only because children often turn to color as a means of expressing notational organization, as this research shows, but also because colors has been integrated into Standard Notation from its early beginning as a means of notational organization. The music theorist Guido of Arezzo [Aretinus] (b c991–2; d after 1033), who is remembered today for his development of the system, which is used today as the Standard Notation, used yellow and red lines (as well as key letters) to represent C and F, respectively (Palisca, 2001). The yellow C-line and red F-line marked beginnings and endings of chant’s phrases.<sup>29</sup> Children, very much like Guido of Arezzo, use color for grouping beginning and ending notes of a musical phrase. By using color when teaching Standard Notation, music educators may build on the child’s intuitive tendency to organize sounds in color, and at the same time relieve the origins of early graphic forms of Standard Notation.

The cultivation of color associations, which come nearer to capturing the subjective essence of a musical stimulus, is as important as teaching traditional shapes of Standard Notation. Synesthetic metaphors add individual dimensions to a notation. Students’ color associations and analogies associating musical parameters and colors can provide music and art teachers with valuable data that stems from the student’s inner-directed activity. Nonetheless, music and art teachers should be sensitive to associations of culturally shared meanings, signs and signals. Over and beyond personal associations, sounds and colors evoke associations of culturally shared meanings, which are learned, and can be shared only by members of a specific group.

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<sup>28</sup> In another recent study, I showed that the effect of SN on students’ perception is limited to the Morphological dimension of the notations (Elkoshi, 2004a).

<sup>29</sup> Guido taught, “when you sing the *Ut queant laxis* melody you must be very careful that you end each neume properly so that its end fits the beginning of the phrase [of the hymn] whose first note begins on the note with which the neume ends” (in: Palisca, 2001). Colored lines and key letters, separately or in combination, on which singers focused disappeared in the 13th century, while the key-letters survive to the present day in the guise of F, C and G clefs.

Only Hebrew speaking members can share the frequent mentioning of yellow as expressing the sound of a skinned drum, which is traced to a particular linguistic connotation. This specific instance demonstrates how cultural circumstances may effect associations between color and sounds.

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