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# "Pictures at a Music-color Exhibition": Exploring Children's and Adults' Color-hearing in Response to Béla Bartók's Piano Work

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**Abstract:** The purpose of this phenomenological study is to identify Chromaesthesia, namely hearing music in terms of colors, among schoolchildren and college and university music majors. Participants were eight-year-old second-graders (N=118) and college and university undergraduate and graduate music majors (N=107) who encountered a piano work by Béla Bartók. Subjects matched musical elements with colors via audio-graphic illustrations and related spoken and/or written notes. The study shows that both young children and adult music majors naturally perceive and convey relationships between music and color, suggesting that Chromaesthesia is not lost in the cognitive transition from childhood to adulthood and into a career of advanced musicianship. However, fixed correlations between music and color are not confirmed, since the music elicits various color metaphors, bearing a strong subjective validity. By implementing Chromaesthism in the curriculum, music educators may promote pedagogical practices that cultivate cross-sensory correspondences and directly develop creativity.

**Keywords**: listening to classical music, color-hearing, Synaesthesia and Chromaesthesia, invented notations

## Theory

The idea that our sight and hearing senses work closely together is as ancient as history itself. In the book of Exodus (20:14) we read about *"The Revelation on Sinai"*:

...וְכָל הָעָם **רֹאִים** אֶת הַקּוֹלֹת וְאֶת הַלַּפִּידִם וְאֵת קוֹל הַשֹּׁפָר (שמות כ14).

*"And all the people* [of Israel] *were **seeing** the sounds* [of thunder and God's voice]*"*.

Comparisons between music and color have seemed "*a most natural human activity*" (Peacock, 1985, p. 398). Throughout the centuries, philosophers, artists, composers and instrument makers came up with ideas on how to integrate music and colors (Elkoshi, 2017a). During the second century BC Greek philosophers disputed whether color, like pitch, could be considered as a physical quality of music (Gage, 1993). Pythagoras (569-475 BC), Plato (427-347 BC) and Aristotle (384-322 BC) explicitly associated color with music (Campen, 2011). Pythagoras and Aristotle studied the correspondences of musical

intervals and shades of gray (Gage, 1993; Campen, 2003). In the Middle-Ages, direct connections of colors to musical notes or modes were made, mainly in books on magic and the occult arts. In the early 6th century, the Roman philosopher Boethius (480–524 AD) linked the blending of colors to the production of sound (Hutchison, 1997-2014). "*Color*" had a specific meaning in the Renascence music as in the 14th century Isorhythmic motet[1] (Peacock, 1987). In the late 1660s, Isaac Newton (1642-1727) theorized that musical harmonies and color harmonies are related by means of the frequencies of light waves and sound waves. Newton created the impression of a repeating cycle of colors, equivalent to the musical octave. The first one to follow Newton's ideas was the French mathematician Louis Bertrand Castel (1688–1757), who developed in 1734 a five octaves color harpsichord, and called it *"Clavecin oculaire"*. When a key was pressed, paper and silk strips, lighted by candlelight, appeared above a screen on top of the harpsichord (Wilfred, 1947). In the 19th century many inventors followed Castell and a variety of color-organs were built (Peacock, 1988). Although several nineteenth-century scientists cautioned against oversimplifying the analogy between color and sound, the belief that colored light and sound were physically similar continued to appear in textbooks published even after the first third of the 20th century. In our modern days, the technological achievements have made it possible to build advanced musical instruments that may integrate, generate and communicate colors and sounds. These include computer programs, music animation machines and color-music products (e.g., Yanagisawa, 2007).

However, philosophers, physicists and inventors had different opinions of what are the "*correct*" correlations between sound and color. While Plato, for example, drawn on Pythagorean theory, had linked the perfect fourth to yellow, Newton, influenced by his optical experiments, linked the same interval to orange due to the similar wavelength properties of light and sound (Westfall, 1962). Newton had suggested that C, being the lowest note in the octave, should be red, the lowest vibration in the spectrum; whereas Castel decided C should be blue because it sounded blue... For the same reason Castel made F yellow-orange, where Newton had it green.

Furthermore, some scholars refuted the notion of sound-color correlations altogether (e.g., J. W. Goethe, in: Zur Farbenlehre, 1810) or suspected that artists have just paid lip service to a vogue of color music or suffered a neurological condition (e.g., Brown, 2008).

The phenomenon of synesthesia, namely cognitive integration between the different senses, has attracted increasing interest during the past few decades (e.g., Marks, 1975/1978; Cytowic, 1995; Vanechkina, 2000). The most usual form of Synesthesia

[1] The Isorhythmic motet technique consists of a repeated melodic pattern called the "Color" embedded in an order of durations or rhythms, called the Talea.

consists of hearing sounds or a piece of music in terms of colors; a phenomenon known as 'color-hearing' or Chromaesthesia[2]. The capacities of subjects to associate sounds with colors was investigated in different ways, ranging from subjective reports (e.g., Palmer et. al., 2013; Haack & Radocy, 1981; Rogers, 1987; Block, 1983; Holm et.al, 2009; Elkoshi, 2004) to brain imaging using PET scans and fMRI (e.g., Campen e. al., 2003).

Based on the idea that colored representations of music is not a unique ability of selected artists, but characteristic of creative imagination common to all people, researchers studied the way children[3] and adults[4] draw music in colors.

Several researchers found consistent correlations between sound and color choices among kindergarten children[5], elementary schoolchildren[6] and adults[7]. However, there is inconsistency in other reported results. Haack & Radocy (1981), for example, revealed a remarkable range and consistency of tone-color linkages over a five-year period, whereas Rogers (1987) found that tone-color associations are not totally consistent over time. Palmer et. al. (2013) found strong correlations between classical orchestral music and color choices among subjects of different cultures; yet Holm et. al. (2009) could not reach consensus among adult participants who linked colors to musical genres. It seems, therefore, that further study is needed.

## The Purpose of the Study

The present qualitative study presumes to join the complex field of color-hearing Chromaesthesia. The general aim is to explore the phenomenology of Chromaesthesia. Specifically, the study aims to identify Chromaesthetic categories and connections between music and color metaphors among children and adult music majors who encounter classical music.

## Procedure

***Participants:*** Participants are divided into two groups: (1) 118 second-grade schoolchildren (age 7.0-8.5) from three elementary Hebrew speaking schools (7 classes) in

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[2] Ger.:*Farbenhören*; Fr.:*audition colorée* (Rothen & Meier, 2010).
[3] e.g., Simpson, Quinn & Ausubel, 1956; Marks, Block,1983; Hammeal & Bornstein, 1987; Rogers, 1987/1991; Vanechkina, 2000; Elkoshi, 2004; Sidoroff-Dorso, 2009.
[4] E.g., Haack & Radocy, 1981; Block, 1983; Rogers, 1987, 1991; Holm et. al., 2009; Palmer, et. al., 2013; Elkoshi, 2017b).
[5] Marks, 1978; Marks in: Sidoroff-Dorso, 2009.
[6] Omwake, 1940 in: Rogers, 1987; Simpson, Quinn & Ausubel, 1956.
[7] Palmer, 2013. Block, 1983.

three cities in Israel (Hod Hasharon, Kefar Sava and Herzelia); (2) college undergraduate music majors (N=67) and college and university graduate music majors (N=40) from two Israeli colleges and one university.

***The Musical Repertoire***[8]**:** Béla Bartók's *'Melody in the Mist'* from the *'Mikrokosmos'* Vol.4 no.107, composed between 1926 and 1939. This is a slow, calm (Tranquillo) work based on dissonant, a-tonal cluster-chords, apparently illustrating the "mist", alternating with tonal unison melodic motifs. Seven cluster-chords and unison motifs end with a sustained cluster-chords cadence. The following score of *'Melody in the Mist'* (Figure 1) includes enclosures that mark the first motif of misty chord-clusters and the first linear melody that follows:

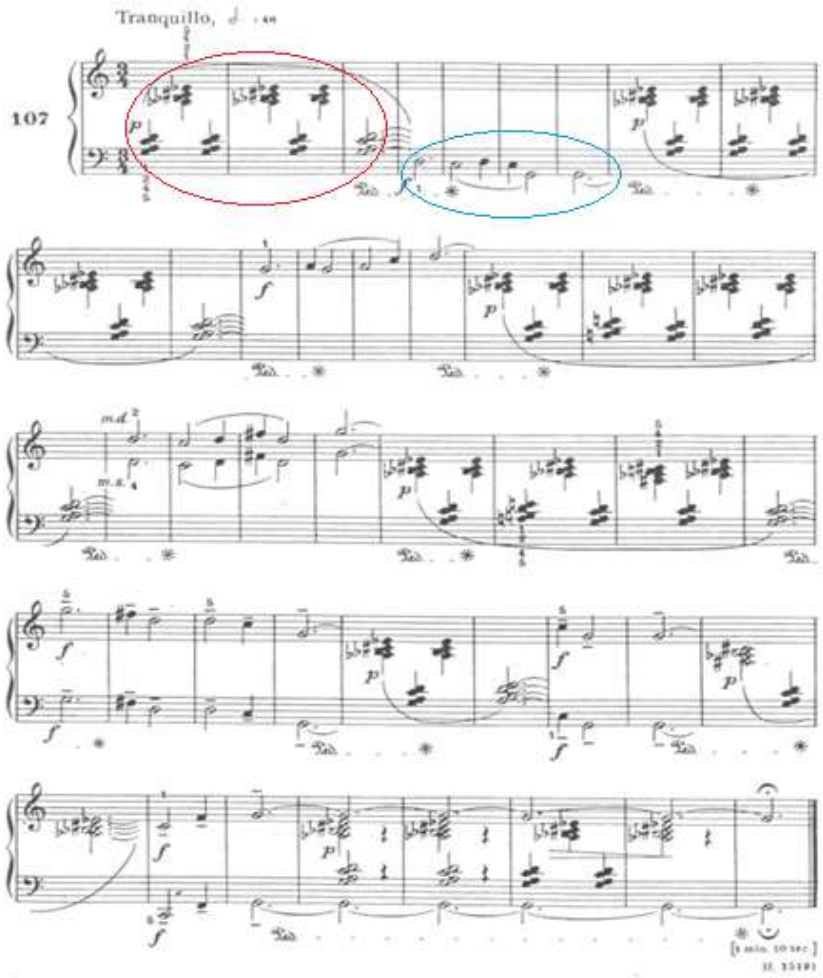



Figure 1: Béla Bartók's *'Melody in the Mist'* from *'Mikrokosmos'* Vol.4 no.107

[8] The scope of this report is limited to Béla Bartók's music. It is part of a more comprehensive study that involves further classical works from different periods (Elkoshi, 2017b).

***Experimental Design and Instructions:*** During a 50-minutes session subjects listened to Bartók's *'Melody in the Mist'*. They were asked to correlate the music with colors via audio-graphic illustrations, and spoken and/or written related notes. The instructions for the adult subjects were:

> *"This is an experiment on how you may associate sound and color while listening to music. What I want you to do is (1) close your eyes and listen to the music with great attention; (2) listen to the music once again and think if there is a color, or colors, that might correspond to the music; (3) use a color or colors of your choice, if there are any, and create an illustration that represents the music. This can be done in whatever way seems appropriate to you. Papers and various colors are provided; (4) write a note that explains what is the color (or colors) that you employ and how it corresponds to the music."*

The instructions for the children were similar except for verbal notes (guideline 4) which were provided orally via individual interviews.

***Chromaethetic Categories:*** Based on a retrospective analysis of the data, three basic Chromaesthetic categories emerged:

(1) *"Programmatic Chromaesthesia"*, which refers to extra-musical associations conveyed by colors, such as metaphoric images, episodes, events etc.

(2) *"Inter-sonic Chromaesthesia"*, which refers to sonic features, such as pitch, rhythm, texture, form, etc.

(3) *"Holistic Chromaesthesia"*, which consists of a combination or juxtaposition of Programmatic and Inter-sonic Chromaesthesia.

## Examples

The following "Music-color Exhibition" (Figure 2) contains examples of Programmatic, Inter-sonic and Holistic Chromaestheic responses elicited by second-graders and adult music majors.

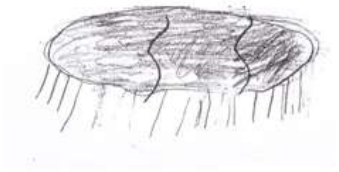
| | **Second-graders** | **Music Majors** |
|---|---|---|
| |  Illus. 1: Sharon (boy, age 7.5) |  Illus. 2: Rom (female, graduate music major) |
| *Inter-sonic Chromaesthesia* |  Illus. 3: *Ela* (girl, age: 8.6) |  Illus. 4: Zipi (female, graduate music major) |
| *Holistic Chromaesthesia* |  Illus. 5: Itamar (boy, age 8.3) |  Illus. 6: *Daniel* (male, graduate music major) |

Figure 2: Second-graders' and music majors' Programmatic, Inter-sonic and Holistic Chromaesthesia

## Data Analysis

**(a) *"Programmatic Chromaesthesia"*** by Sharon (boy, age 7.5) and Rom (female graduate music major) (Illus. 1 and 2)

**Illustration 1:** Sharon draws a gray-black rainy cloud and says**:** *The music is gloomy dark... the sky is dark. I depicted a black cloud, rain and lightning* [vertical zigzags]*."*
**Interpretation:** Bartók's music sounds *"gloomy dark"* like a black rainy cloud. The image of a dense black cloud is in unanimity with the composer's programmatic intention, as suggested in his title.

**Illustration 2:** Rom draws a yellow sun, some purple sunrays and birds in the air.
Rom writes: *"Apparently, I can decide what to see and what to feel in the music. In this case, the music is mostly happy. My picture shows a landscape. One can see the bright yellow sun. There are birds in the air. So that life can be sweet. However, sometimes there are obstacles in life and bitterness here and there. Dark purple rays represent such obstacles.*"
**Interpretation:** The *"mostly happy"* atmosphere of Bartók's work evokes a scene of contrasting colors as the bright yellow sun is a symbol of *"sweet life*" versus the dark purple rays that represent obstacles and bitterness.

**Summary**: The two paintings by Sharon and Rom depict sky views. However, the atmosphere represented in them is different. While Sharon considers the music *"gloomy dark*" (Illus.1), Rom regards it *"mostly happy"* (Illus.2).

**(b) *"Inter-sonic Chromaesthesia"*** by Ela (girl, age: 8.6) and Zipi (female, graduate music major) (Illus.3 and 4)

**Illustration 3:** Ela's illustration includes the Hebrew word for *"beginning"* (left) and six brown circles arranged horizontally, encapsulating green vertical streaks of varied quantities. Ela's says: *"I listened to heavy and thin tones. It begins right here* [left] *with heavy, then thin, then heavy... heavy and thin tones by turns."*
**Interpretation:** Each brown circle represents a musical phrase. Alternating texture is represented by the amount of green vertical streaks inside each circle. A number of streaks versus a solo streak represent cluster chords (*"heavy tones"*) versus unison (*"thin tones"*), respectively

**Illustration 4:** Zipi draws tri-chromic lines (bleu, orange, green) above and below six gray spots. She writes: "*I used gray for the vague chords which return six times. Melodies (colorful dashes) are sometimes above and sometimes below the middle range chords. Chords and melodies alternate.*"
**Interpretation**: Six gray spots represent six musical phrases (form); "*Vague chords*" (gray spots) alternate with melodies (colorful dashes) to represent alternating textures; Middle, high and low levels represent middle, high and low pitch-levels (range).

**Summary:** both young and adult listeners illustrate musical phrases and display alternations between cluster chords and unison, via linear schemes. However, Zipi (Illus.3) gives more inter-sonic information by representing three alternating pitch levels.

**(c) *"Holistic Chromaesthesia"*** by Itamar (boy, age 8.3) and Daniel (male, graduate music major) (Iluss. 5 and 6)

**Illustration 5:** Itamar draws a transparent helicopter amid a dark scribbled sky illuminated by yellow spots. Itamar says: *"The music is vague, unclear. I imagined a dark sky and a police helicopter searching for a lost child in the desert. The pilot fires yellow flashes of light to draw the child's attention... I drew six yellow lights because I heard the music six times... Eventually, the* [lost] *child was found*."
**Interpretation**: Embedded in a detailed narrative about a lost child in the desert, six yellow rescue lights stand for six musical sections, the overall form of Bartók's composition.

**Illustration 6:** Daniel's illustration includes greenish surfaces and some brownish shapes above it. Daniel writes: *"Since I had a watery feeling of mud, elicited by the lower clusters, I painted a swamp using cold colors; green blue and purple colors that look muddy, watery and dark. Compared to the higher tones, the clear high-pitched phrases are represented by warm colors, by a clear brown and yellow color."*
**Interpretation**: *"Cold green-blue-purple colors"* of a swamp are aligned with low-pitched clusters, versus *"warm colors"*, brown yellow, that are equated with high-pitched tones. Inter-sonic elements of pitch and texture are interconnected with the pictorial idea of a *"muddy watery swamp"*.

**Summary:** Both Itamar and Daniel imagines landscapes: a desert (Illus.5) and a swamp (Illus.6). Both use colors to paint their landscapes. Inter-sonic elements of form, (Illus.5) or pitch and texture (Illus.6) are combined with extra-musical descriptions, as six yellow spots represent six musical sections (Illus.5), and *"warm colors"* versus *"cold colors"* represent, respectively, high versus low pitches and cluster-chords versus unison (Illus.6).

## "Bartók's Music-color Exhibition": Summary

### Chromaesthetic Categories

When listeners focus on programmatic notions, their audio-graphic production is based exclusively on pictorial forms such as, landscapes (Illus.1, 2 and 6) or objects and events (Illus. 5). Pictorial signs represent imaginative sceneries, rather than musical information per se. When the focus is on inter-sonic characteristics, the audio-graphic experience is dominated by abstract symbols, exclusively directed toward musical information, such as alternations between different textures (Illus. 3 and 4), pitch levels (Illus. 4) and musical phrasing (Illus. 3 and 4). Often listeners shift their focus back and forth from inter-sonic conceptions to programmatic associations. The result is a compound response, based on pictorial and/or abstract signs, which stand for both imaginative sceneries, such as landscapes (Illus. 5 and 6) objects and events (Illus.6) and inter-sonic elements, such as transitions between chords and unison (Illus.6), pitch levels (Illus.6) and musical form (Illus.5).

### Notational Strategies

All the illustrations in this exhibition consist of invented symbols, rather than conventional notation. Although the adult participants are musically literate, they do not rely on the acquired calligraphy of staff notation, neither in their graphic productions nor in their related verbal notes. Yet, some conventional rules are retained and embedded in children's and adults' productions: (a) Participants tend to organize graphic symbols in a linear directionality, thus recording the progression of musical materials through time (Illus.3 and 4); (b) The equation of sound density to visual size; Dense chords versus clear unison motifs are represented by relatively large surfaces versus thinner signs (Illus.4 and 6) or a reduced number of marks (Illus.3), respectively. Another rule that probably originates in standard notation is maintained in adults' but not in children's productions. It is the equation of auditory pitches to a vertical axis on the page. Sounds that persist in the middle range are depicted across the middle area of the page, while flexible contours, which move from low to high to middle ranges, are depicted accordingly along a vertical axis (Illus.4). High pitched sounds are paired with symbols that are located at the top of the page (Illus.6).

### The Meaning of Colors

Different colors or color groupings function as inter-sonic signifiers. For example, two different colors symbolize two respective textures: chord progression and unison (Illus.4 and 6).

Colors are used to illustrate mood. Bartók's *'Melody in the Mist'* is a slow, calm (Tranquillo) piano piece. Its descriptive title suggests blurry hues (the mist). Some listeners hit the composer's programmatic target by employing foggy images, such as a black rainy cloud (Illus.1), dark-purple sunrays (Illus.2), a dense black sky (Illus.5) and a misty landscape (Illus.6).

## Results

### (1) Music and Color Metaphors among Children and Adult Music Majors

In all cases, associations exist between Bartók's music as the inducer in the auditory modality and color metaphors as the induced percept/image in the visual modality. The fact that cross-sensory Chromasthetic correspondences are evident in the data suggests that (1) young eight-year-old children as well as adult music majors naturally perceive and convey relationships between music and color; (2) Chromaesthesia, as a cross-sensory phenomenon, is not lost in the cognitive transition from childhood to adulthood and into a career of advanced musicianship.

### (2) Identifying Chromaesthetic Categories and Graphic Forms

Young and adult listeners alike produce three basic types of audio-graphic productions that fall under the three heads: "Programmatic, Inter-sonic and Holistic Chromaesthesia". There is a connection between the conceptual thinking of the listener and the graphic forms that he chooses. Programmatic productions are based exclusively on pictorial forms representing imaginative scenarios, rather than musical information per se. Inter-sonic productions are based mainly on abstract symbols, exclusively directed toward musical information. Compound responses usually include both pictorial and abstract signs to represent both programmatic and inter-sonic characteristics, respectively.

### (3) The Subjective Validity of Chromaesthesia

Bartók's musical piece elicits different associations, either programmatic and/or inter-sonic which are correlated with a wide range of colors and color metaphors, bearing a strong subjective validity. Fixed correlations between musical elements and specific colors are not confirmed in this study. Nevertheless, The Tranquillo tempo of Bartók's *'Melody in the Mist'* often elicits misty dark hues, such as black, gray, dark purple and green-blue-purple (e.g., Ilus. 1, 2, 5 , 6).

### (4) The Phenomenology of Chromaesthetic Invented Notations

By and large, both children's and adults' audio-graphic productions consist of invented symbols, rather than conventional notation. Nevertheless, some writing rules, which seem to originate in standard notation, are used: (a) the horizontal directionality of signs that records the progression of musical materials through time (e.g., Illus. 3 and 4); (b) the equation of aural density to visual size, as chords versus single tones are represented by larger versus thinner signs, respectively (e.g., Illus. 3, 4, 6); (c) the equation of auditory pitch to a vertical axis; Given a set of notes varying in pitch, the higher the auditory range, the higher the colored symbol paired with it on the drawing page (e.g., Illus.4 and 6).

### (5) The Chromaesthetic Meaning of Colors

Different colors (or color groupings) function as signifiers of both programmatic and inter-sonic meanings. Bartók's score itself suggests some Chromaesthetic Meaning: lightness (melody) versus darkness (mist). As illustrated in the figure below (3), one can think of Bartók's score as the composer own Chromaesthetic "score painting" while the dense black cluster-chords represent a blurry mist versus the clearer unison:

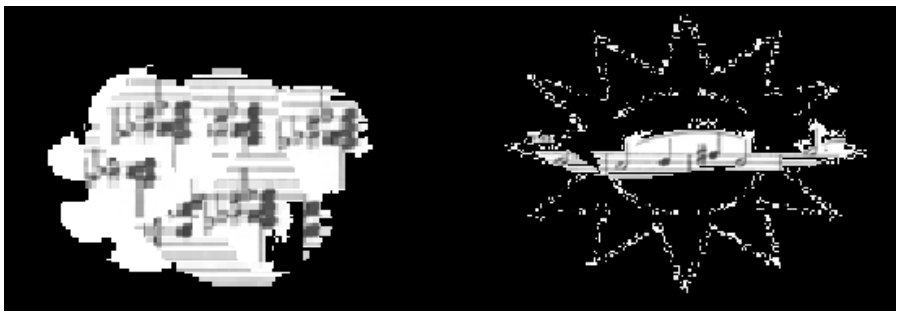


Figure 3: Illustration of Bartók's *'Melody in the Mist'*

Dark colors employed by young and adult listeners comply with the composer's "mist". Furthermore, some listeners hit the composer's Chromaesthetic target by using brighter colors to illustrate a bright mood versus dark colors that stand for a mysterious, dim atmosphere (e.g., Illus.2).

## Conclusions and Discussion

This study shows that children and adult music majors alike perceive and convey relationships between music and color as "*a most natural human activity*" (Peacock, 1985 p. 398). In accordance with this finding, Peacock (1985) asserts that all people

psychologically produce a certain specific color or a set of colors when they hear a single note or a piece of music.

The division of Chromaesthic responses into three broad categories: programmatic, inter-sonic and holistic, recalls Meyer's (1956) inquiry about problems of musical meaning and the manner of musical communication. Meyer outlines two contrasting dichotomies: the *"Referentialist"* versus the *"Absolutist"* views. For the *"Referentialist"* musical meanings refer to the extra-musical world of concepts, actions, emotional states, and character. For the *"Absolutist"*, musical meaning lies exclusively within the context of the musical work itself. Meyer lays out a compromise position that acknowledges the existence of both types of musical meanings. This study, however, deals with programmatic (referential) and inter-sonic (absolute) responses to music as flexible patterns of action, rather than psychological contrasting dichotomies. Through cognitive interrelationships, programmatic often coincides with inter-sonic chromaesthesia, resulting in a densely interconnected form of holistic representations. In this context, Cytowic (1995) confirms that reason and emotion evolve together and their neural substrates are densely interconnected.

Colors often enhance the meanings conveyed by shapes and/or contribute to additional data whether programmatic or inter-sonic. Colors play an important role in representing tempo. Bartók's slow composition is often aligned to dark colors. This accords with Palmer et. al. (2013) who found that slow music produces choices that are darker. However, fixed correlations between musical elements and colors are not confirmed. The choice of specific colors bears a strong subjective validity. This adheres to a broader study (Elkoshi, 2017b) which shows that associations between classical compositions from different historical periods and colors are highly subjective.

Bartók's composition is based on contrasts of melodic unison versus cluster-chord textures. This salient feature of texture alternations is conspicuously present in children's and adults' data (e.g., Ilus.3, 4, 5, 6). According to Cytowic (1995), the word "salience", which means to "leap up" or "stick out", describes how the limbic brain alerts us to what is meaningful. Erickson (1975) puts it as follows:

> *Foreground elements have the character of figure in relation to a ground; they are more distinct, more formed, and "closer" than ground, which is less distinct, less formed, and farther away.* (p. 139)

Listening to complex music of the classical repertoire is an active process of selection and choice. The brain must ignore much of the musical information reaching it and select from that information only what is most meaningful. However, ignoring is not the same as ignorance. The exclusion of certain musical aspects does not mean that a listener is ignorant

of these aspects. It only means that he or she decides to exhibit conceived foreground features, rather than subdued elements.

## Implication for Music Pedagogy

Scholars often complain that learners are lacking multisensory programs in the curriculum. Campen (2009), for example, realizes that *"the awareness of synesthetic abilities is hardly developed… and multisensory development is halted by neglect"* when educational institutions pay little attention to the sensory development of their students (p. 9).
The introduction of Chromasthetic activities in the music curriculum may at least partially reform this lacuna. Chromasthetic activities allow students to involve the sense of vision and sound in the arts; Chromasthesia provide a valuable poly-aesthetical tool to convey both inter-sonic and associative interpretations of music; and it can enable music educators to explore their students' audio-graphic skills and cross-modal behaviors.
An audio-graphic response to music is intuitive as it allows listeners the freedom to convey musical and extra-musical information in creative ways. In the field of music education, there is a need to promote practices that directly develop creativity (Burnard, 2012). It stands to reason that employing Chromaesthesia in music pedagogy would help achieve this goal with flying colors.

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