

# COLOR & MUSIC: A STUDY OF THE PHYSICAL AND PSYCHOLOGICAL RELATIONSHIP BETWEEN COLOR AND SOUND

## ABSTRACT

Objective of this work has been to find and prove the existence of a correlation between color variables (hue, value, and chroma) and physical dimensions of sound (height, volume and timbre) respectively.

First, and as a preparatory phase, we have studied the timbre of traditional musical instruments in order to obtain a ranking on the purity of sound. Sounds of cello, horn, bassoon and piano, were analyzed to obtain their spectra with the first 16 harmonics of common musical notes in their tessitura. Central notes (A2, B3 and E3) in this instruments tessitura were analyzed and has been obtained sonority sensation  $S$  of each harmonic. It has been evaluated, mathematically and graphically, sonority of their harmonics establishing an order and purity ranking of the instruments; for which, we have introduced concepts of "harmonic importance value", "valued sonority" and "harmonic ideal surround".

In a second part, a proposal of agreement has been made between hue and musical tones. Based on the correspondence of spectrum wavelengths with musical notes of tempered scale ( $\lambda_c = 72,135 \cdot \ln(\lambda_m) + 577,76$ ), colors tones of the light spectrum have been adjusted to Munsell colors. Series of harmonic musical notes issued by different instruments were generated and series of harmonic colors were formed relating them with the harmonic series of musical notes; considering purity rank obtained in the first part of the work and color chroma. Thus, color series with varying hue towards red to blue have been associated with series of musical notes (chords, fifths and octaves) issued by the same instrument from low to high pitch.

Having defined timbre purity and proposed a relationship between hue and musical tones, third part of this paper analyzes and correlates chroma with musical timbre. Colors with same hue and value but different chroma have been associated with different musical instruments issuing same single musical note at equal intensity.

Fourth part of this paper analyzes correlation between value and intensity of sound. For this, examples of correlation between sets of colors (same hue and chroma but value variation) with sound series of a musical note issued by the same instrument (varying intensity) are proposed.

As a final part of the work, and looking for psychophysical validation, through a population study, of previously developed in a theoretical level, it has prepared a comparison test between colors and musical notes as proposed by previous studies seeking possible relationships between variables. This test was published in Internet (URL <http://clapton.alc.upv.es/jperez/>) and a group of observers were invited to participate. Their responses were collected in a database and later analyzed, obtaining following conclusions:

- There is a greater tendency to relate color tones with long, medium and short wavelengths with musical notes with long, medium and short wavelengths respectively. That is, a positive correlation between hue and musical pitch (height).
- There is a greater tendency to relate purest musical notes with the most chromatic colors. That is, a positive correlation was observed between chroma and timbre.
- For a related color (on white background), there is a greater tendency to relate more loudness with less clarity. That is, a negative correlation was observed between clarity and intensity.

Therefore, it has been demonstrated for the first time a relationship between visual and auditory stimuli of proportional wavelengths and with the same direction. And even when a color tone can vibrate in harmony with the same musical note issued by various musical instruments, sense of wellbeing in the receiver of both stimuli will be more present as there is greater concordance between color chroma and timbre purity of musical sound. Likewise, greater or lower intensity of that sound will be perceived better concorded with lower or higher clarity of that same color.

Keywords: Color and music, perception, vision, hearing, harmony.