The Color of Music

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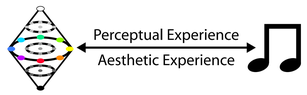
Background

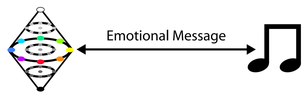
According to Arnheim (1986), perceptual relations exist between color and sound based on shared "expressive qualities."



Some propose a direct mapping between dimensions of color and sound (e.g., Caivano, 1994).

Color		Sound
Hue	⟷	Pitch
Saturation	⟷	Timbre
Brightness	⟷	Loudness
Size	⟷	Duration

Sebba (1991) concluded that the underlying commonality is emotional message.



Bresin (2005) tested how musicians' emotional intent influenced color-music associations, but neglected to measure perceived emotional content of the music or the colors in his experiment.

Although there is weak evidence that color dimensions (e.g. saturation) are related to musical structure (e.g. major/minor) (e.g. Sebba, 1991; Bresin, 2005), the role of emotion in music-color association is unclear.

Research Questions

What is the relationship between color and (classical) music?

What are the relations between color-emotion associations and music-emotion associations?

Could emotional response mediate the relationship between color and music?

General Method

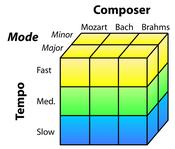
48 Participants:

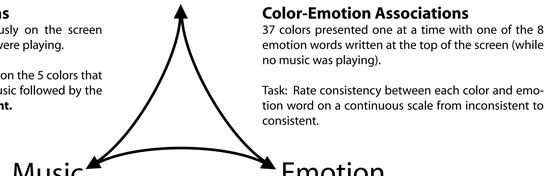
	Male	Female
Artist	12	12
Non-Artist	12	12

Massive Repeated Measures (MRM) design

Color-Music Associations
37 colors presented simultaneously on the screen while each of 18 pieces of music were playing.

Task: Listen for 1 minute and click on the 5 colors that are **most consistent** with the music followed by the 5 colors that are **most inconsistent.**





Color-Emotion Associations
37 colors presented one at a time with one of the 8 emotion words written at the top of the screen (while no music was playing).

Task: Rate consistency between each color and emotion word on a continuous scale from inconsistent to consistent.

Music-Emotion Associations
8 emotion words presented one at a time while each of 18 pieces of music were playing.

Task: Listen for 1 minute, then rate consistency between the music and each emotion word on a continuous scale from inconsistent to consistent.

HAPPY	SAD
LIVELY	DREARY
STRONG	WEAK
CALM	ANGRY

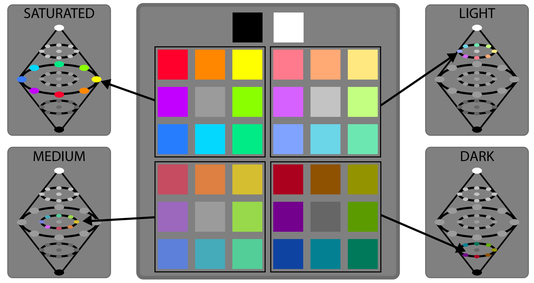
Our Colors: The Palmer Lab 37

4 unique hues:
red
yellow
green
blue

4 angle bisectors:
orange
chartreuse
cyan
purple

3 lightness levels
2 saturation levels

Five achromatic colors



Munsell colors specified in CIE 1931 values through the Munsell Renotation Table (Wyzecki & Stiles, 1967)

Relations between Dimensions of Color and Music

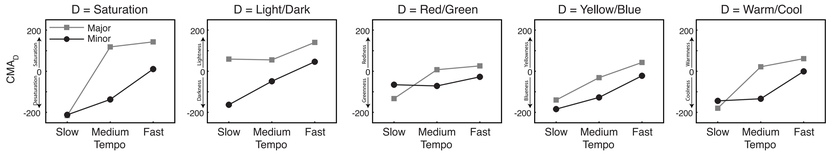
Participants rated each color on 5 colorimetric dimensions prior to listening to the music:
saturation, light/dark, red/green, yellow/blue, warm/cool.

We analyzed each participant's **Color-Music Association (CMA)** for each musical selection in terms of the colorimetric composition of the five colors that were most **consistent** with the music (***C***) and the five that were most **inconsistent** with the music (***I***).

$C_{\mathrm{D}} = 5c_{1,\mathrm{D}} + 4c_{2,\mathrm{D}} + 3c_{3,\mathrm{D}} + 2c_{4,\mathrm{D}} + c_{5,\mathrm{D}}$, where $c_{1,\mathrm{D}}$ = rating of most consistent color along dimension D

$I_{\mathrm{D}} = 5i_{1,\mathrm{D}} + 4i_{2,\mathrm{D}} + 3i_{3,\mathrm{D}} + 2i_{4,\mathrm{D}} + i_{5,\mathrm{D}}$, where $i_{1,\mathrm{D}}$ = most inconsistent color along dimension D

$$CMA_{\mathrm{D}} = C_{\mathrm{D}} - I_{\mathrm{D}}$$



Faster music ($p < .001$) and music in the major mode ($p < .001$) were associated with colors that were more **SATURATED**.

Faster music ($p < .001$) and music in the major mode ($p < .001$) were associated with colors that were **LIGHTER**.

Faster music was associated with colors that were **REDDER** for music in the major ($p < .001$), but not in the minor mode.

Faster music ($p < .001$) and music in the major mode ($p < .001$) were associated with colors that were **YELLOWER**.

Faster music ($p < .001$) and music in the major mode ($p < .001$) were associated with colors that were **WARMER**.

Scaling Colors and Music from Emotional Similarity

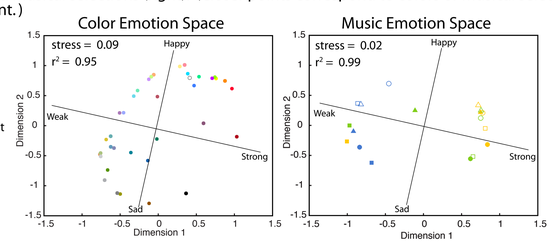
Each pair of colors (or musical selections) is emotionally similar to the degree that they were rated similarly across the 8 emotional dimensions.
We therefore computed correlations over emotional dimensions for each pair of colors (or musical selections).
For example:

	HAPPY	SAD	LIVELY	DREARY	STRONG	WEAK	ANGRY	CALM
Saturated Orange:	143.19	-163.00	164.79	-166.56	117.40	-152.65	46.04	-151.54
Saturated Yellow:	152.44	-173.63	173.35	-160.15	135.71	-125.29	-33.23	-135.13

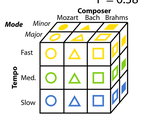
r = 0.98, therefore, emotionally similar

Pair-wise correlations were used as similarity measures to construct multidimensional scaling (MDS) of emotional content of colors (left) and musical selections (right). (Closer points correspond to colors or musical selections that have similar emotional content.)

Colors that are...
Happy: saturated and light
Sad: desaturated and dark
$r^2 = 0.84$
Strong: saturated and dark
Weak: desaturated and light
$r^2 = 0.60$



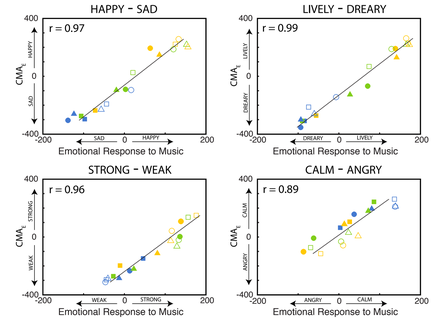
Music that is...
Happy: faster and major
Sad: slower and minor
$r^2 = 0.77$
Strong: faster
Weak: slower
$r^2 = 0.38$



Emotions Mediate Color-Music Associations

There are strong correlations between
emotional ratings of each musical selection and
emotional ratings of colors consistent with the music (CMA_E)*

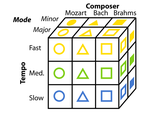
*CMA_E is analogous to CMA_D, but using emotional dimensions rather than colorimetric dimensions.



Pairs of opposite emotions were combined to form single dimensions.

Opposite emotions were determined by strong negative correlations:

	Color-Emotion	Music-Emotion
HAPPY - SAD	-0.94	-0.98
LIVELY - DREARY	-0.99	-0.95
STRONG - WEAK	-0.97	-0.99
CALM - ANGRY	-0.69	-0.51

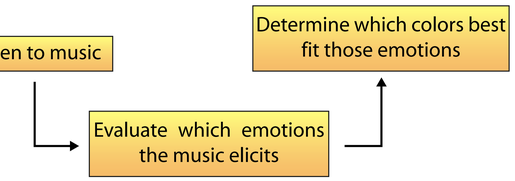


This suggests that emotion may mediate the relation between color and music.

Conclusion

Both color and music seem to be associated with specific emotions according to well-defined dimensions.

When making color-music associations, individuals appear to evaluate which emotions the music evokes, and then determine the colors that best fit those emotions (even if emotion is never mentioned in the task instructions).



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