Music, Color, and Emotion in Synesthetes and Non-Synesthetes

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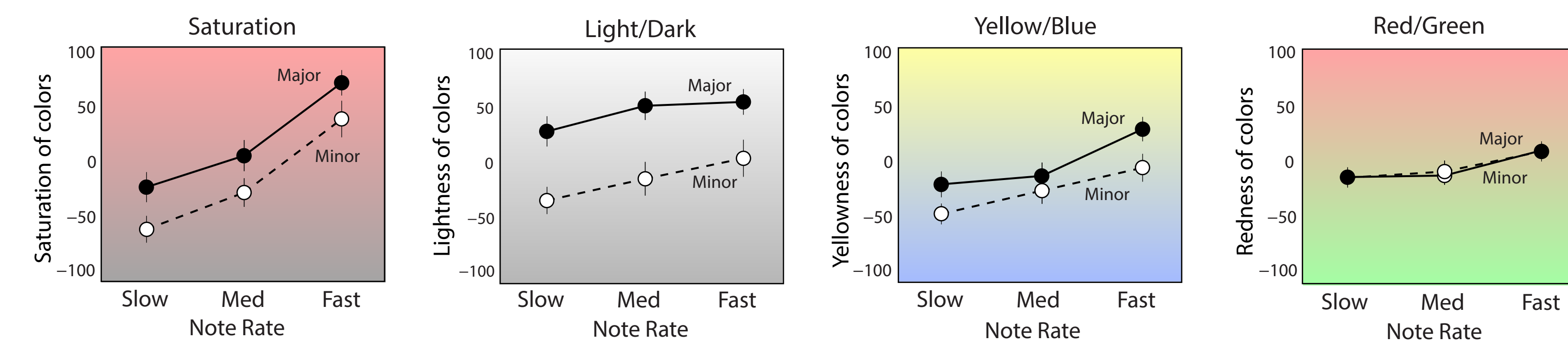
Background

Music-Color Association Task:
Pick the three colors that go best/worst with the music.
- Classical orchestral music (Palmer, Schloss, Xu & Prado-Leon, PNAS, 2013)
- Single-line piano melodies (Palmer, Langlois, Tsang, Schloss, Levitin VSS-011)

Associations of color dimensions with piano melodies

The Emotional Mediation Hypothesis: Non-synesthetes associate the colors that match the emotional content the music (Palmer, Schloss, Xu & Prado-Leon, PNAS, 2013; Palmer, Langlois, Tsang, Schloss, Levitin VSS-011)
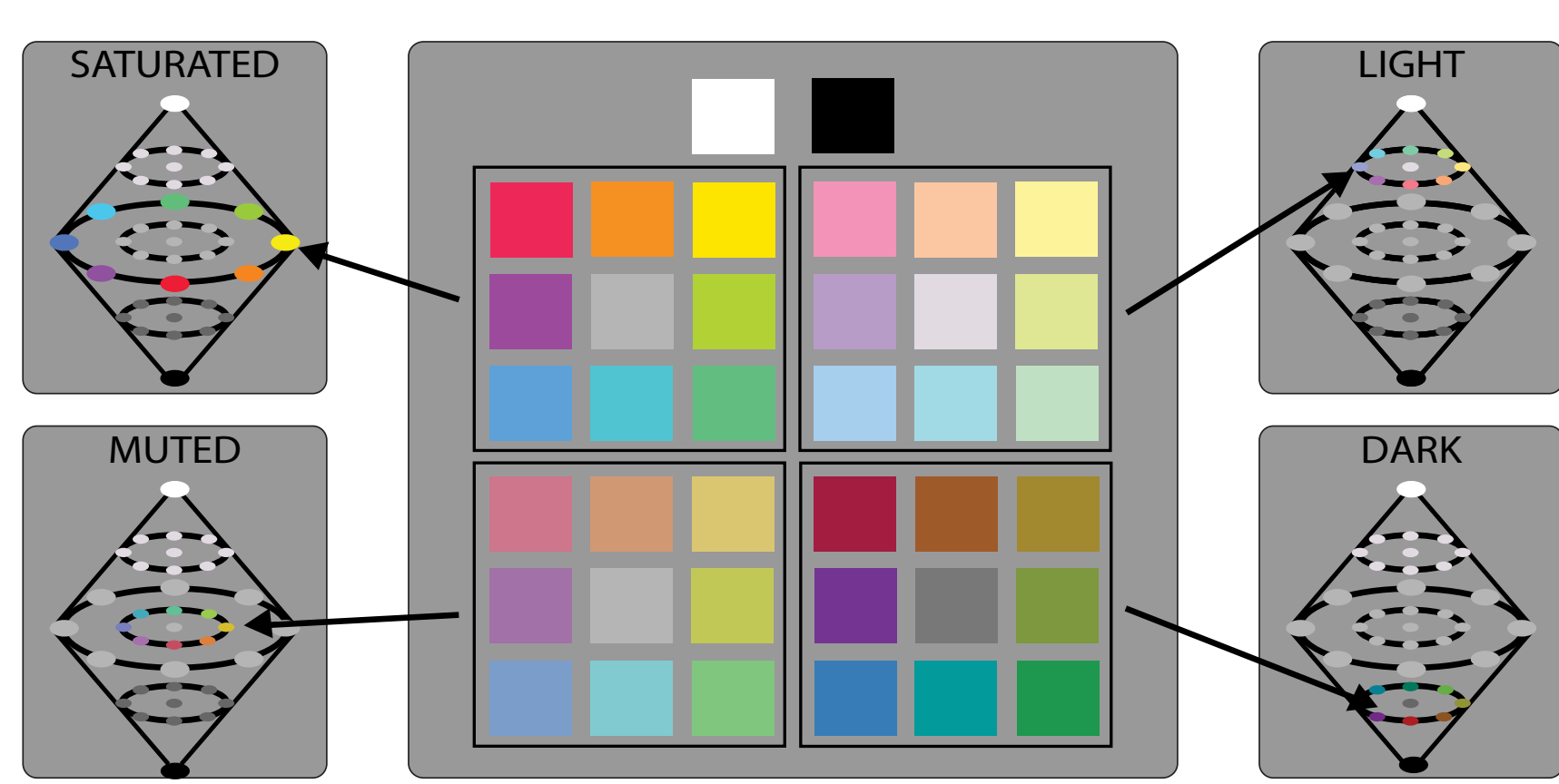
What about synesthetes?
Do music-color synesthetes experience similar colors to those that non-synesthetes associate with the same music?

Note: Visual depiction of music-color synesthesia used in graphic is taken from the motion picture "The Soloist."

Color and Music

Berkeley Color Project (BCP) 37 Colors

8 Hues: Red, Yellow, Green, Blue, Orange, Chartreuse, Cyan, Purple
4 Saturation/Lightness "cuts": Saturated, Light, Muted, Dark
5 achromatic colors: white, black, and 3 grays

24 Mozart Melodies*
A single-line melody adapted from a Mozart theme

2 Timbres x 2 Modes x 2 Registers x 3 Note Rates
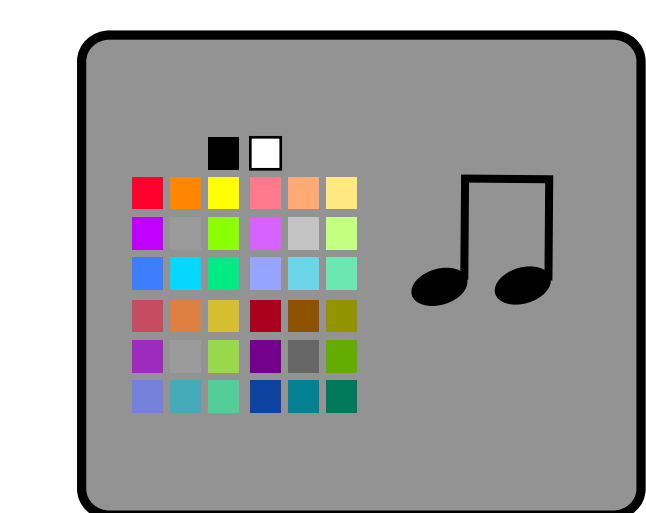piano/cello   major/minor   low/high   slow/med/fast

Participants

11 Music-Color Synesthetes scored less than 1.0 on the Synesthete.org battery (mean = .65).

11 Non-Synesthete Controls were matched for age, sex, and musical and artistic background.

*We thank Daniel J. Levitin, and Karle-Philip Zamor for generating the musical stimuli.
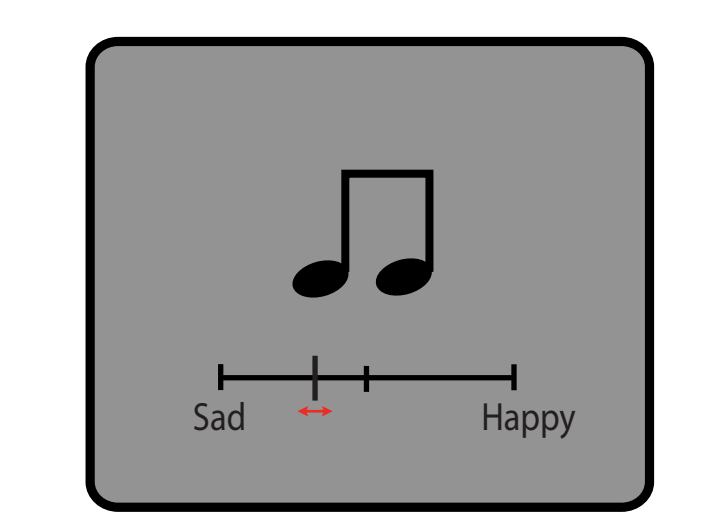
General Methods

Music-Color Choices

Non-Synesthetes: Pick 3 colors that are most/least consistent with the melody

Synesthetes: Pick 3 colors that are most/least similar to their synesthetic experience (options for "no further color experiences")
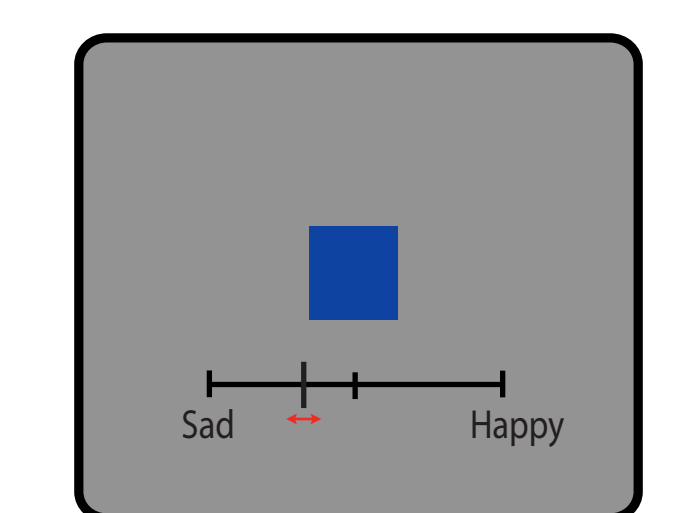
Music-Emotion Ratings

Rate the emotional content of each melody:
Agitated-Calm   Sad-Happy
Weak-Strong   Angry-Not Angry
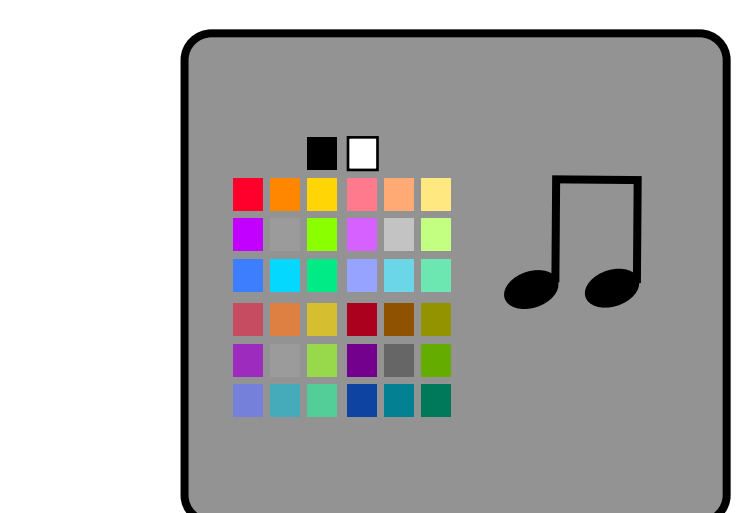Passive-Active

Color-Emotion Ratings

Rate the emotional content of each color:
Agitated-Calm   Sad-Happy
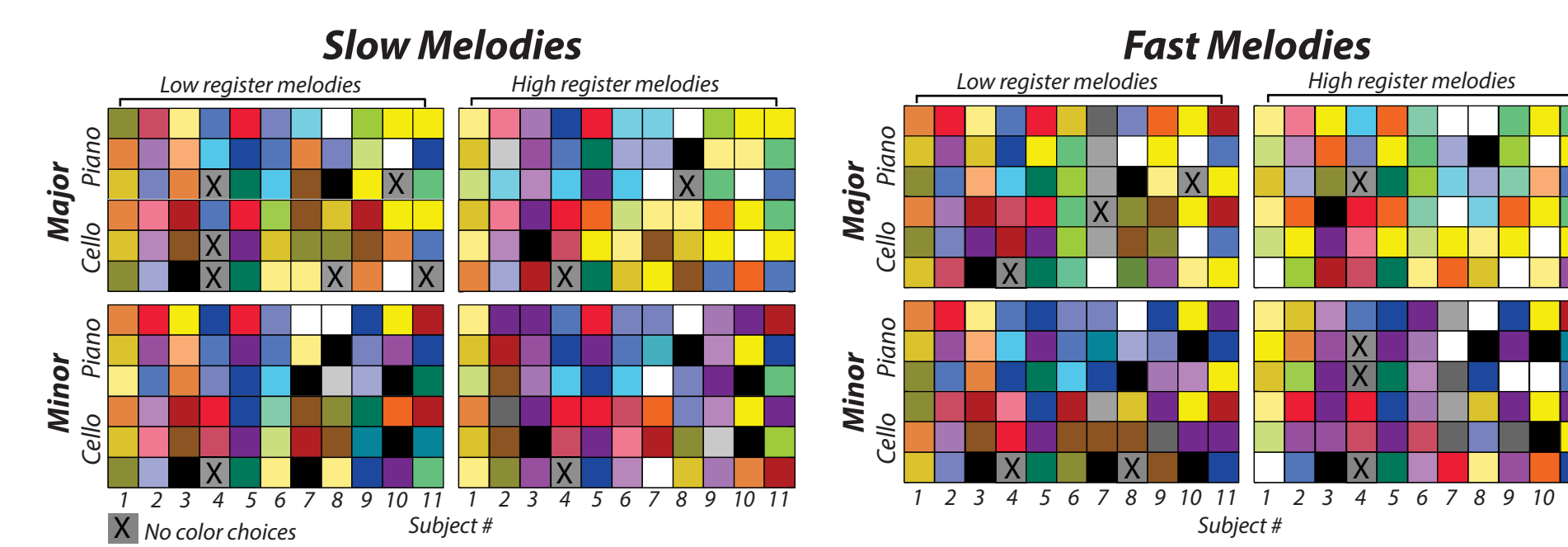Weak-Strong   Angry-Not Angry
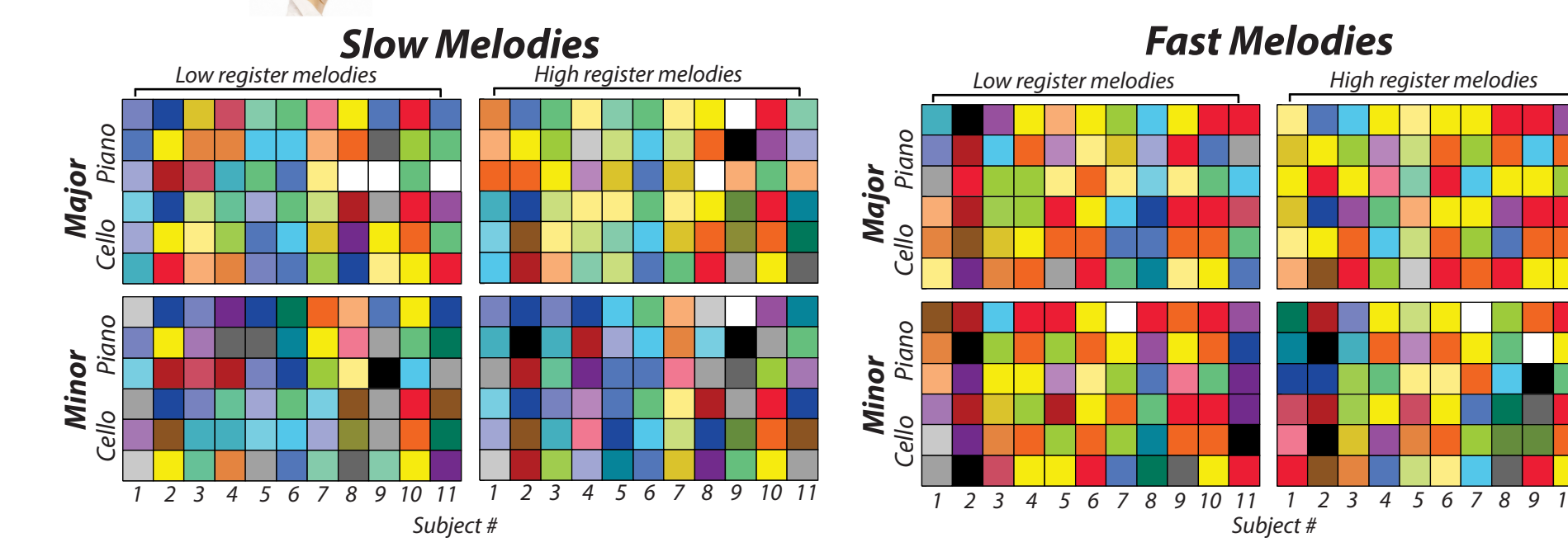Passive-Active

Emotional Compatibility Task

All participants: pick the 3 colors that are most/least emotionally compatible with the music (e.g., "Pick happy colors for happy music").
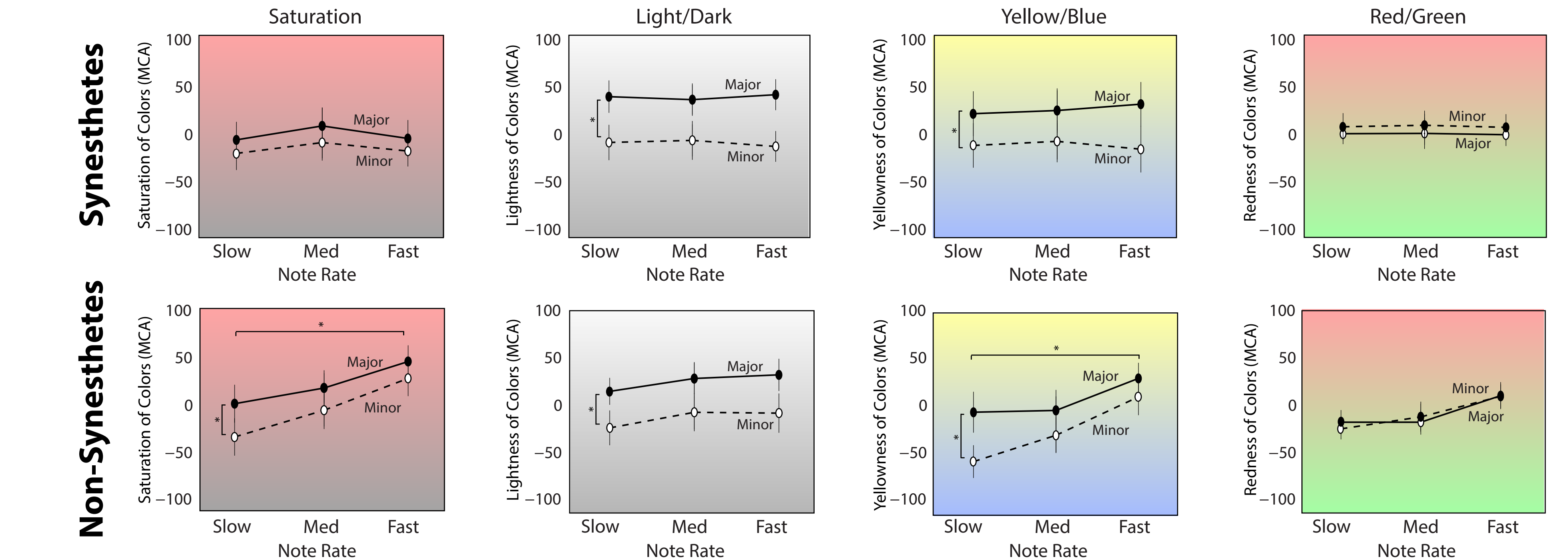
The Color of Music

Colors Picked by Synesthetes:

Colors Picked by Non-Synesthetes:

Effects of Note Rate and Mode on Color Choices: Note rate influences color choices for Non-synesthetes but not for Synesthetes

Music-Color Association (MCA_D):
The weighted average of the colors picked as most consistent with the music ($C_{d,m}$) minus the weighted average of the colors picked as most inconsistent with the music ($I_{d,m}$) along a given dimension (D).

$$C_{d,m} = (3c_{1,d,m} + 2c_{2,d,m} + c_{3,d,m})/6, \quad \text{[consistent]}$$
$$I_{d,m} = (3i_{1,d,m} + 2i_{2,d,m} + i_{3,d,m})/6, \quad \text{[inconsistent]}$$
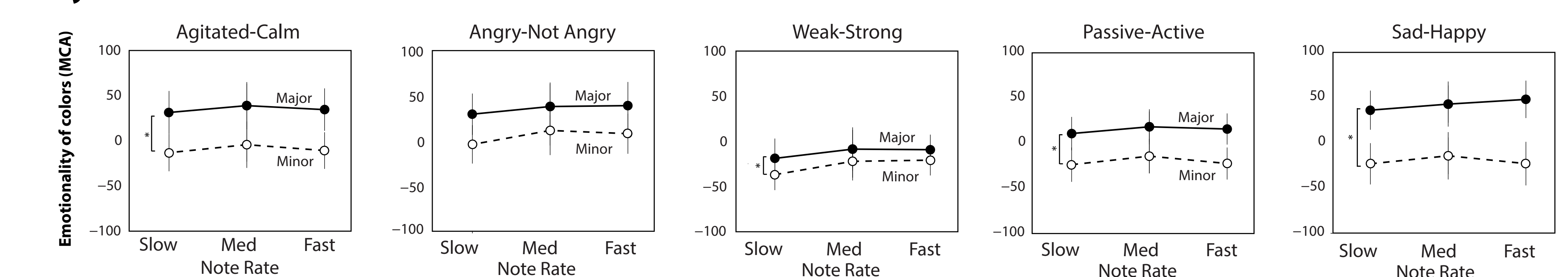$$MCA_{d,m} = C_{d,m} - I_{d,m} \quad \text{[combined]}$$
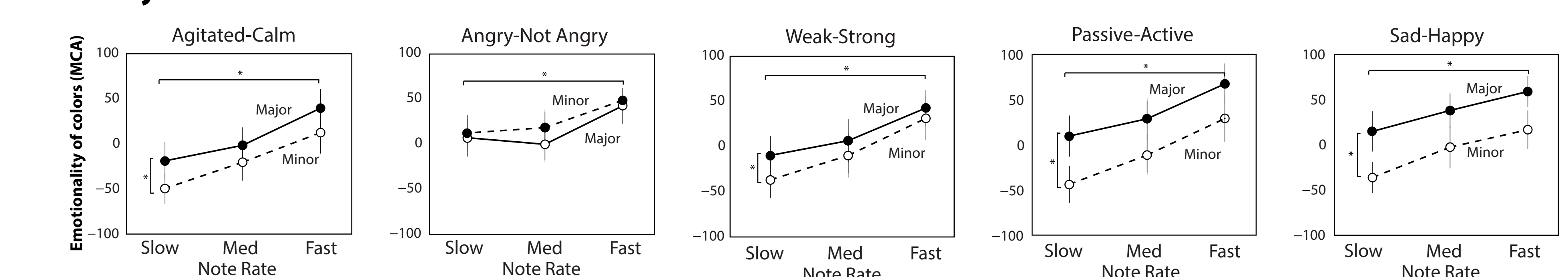
Relations among Music, Emotion and Color

Emotionality of colors picked to go with the music:
For synesthetes, differences in mode influenced the emotionality of the experienced colors, but note-rate had no effect. For non-synesthetes, both mode and note-rate influenced the emotionality of the associated colors.
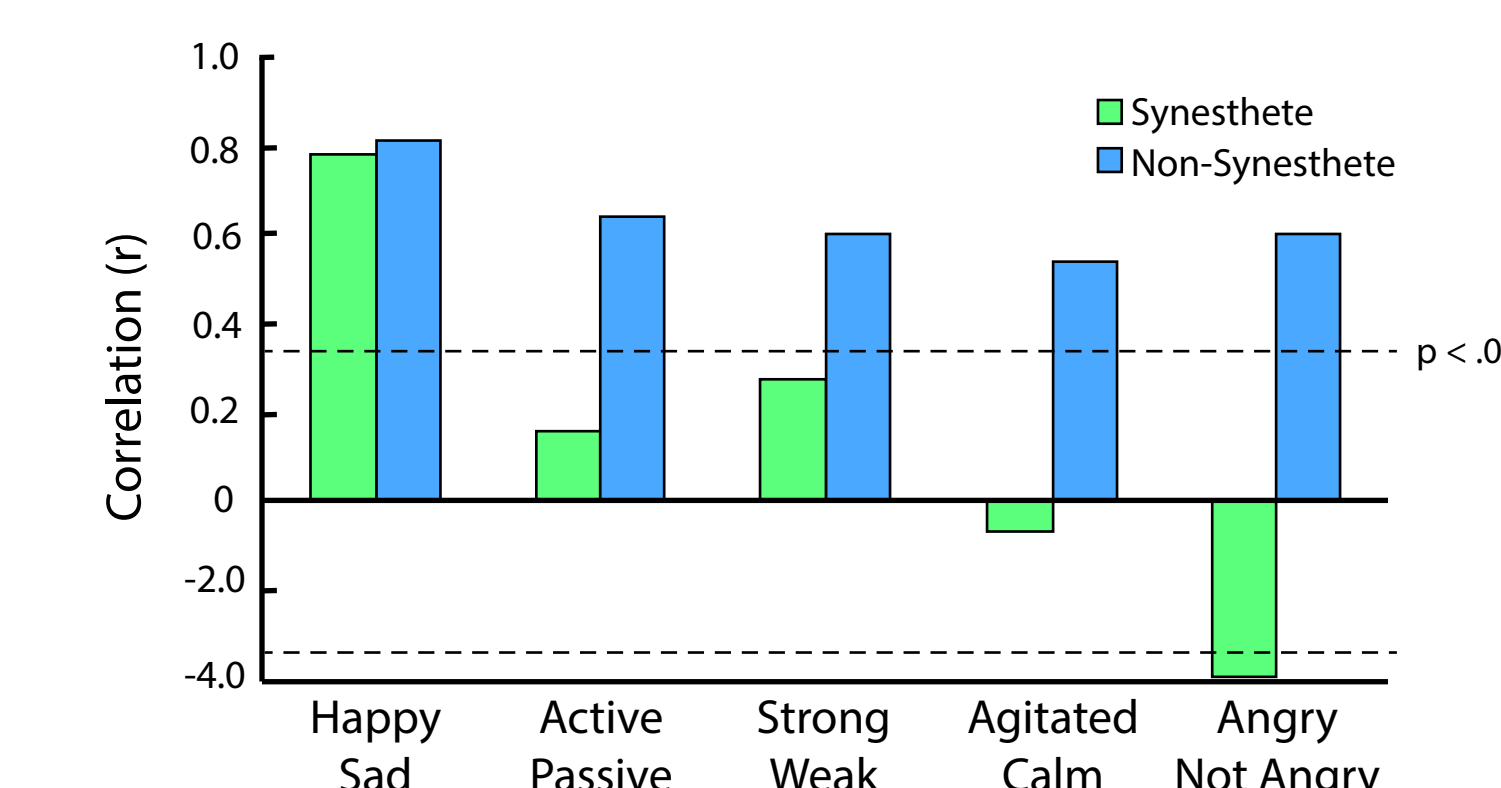
Synesthetes

Non-Synesthetes

Emotional Music-Color Association (MCA_E): calculated for each melody for each emotion dimension (E) as in the Music-Color Association (MCA_D).

Emotional Mediation: Synesthetes vs. Non-Synesthetes

Music Color Choice Task:
Correlations between the emotional content of the music and that of the associated colors (e.g., happiness of music vs. happiness of chosen colors).
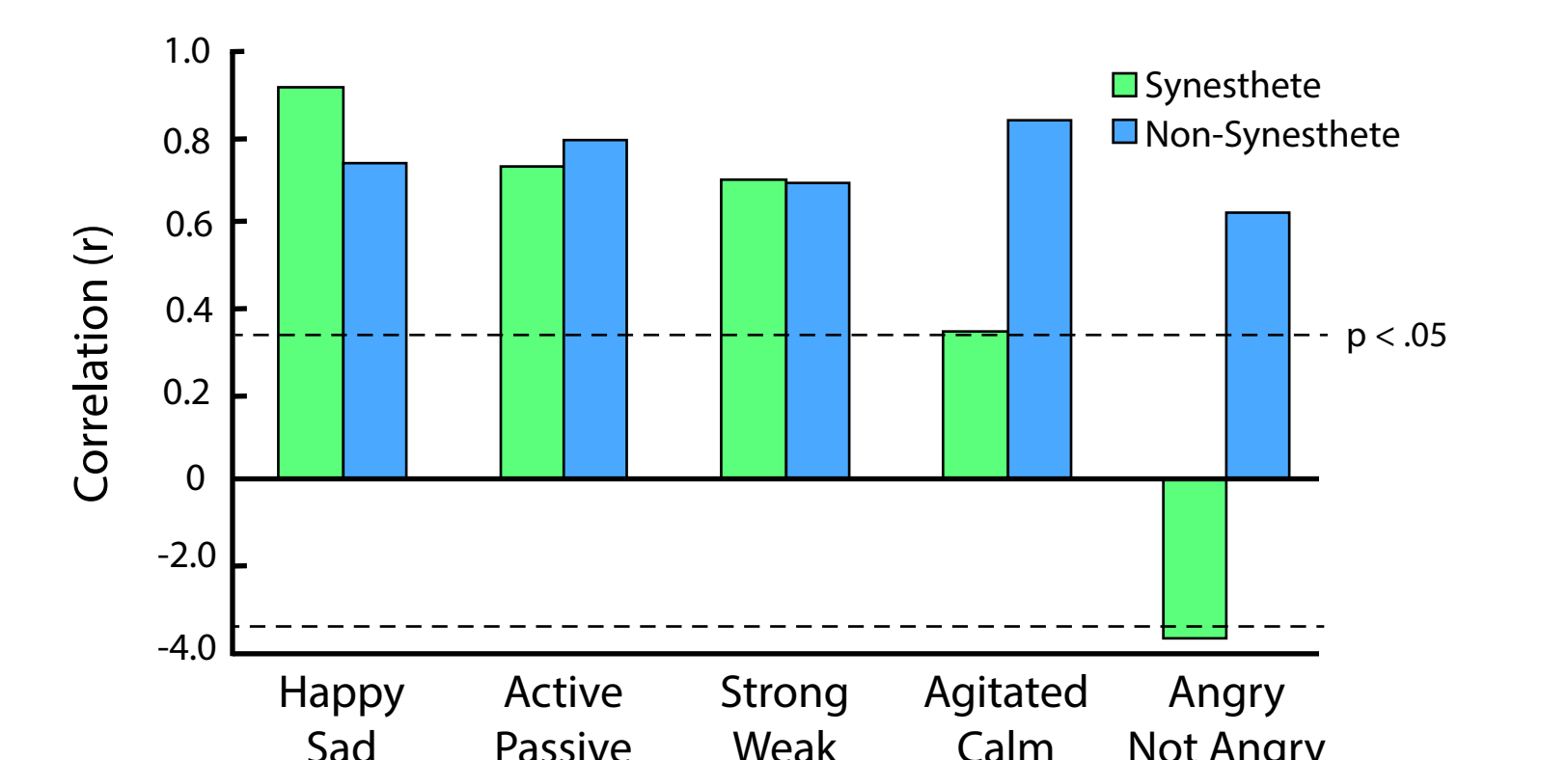

Non-synesthetes showed strong correlations between the emotion of the melodies and the emotion of the chosen colors for all five dimensions, which supports the emotional mediation hypothesis.

Synesthetes showed overall lower emotional correlations; only Happy-Sad was reliable, which weakly supports the emotional mediation hypothesis.

Emotional Compatibility Task:
Correlations between the emotional content of the music and that of the colors that were chosen to be emotionally compatible (e.g., happiness of music vs. happiness of emotionally compatible colors).

Both groups showed reliable correlations for all dimensions, but anger was unexpectedly negative for the synesthetes.

Therefore, synesthetes generally know which colors are emotionally compatible with the music, but do not always experience them when they hear music.

Conclusion

1. **For both synesthetes and non-synesthetes:**
   Major, higher-register melodies were associated with more saturated, lighter, yellower colors
   Minor, lower-register melodies were associated with grayer, darker, bluer colors

2. **For non-synesthetes, note-rate was associated with more saturated, lighter, yellower colors, but not for synesthetes.**

3. **Non-synesthetes' color associations strongly match the emotional tone of the music.**

4. **Synesthetes' color experiences tended to match the emotional tone of the music much less, except for Happy-Sad.**

References and Acknowledgements

Eagleman, D. M., Kagan, A. D., Nelson, S. S., Sagaram, D., & Sarma, A. K. (2007). A standardized test battery for the study of synesthesia. *Journal of Neuroscience and Methods*, 159,1, 139-145.

Palmer, S. E., Schloss, K.B., Xu, Z., & Prado-Leon, L. (2013). Music-color associations are mediated by emotion. *Proceedings of the National Academy of Sciences*.

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