

Shape-to-Color Associations in Non-synesthetes: Evidence for Emotional Mediation

Michela Malfatti¹, Karen B. Schloss², Liliana Albertazzi^{1,3}, & Stephen E. Palmer⁴

¹ Center for Mind/Brain Sciences, University of Trento

³ Department of Humanities, University of Trento

² Department of Cognitive, Linguistic & Psychological Sciences, Brown University

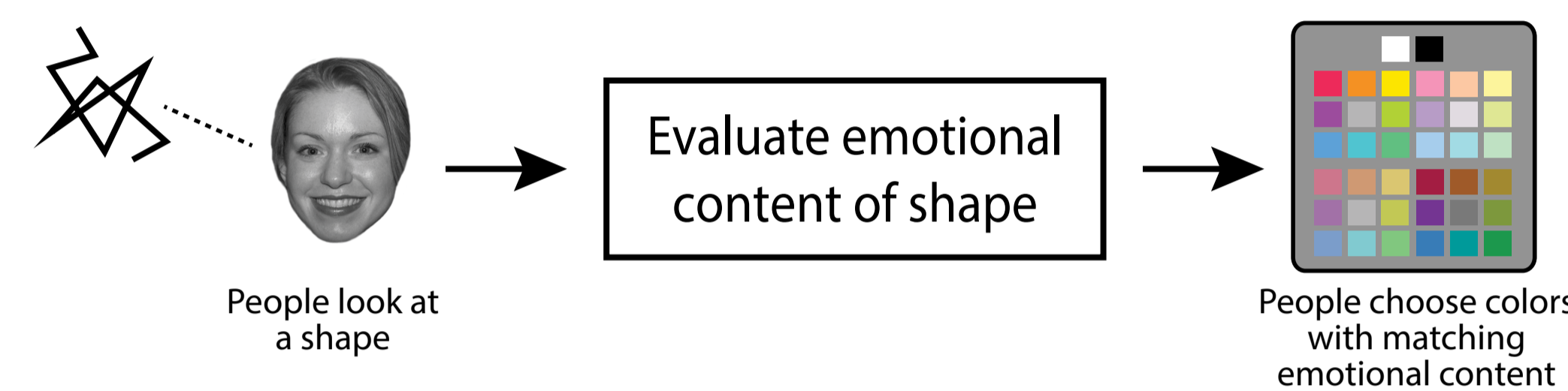
⁴ Department of Psychology, University of California, Berkeley

Background

Non-synesthetes have systematic associations between hues and shapes (Albertazzi et al., 2012). Here we extend the study of shape-to-color associations in non-synesthetes to other color attributes and a wider variety of shapes and shape features. Moreover, we test if such associations might be mediated by emotions, as music-to-color associations are (Palmer et al., 2013).

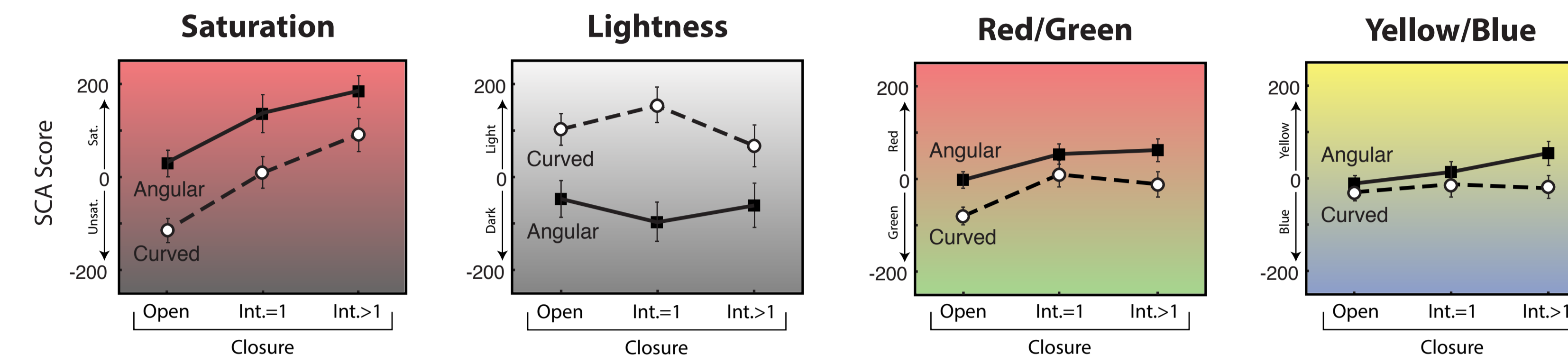
Emotional Mediation Hypothesis:

Colors are mapped onto shape through their shared emotional content.



The Color of Line-Shapes

Geometric features of the shape (in particular its curviness and closure) influence the colors picked to go with it for different Color Appearance Dimensions (e.g. more angular and intersecting line-shapes are consistent with more saturated colors).



Shape-Color Association (SCA Score): $SCA_{d,s} = C_{d,s} - I_{d,s}$

The weighted average of the colors picked as most consistent with the shape ($C_{d,s}$) minus the weighted average of the colors picked as most inconsistent with the shape ($I_{d,s}$), along a given dimension (d).

$$C_{d,s} = (3c_{1,d,s} + 2c_{2,d,s} + c_{3,d,s})/6$$

most consistent color

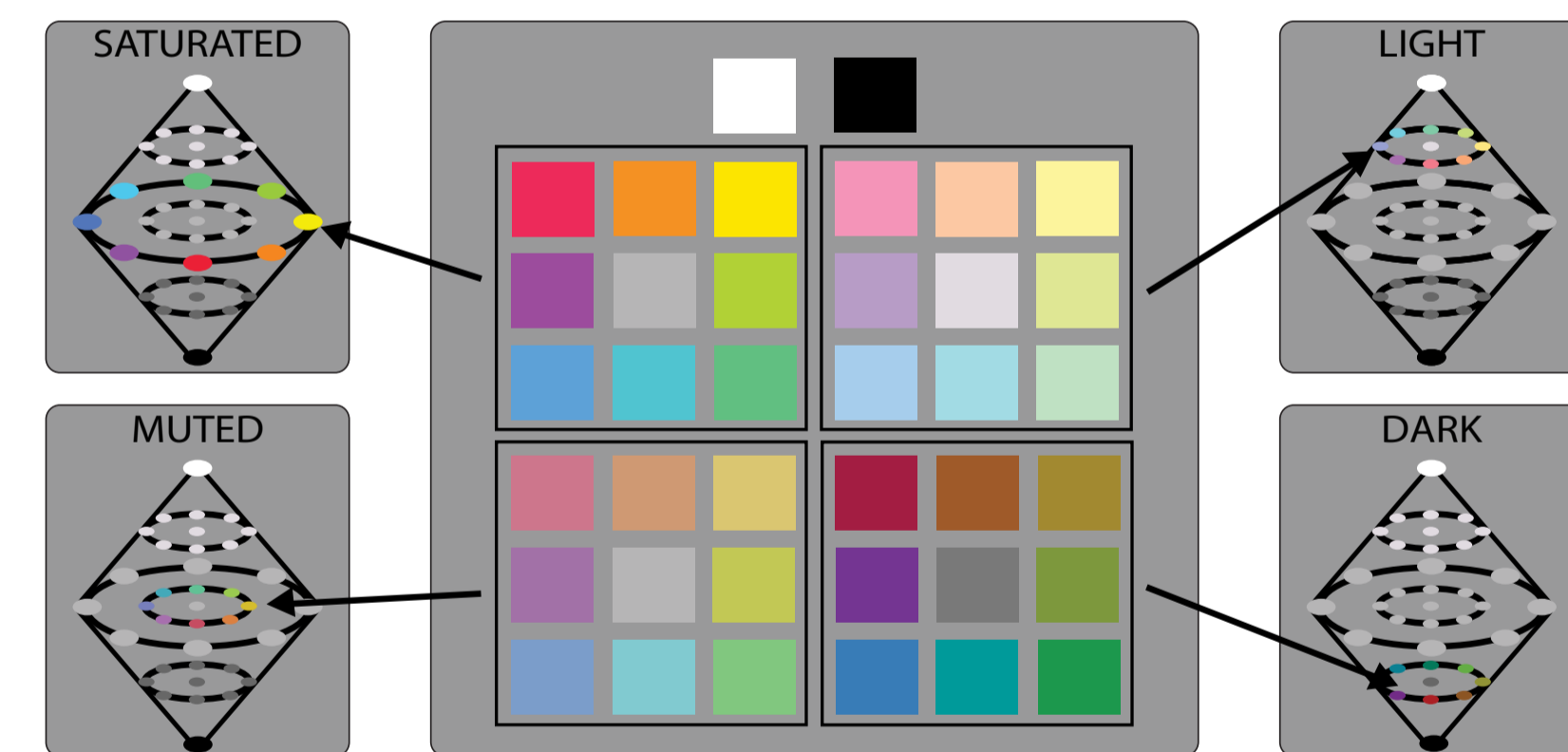
$$I_{d,s} = (3i_{1,d,s} + 2i_{2,d,s} + i_{3,d,s})/6$$

most inconsistent color

Color and Shape: Stimuli

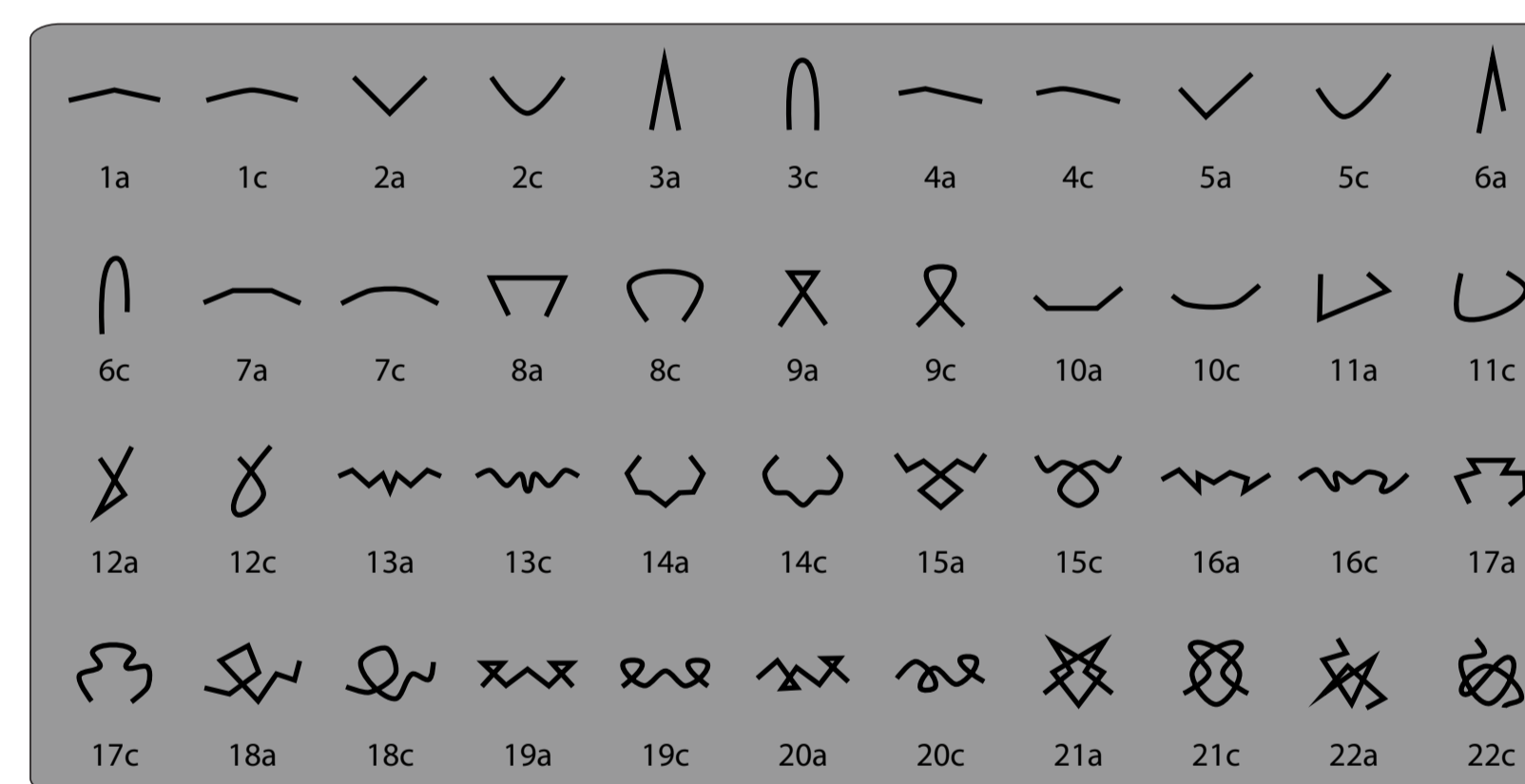
37 Colors (Berkeley Color Project)

8 Hues: Red, Yellow, Green, Blue, Orange, Chartreuse, Cyan, Purple
4 Saturation/Lightness levels ("cuts"): Saturated, Light, Muted, Dark
+ 5 Achromatic Colors: White, Black, Light, Medium, & Dark Gray



4 Color Appearance Dimensions:
Saturation, Lightness, Red/Green, Yellow/Blue

44 Line-Shapes

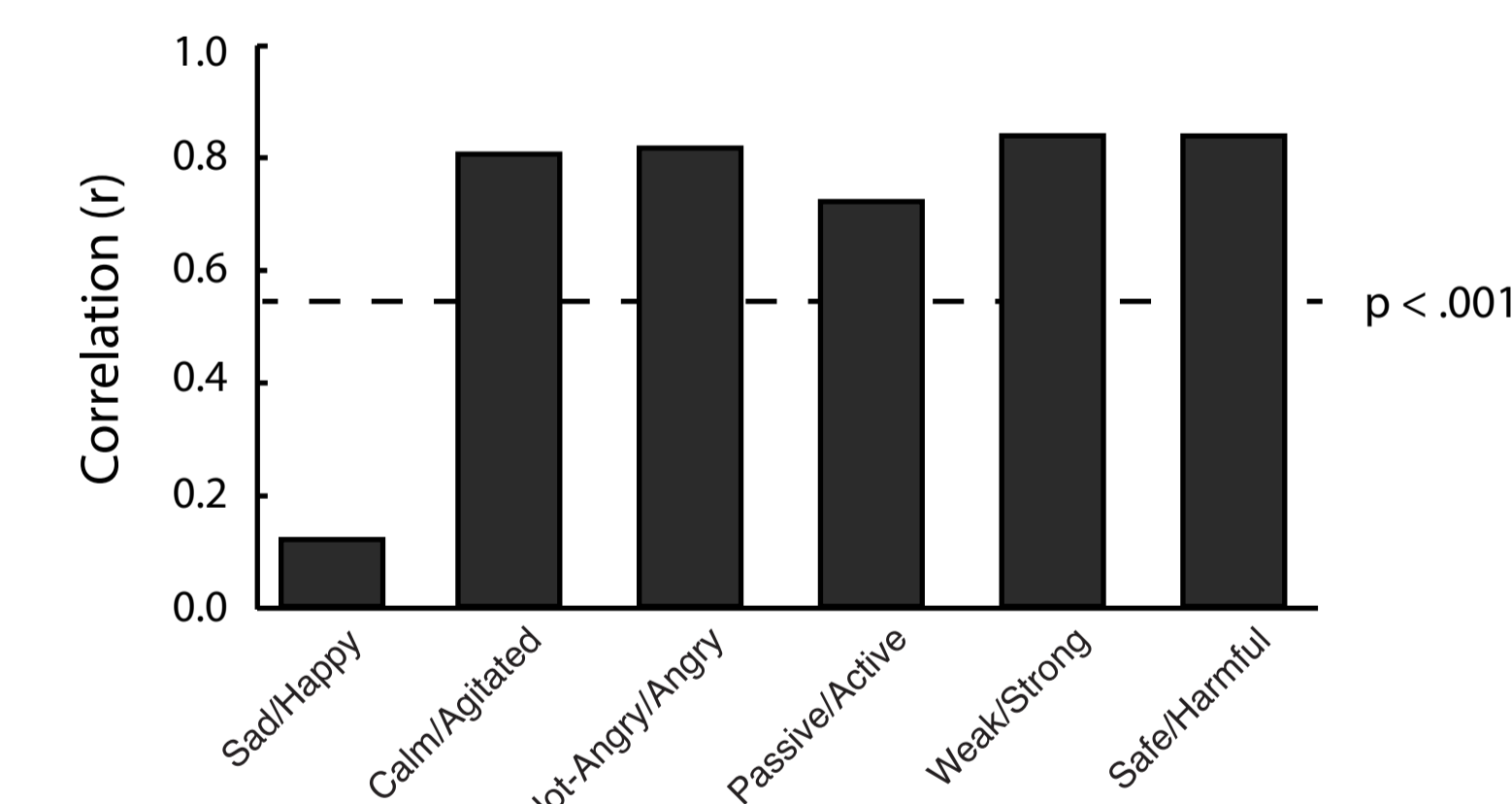


4 Shape Features:
Curviness: Curved, angular
Symmetry: Asymmetric, symmetric
Closure: Open, intersecting-once, intersecting>1
of Line-Segments: 2, 3, 8 line-segments

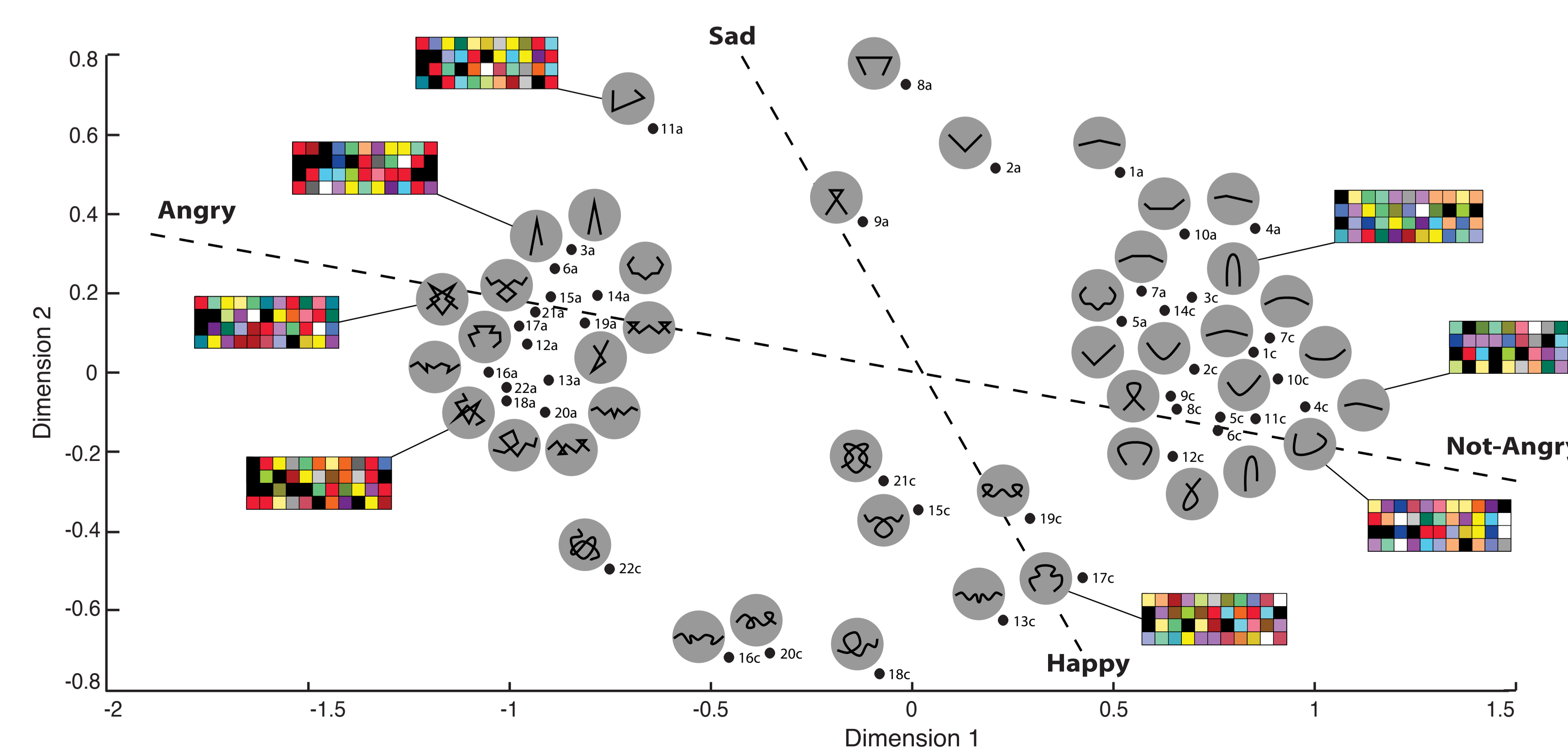
Relations Between Color, Shape, and Emotion

Support for the Emotional Mediation Hypothesis: There are strong correlations between emotional ratings of each line-shape and emotional ratings of the colors consistent with that shape, except for Sad/Happy.

Principal Component Analysis (PCA) of the Dimensions showed that 83% of variance could be explained by 1 Component that roughly corresponded to Not-Angry/Angry (PC loadings: Not-Angry/Angry = .99; Safe/Harmful = .99; Calm/Agitated = .99; Passive/Active = .93; Weak/Strong = .91; Sad/Happy = -.62).



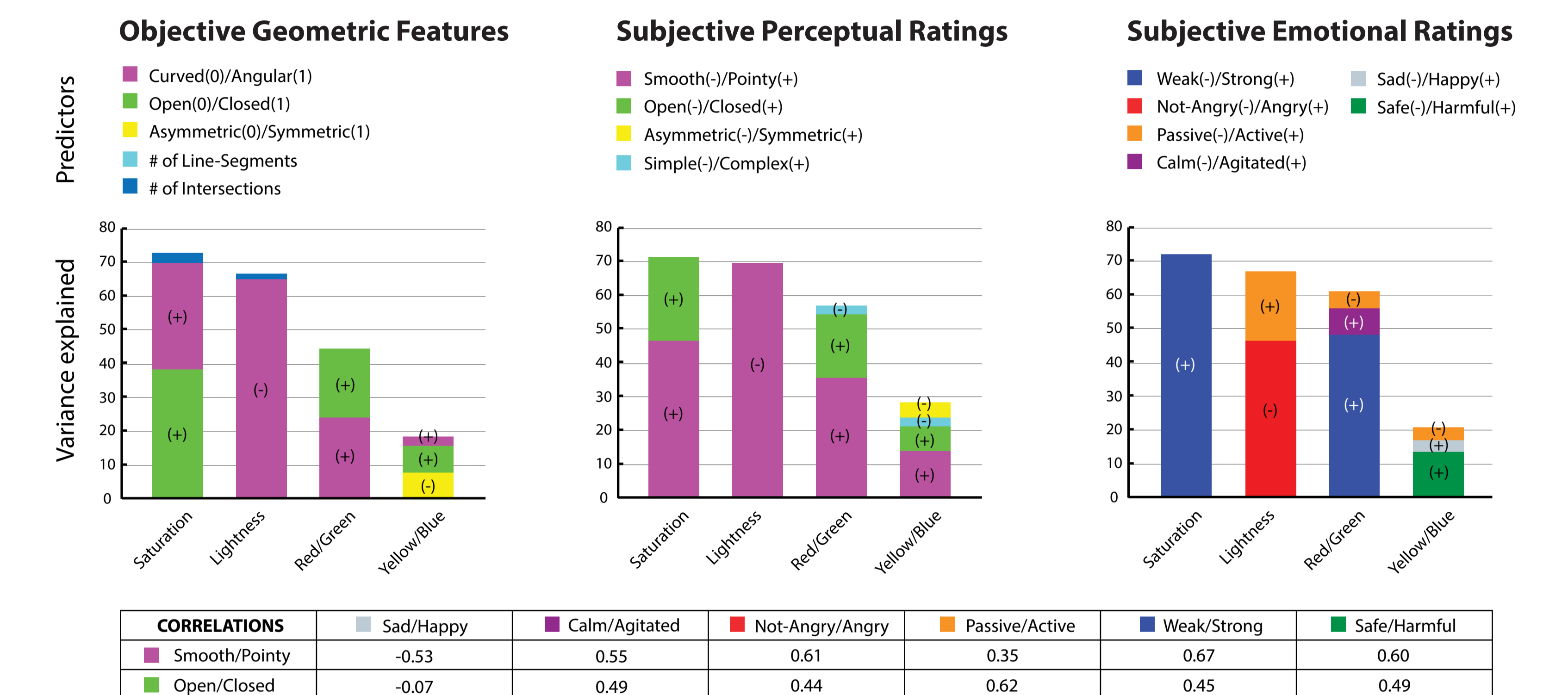
Multidimensional Scaling of Shapes based on Emotional Ratings



Objective Features vs Subjective Ratings

The color of a line-shape could be better predicted by its Subjective Ratings rather than its Objective Features. Both Subjective Perceptual Ratings and Subjective Emotional Ratings explained a good amount of variance.

Stepwise Multiple Linear Regression



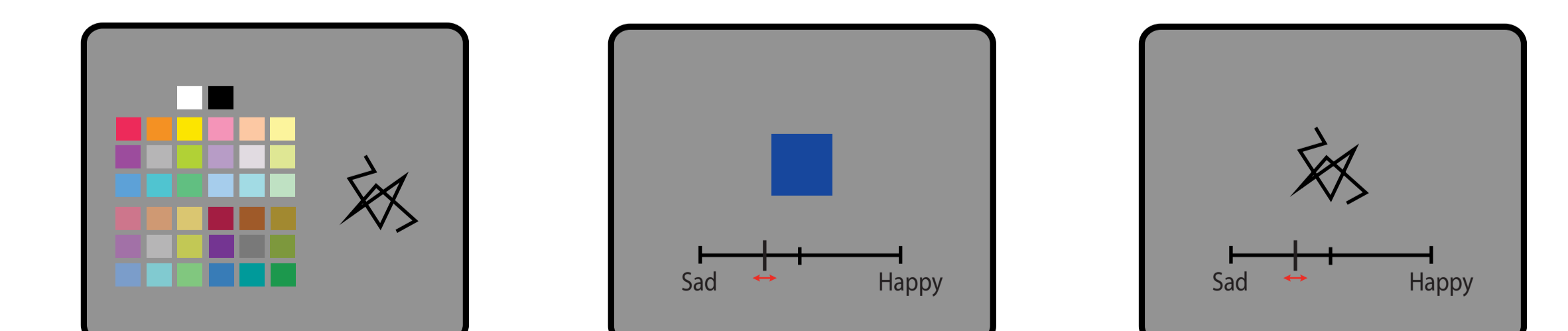
Conclusions

- Systematic associations between shapes and colors in non-synesthetes were confirmed.
- We investigated what **Shape Features** are mapped to what **Color Appearance Dimensions** specifically, and we found main effects of the curviness and closure of line-shapes in particular on the saturation and lightness of the associated colors.
- We further found support for the **Emotional Mediation Hypothesis**: line-shapes and colors picked to go together were associated with many overlapping emotions, which mainly reflect the Not-Angry/Angry emotional dimension. When making shape-to-color associations, subjects may evaluate the emotional content of the shape and then choose the colors that have a similar emotional content.

General Methods

Group 1 Participants: 44 non-syns., determined by synesthete.org

Shape-Color Associations **Color Emotional Ratings** **Shape Emotional Ratings**



Pick the 3 colors that are **most consistent** (and the 3 that are **most inconsistent**) with the shape in order (1st, 2nd, 3rd).

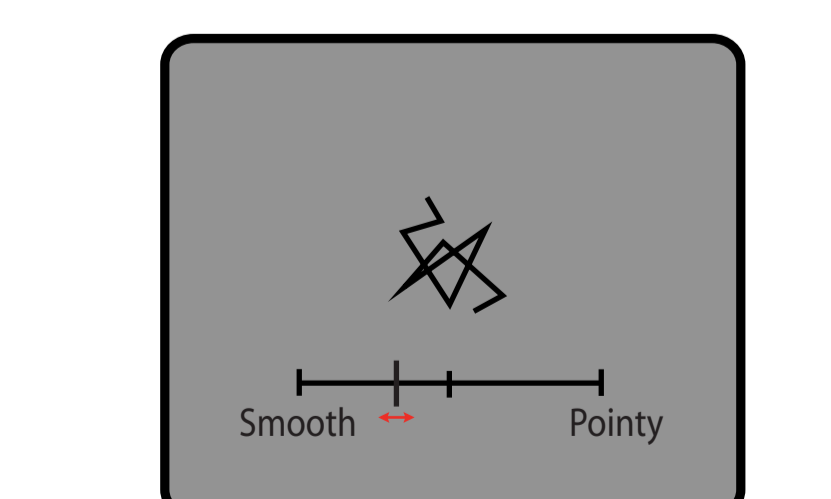
Rate each color/shape on 9 bipolar (emotional + other) scales:

Sad/Happy Passive/Active
Calm/Agitated Weak/Strong
Not-Angry/Angry Safe/Harmful

EMOTIONAL

Group 2 Participants: 20 non-syns.

Shape Appearance Ratings



Rate each shape on 5 bipolar perceptual scales:

Smooth/Pointy Asymmetric/Symmetric
Open/Closed Convex/Concave
Simple/Complex

PERCEPTUAL

References and Acknowledgements

- Albertazzi L., Da Pos O., Canal L., Micciolo R., Malfatti M., & Vescovi, M (2012). The Hue of Shapes. *Journal of Experimental Psychology: Human Perception and Performance*, 39, 37-47.
- Albertazzi L., Malfatti M., Canal L., Micciolo R. (in press). The Hue of Angles: Was Kandinsky right? Art and Perception.
- Palmer, S. E., Schloss, K. B., Xu, Z. R. M., & Prado-Leon, L. R. (2013). Music-color associations are mediated by emotion. *Proceedings of the National Academy of Sciences*, 110, 22, 8836-8841.
- Whiteford, K. L., Schloss, K. B., & Palmer, S. E. (2013). Music-Color Associations from Bach to the Blues: Emotional Mediation in Synesthetes and Non-synesthetes. Presented at the *13th Annual Meeting of the Vision Science Society*, Naples, FL, May 2013.

Acknowledgements: We thank Will Griscom (at UC Berkeley) and Kelly Whiteford (at University of Minnesota) for support throughout the development of the project.