

Introduction

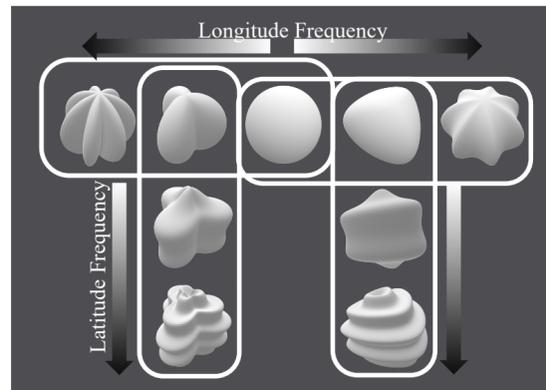
An object is perceived in both visual and haptic modalities through its sensory information. The present study aimed to investigate shape-color correspondence of a three-dimensional object. In Expt.1, we selected several hues that matched well with the shapes and explored the relationship between shape complexity and hue. In Expt.2, we examined whether shape complexity has a systematic relationship with saturation and luminance and whether the relationship depends on the modality of exploration (i.e., visual or visuo-haptic).

Experiment 1: Hue

Participants: 190 participants

Stimuli

- 3D visual stimuli: 3D shape models parametrically modulated in complexity were produced by Superformula [1] and presented visually through rotating video clips.
- Color palette: For each hue [2], color palettes were sparsely selected for luminance and saturation dimensions.



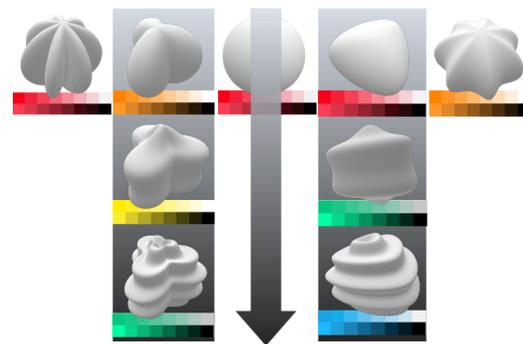
Task

Choose a color palette that best matches the 3D shape below.



- Participants chose from 8 color palettes the one that best matched the 3D shape.

Results



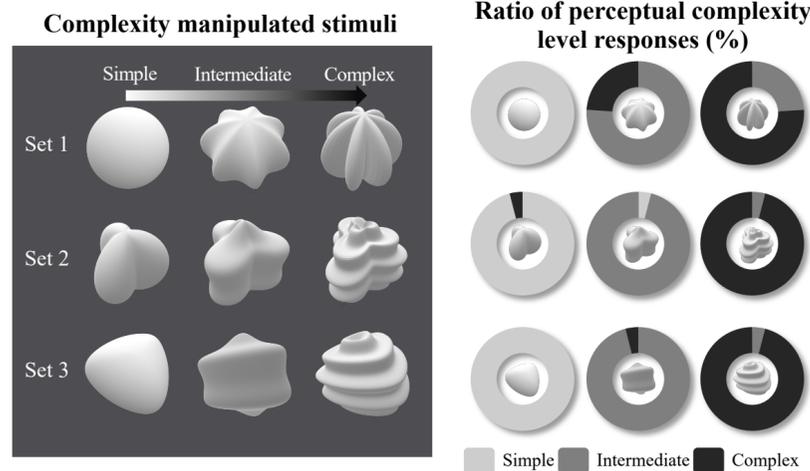
- As the complexity level increases in latitude, short-wavelength colors tend to be matched.

Experiment 2: Luminance & Saturation

Stimuli

Manipulation check survey (N=25)

- To confirm whether the stimuli's complexity was manipulated in line with perceptual complexity.
- Task: Listing the objects according to level of complexity in each set.



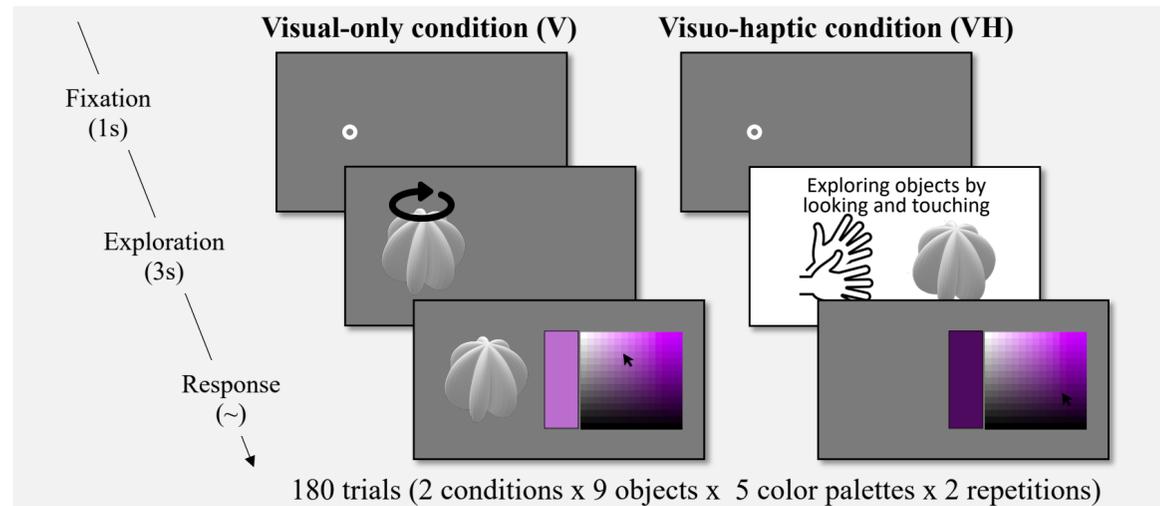
→ Three complexity sets were used in Expt. 2 based on the results.

- 3D visual stimuli: presented with a video clip of rotating white 3D objects.
- 3D haptic stimuli: printed in a white color using Stratasys' J750
- Color palette: 5 palettes consisted of saturation and luminance dimensions on HSV space for five hues selected from Expt. 1.

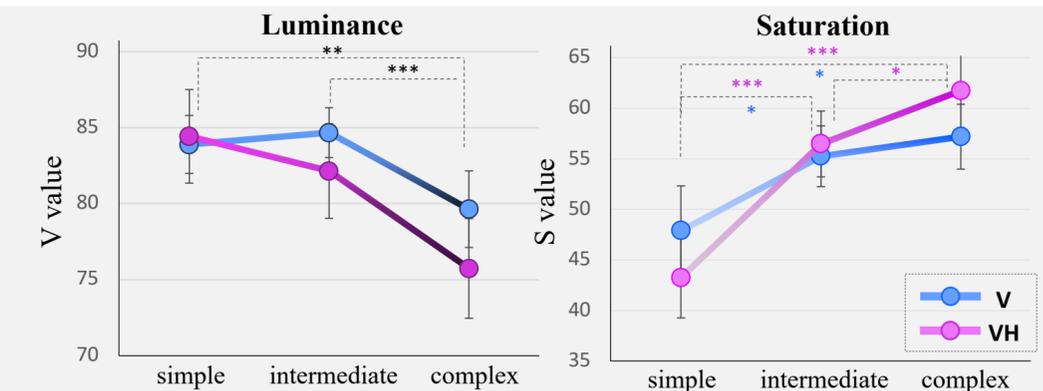
Participants : 26 participants

- Task** - Participants proceeded to pick a color that best matches each shape from the palette.

Procedures & Conditions



Results



- Luminance decreased, and saturation increased with increasing shape complexity (luminance, $F(2,50)=8.892, p < .001$; saturation: $F(2, 50)=14.739, p < .001$).
- The visuo-haptic condition elicited more pronounced modulation of luminance and saturation with increasing shape complexity. A condition x complexity interaction was statistically significant in Saturation ($F(2, 50)=6.432, p = 0.003$).

Conclusion

These results suggest that the complexity of shape has a non-arbitrary association with color in a 3D object. As shape complexity increased, short-wavelength colors tend to be matched. With increasing shape complexity, luminance decreases in an all-or-none fashion, whereas saturation increases gradually. Furthermore, our findings suggest that adding haptic exploration to visual exploration tightens the associations, with the pattern of shape-color correspondence maintained.

References & Acknowledgment

- [1] Gielis (2003). Am. J. Bot. 90(3), 333-338.
 - [2] Palmer & Schloss (2010). PNAS. 107(19), 8877-8882.
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