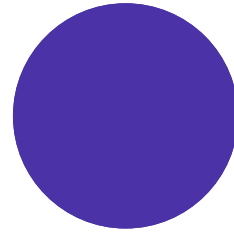
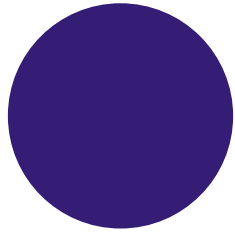
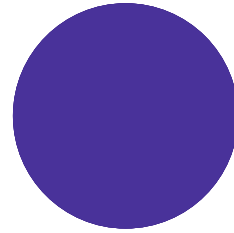
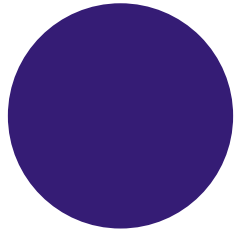


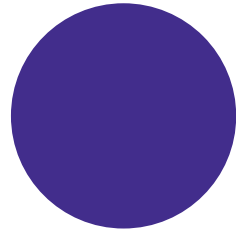
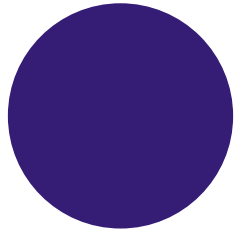
Modeling Color Difference for Visualization Design

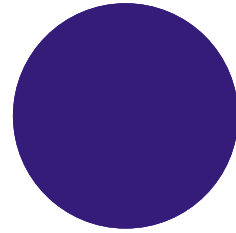
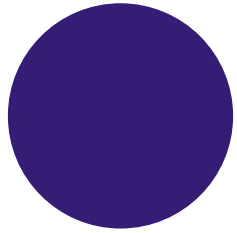
Danielle Albers Szafir
Proc. InfoVis 2017

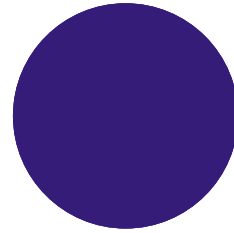
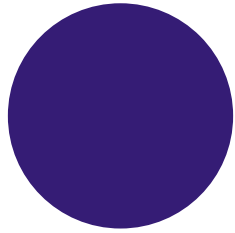
Are the colours the **same** or **different**?





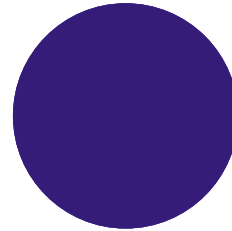
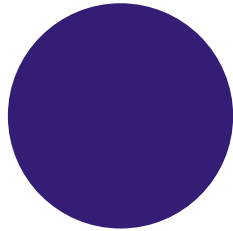




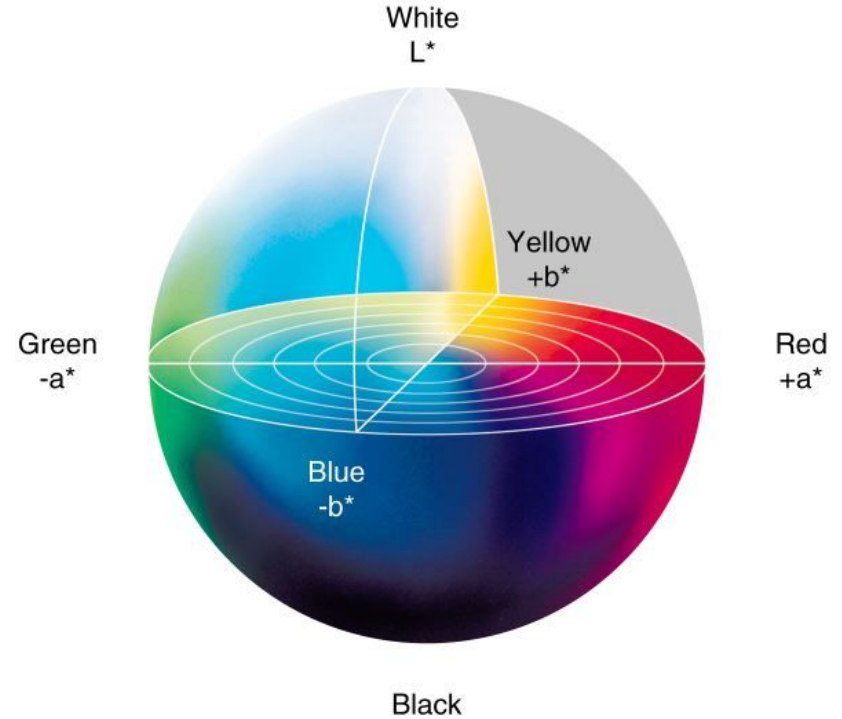
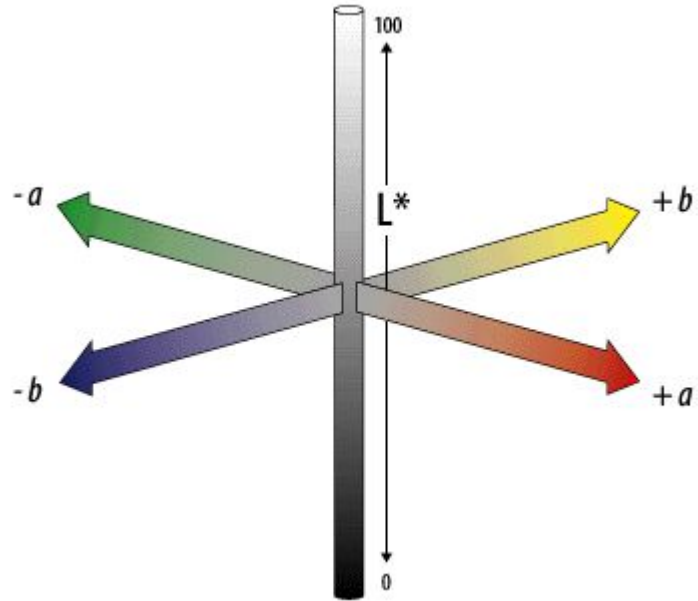


Just noticeable differences (JNDs)

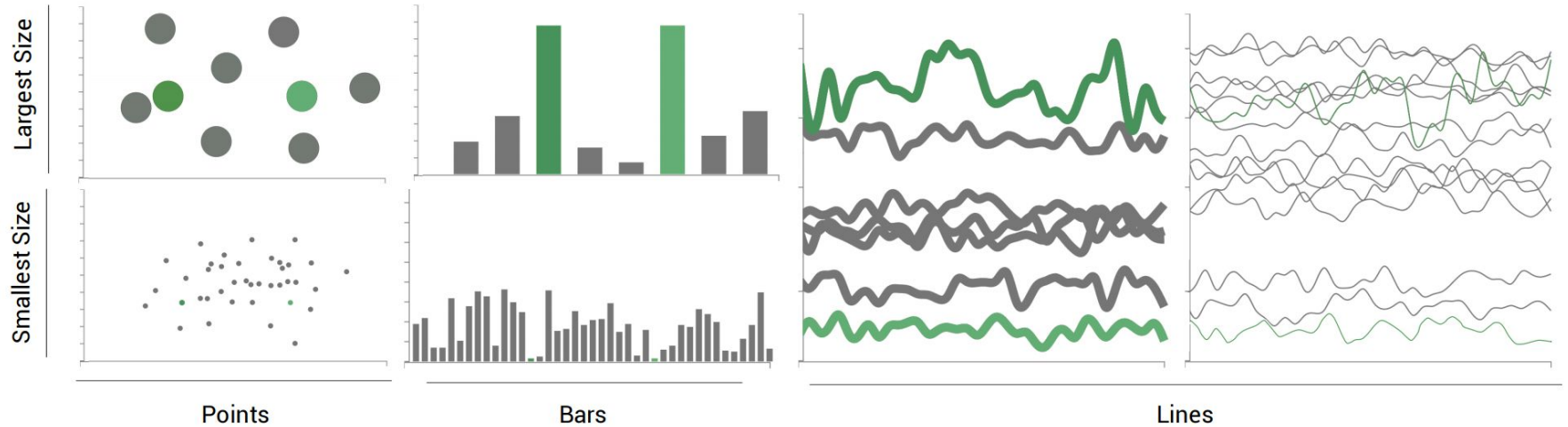
the point at which we can notice the difference 50% of the time



CIE L*A*B* colour space: perceptually equal steps



Visualizations are more complex



goal: build **qualitative understanding** of color perception in *visualization*

Assumptions

Simple World

Isolation

Geometric

Assumptions

Simple World

Isolation

Geometric

P011-U

Broodstock Conditioning and Larval Culture of the Yasha Goby *Stonogobiops yasha*

Laura Gaitan Daza¹, Anthony Stella¹, Laura Anderson¹, Bradford Bourque², Joe Szczepak³, Andrew Ruppel⁴,
Department of Biology and Marine Biology, Roger Williams University, Bristol, RI, USA¹; John H. Prescott Marine Lab, Anderson Cabot Center for Ocean Life, New England Aquarium, Boston, MA, USA²

INTRODUCTION

- The recent shift in aquaculture for ornamental fish species has opened new avenues for the broodstock and larval culture of ornamental fish, such as *Stonogobiops yasha*.
- Despite being an ideal candidate for the ornamental trade, *S. yasha* has not been cultured in captivity, and its life history is largely unknown.
- It is an excellent fish for hobby breeding of the Atlantic coast of North America.
- As far as we know, *S. yasha* has never been bred in captivity, and its life history is largely unknown.
- It is a species that is highly sought after by hobbyists in the United States, and its life history is largely unknown.

Broodstock Conditioning

- Broodstock conditioning is a variety of treatments that are used to prepare broodstock for spawning. It includes treatments such as photoperiod, temperature, and photoperiod.
- Photoperiod is the most important factor in broodstock conditioning.
- Temperature is the second most important factor in broodstock conditioning.
- Photoperiod is the most important factor in broodstock conditioning.

LARVAL REARING

- Eggs were collected by removing the ovaries from the female broodstock of the fish between 10:00 and 12:00 and placed in a 100% oxygenated water.
- The larvae hatched approximately at 8:00 AM of the next day after fertilization with highly abundant eggs and 100% survival.
- Photoperiod is an important factor in larval rearing in a density of 5-10 larvae per liter.

JUVENILE GROW OUT

- Survival was around 100% for larvae up to 10 days.
- Survival was around 100% for larvae up to 10 days.
- Survival was around 100% for larvae up to 10 days.

ACKNOWLEDGMENTS

Questions that remain: How long do I need to condition the broodstock? What is the best way to condition the broodstock? Can the larvae be reared in commercial quantities for the hobby market?

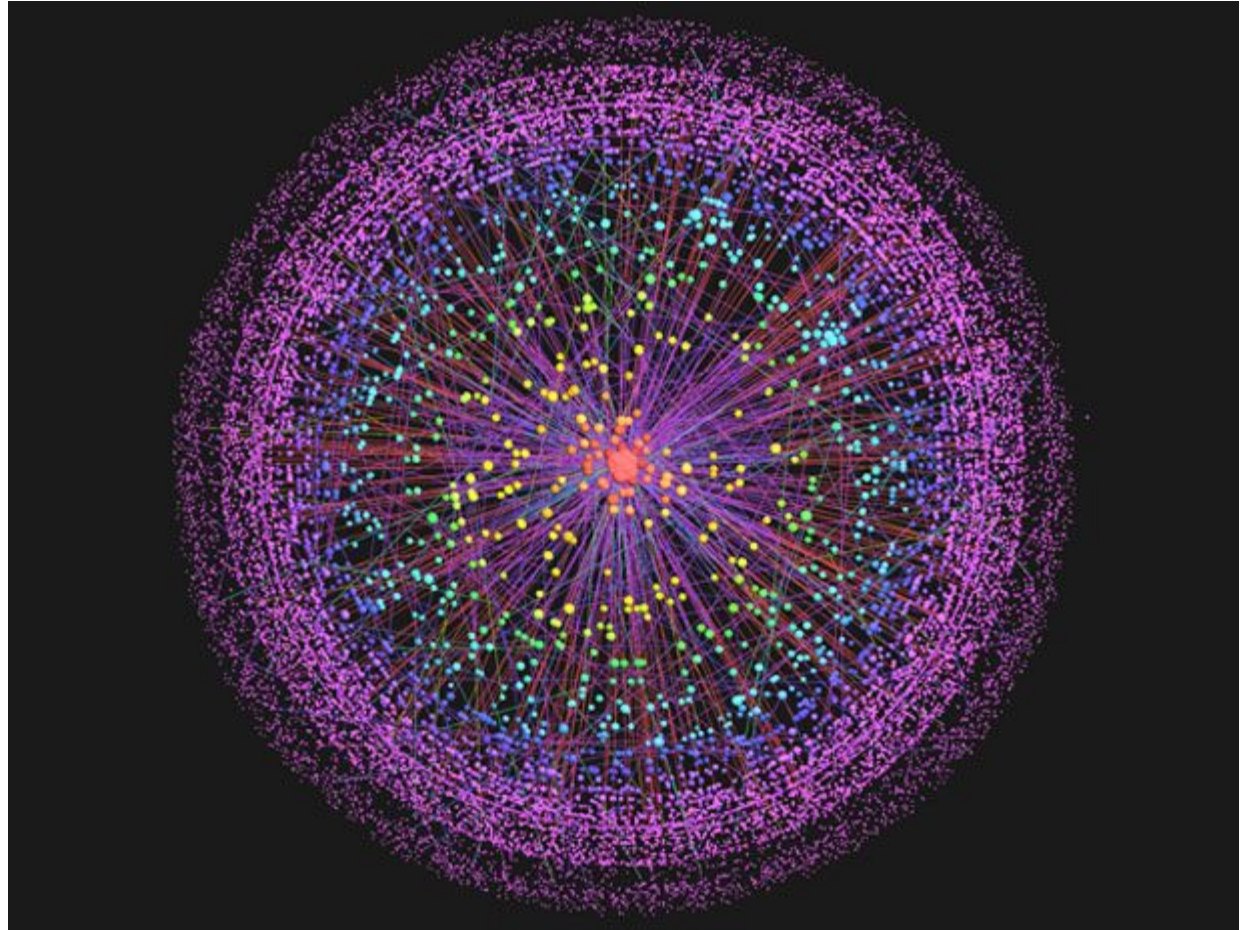
1. Gaitan Daza, L., Stella, A., Anderson, L., Bourque, B., Szczepak, J., Ruppel, A., Prescott, J. H. (2023) Broodstock Conditioning and Larval Culture of the Yasha Goby *Stonogobiops yasha*. *Journal of Applied Aquaculture*, 35(1), 1-10.

Assumptions

Simple World

Isolation

Geometric



Solution

Simple World

crowdsource

Isolation

Geometric



Solution

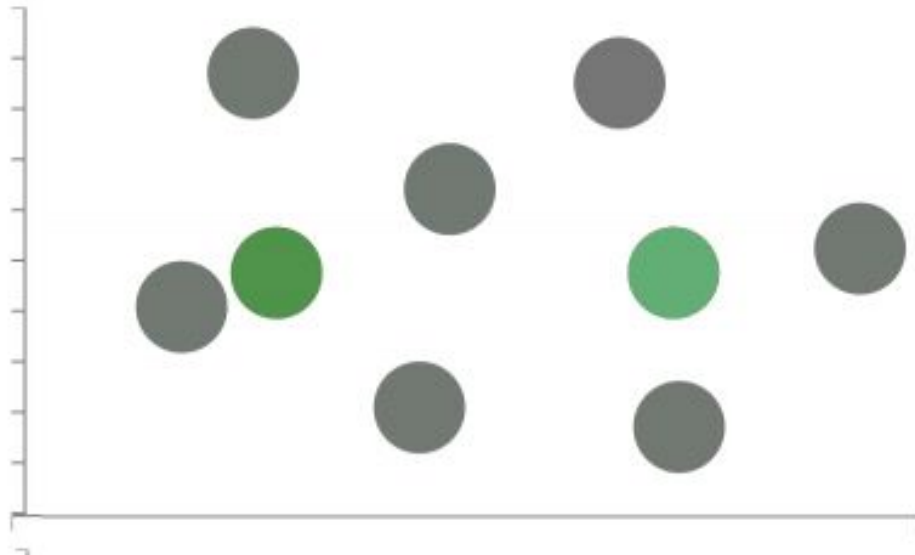
Simple World

Isolation

Geometric

crowdsource

distractors



Solution

Simple World

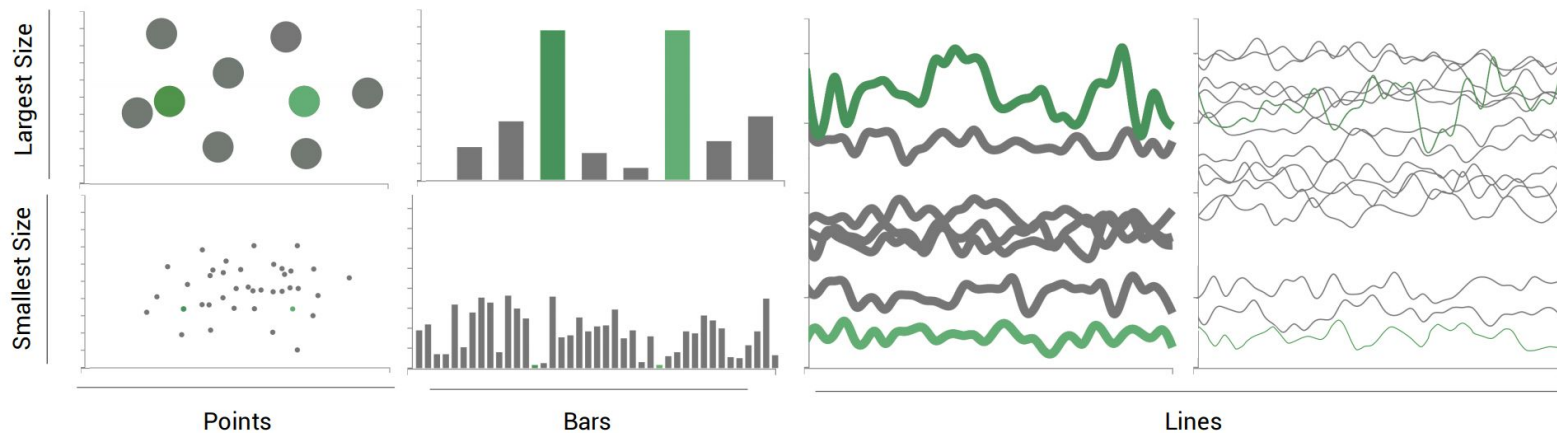
crowdsource

Isolation

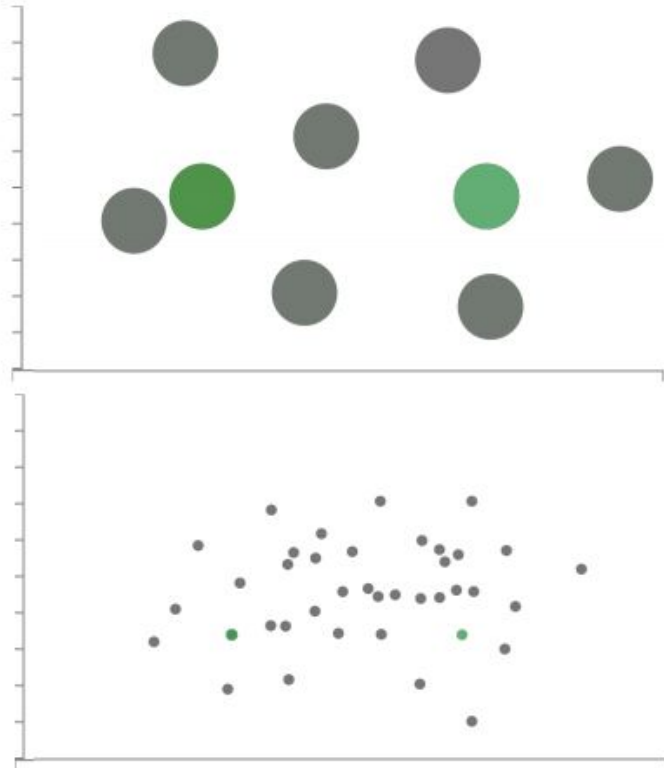
distractors

Geometric

varied mark shape, size



Scatterplots



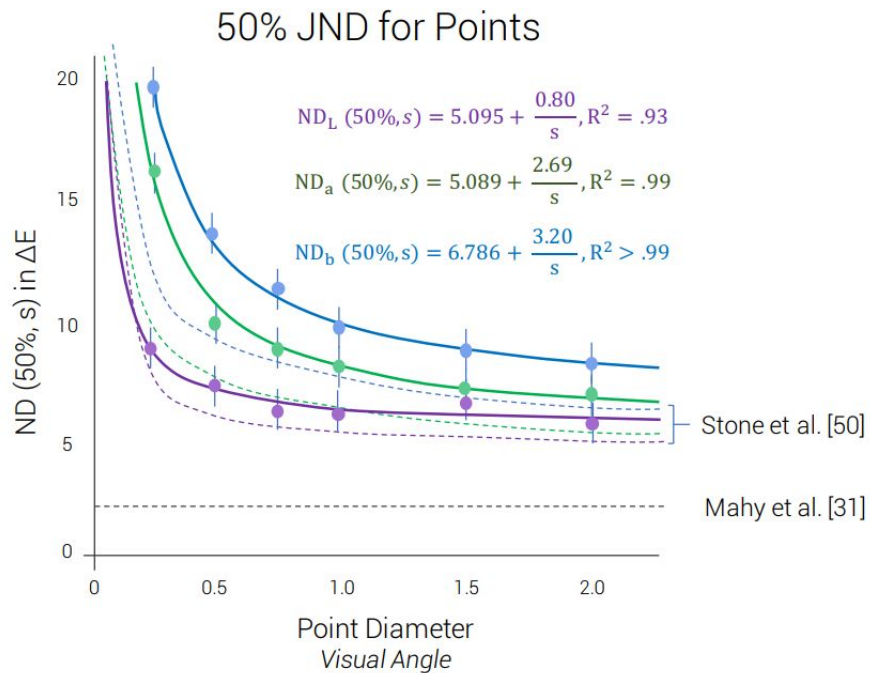
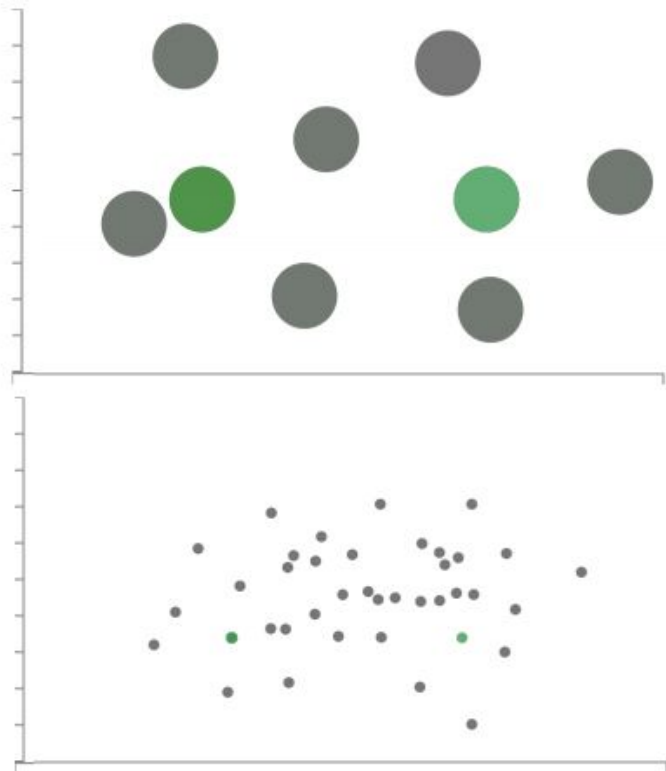
72 participants

factors:

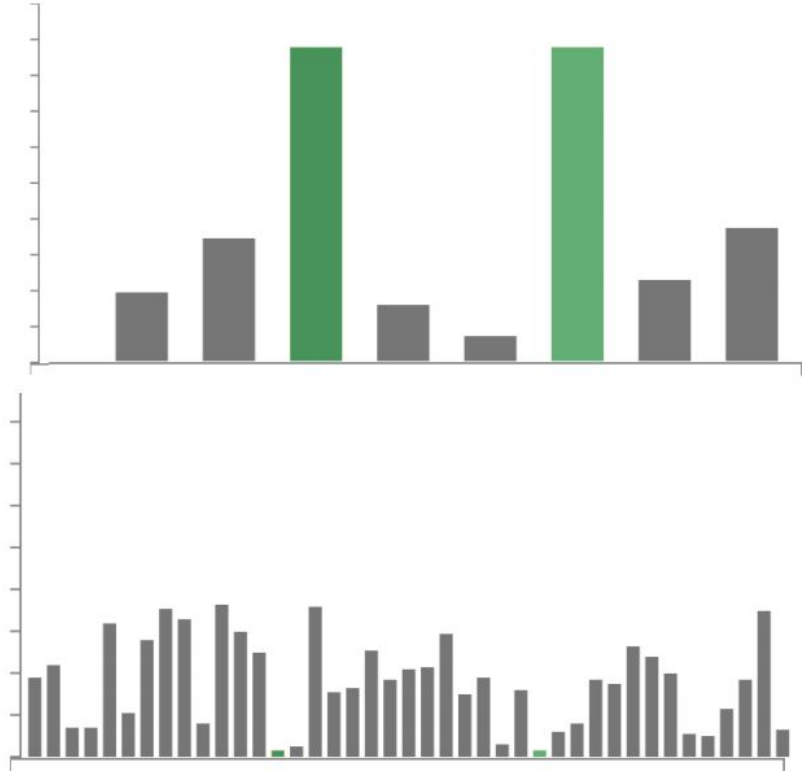
- 6 diameters ×
- 6 color differences ×
- 3 color axes

each participant saw each diameter ×
color difference twice

Scatterplots



Bar charts

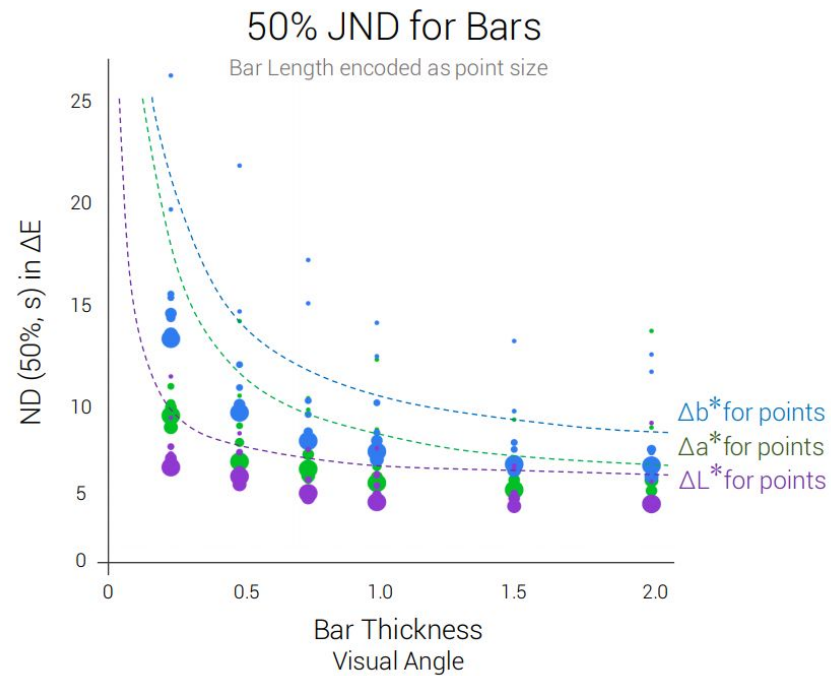
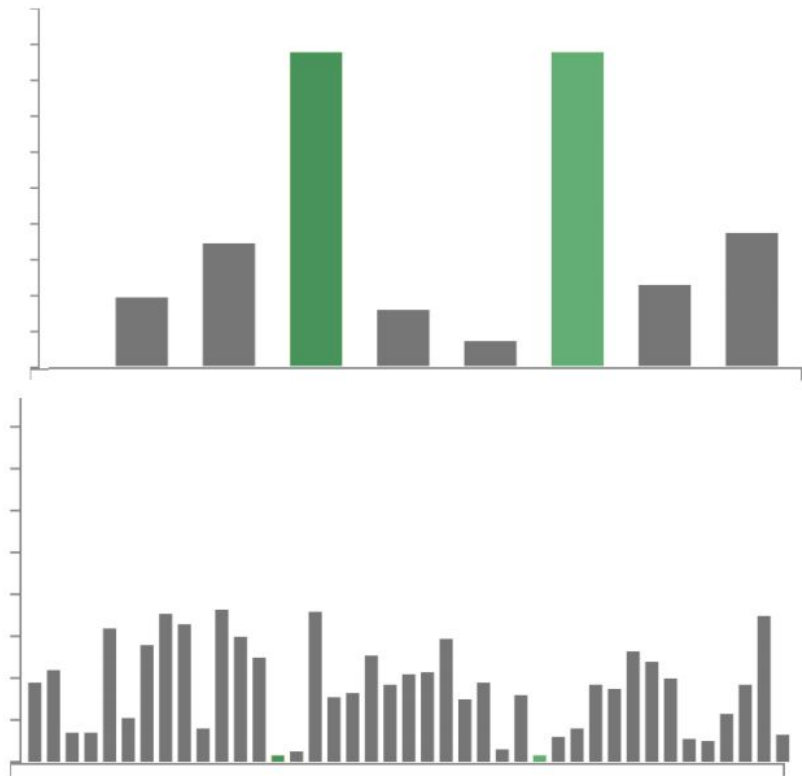


288 participants

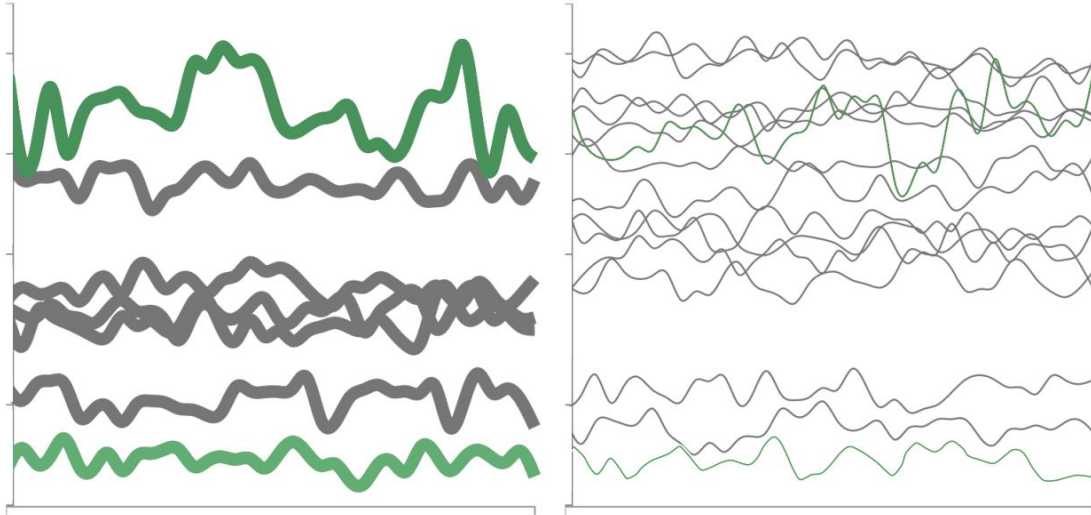
factors:

- 6 thicknesses ×
- 8 lengths
- 6 color differences ×
- 3 color axes

Bar charts



Line graphs

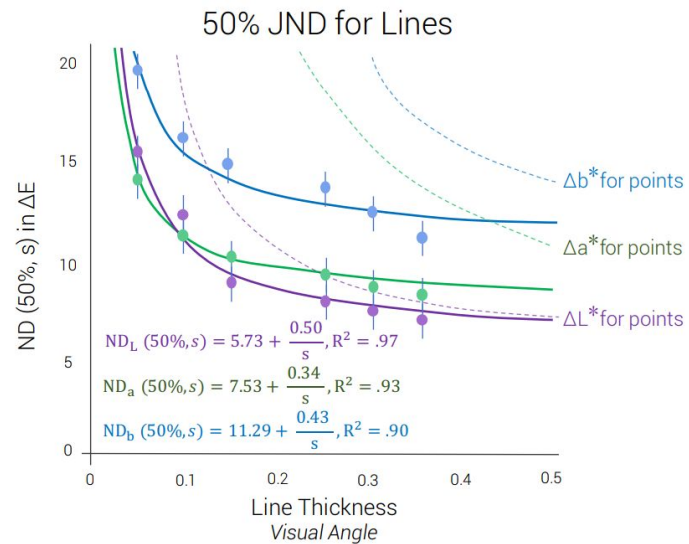
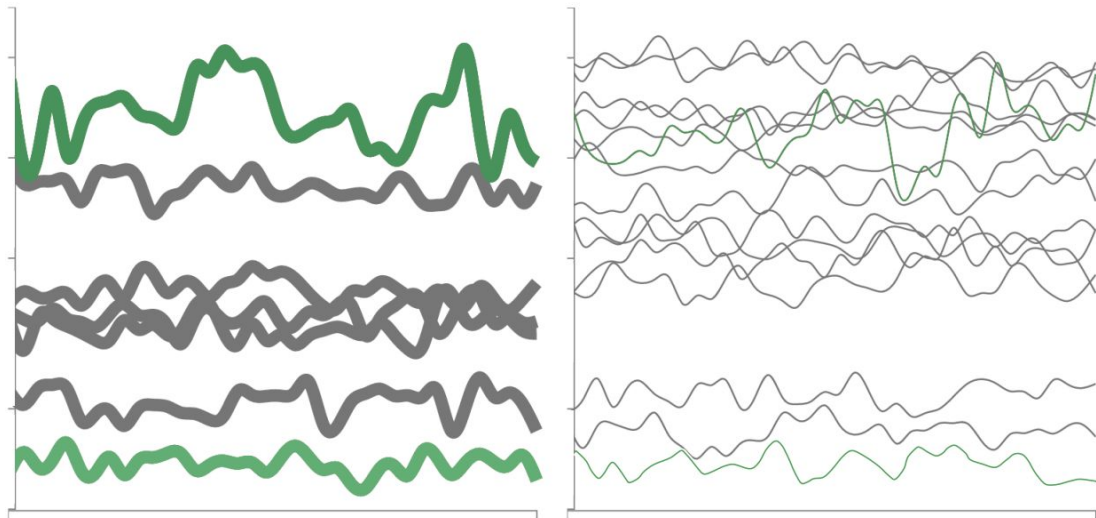


72 participants

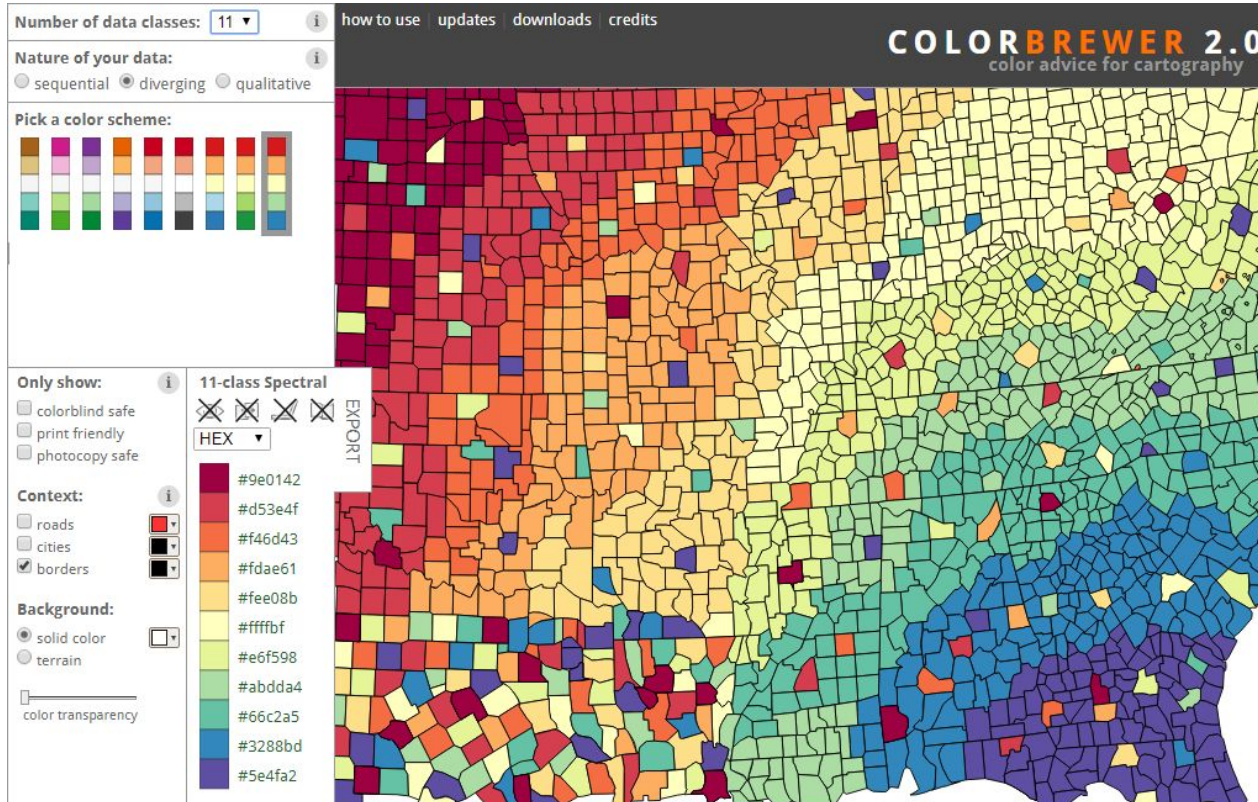
factors:

- 6 thicknesses ×
- 6 color differences ×
- 3 color axes

Line graphs



ColorBrewer



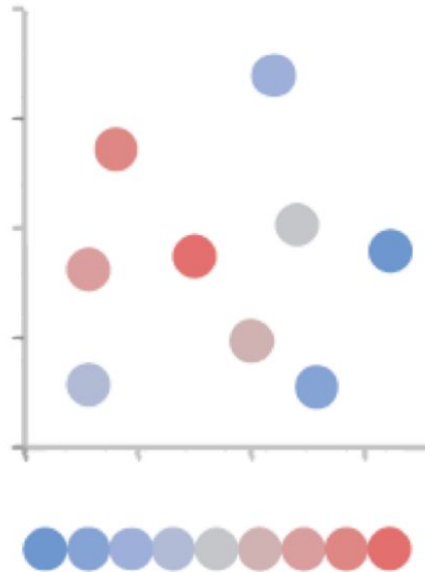
not robust to smaller
mark sizes!

Applications

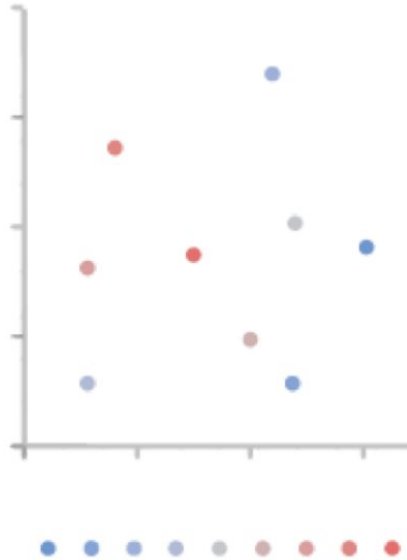


Applications

Large Points

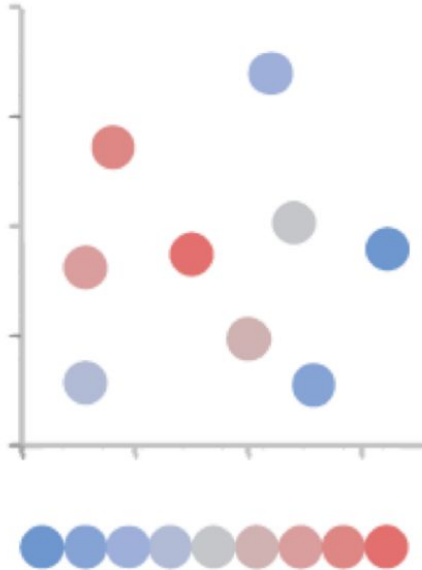


Small Points

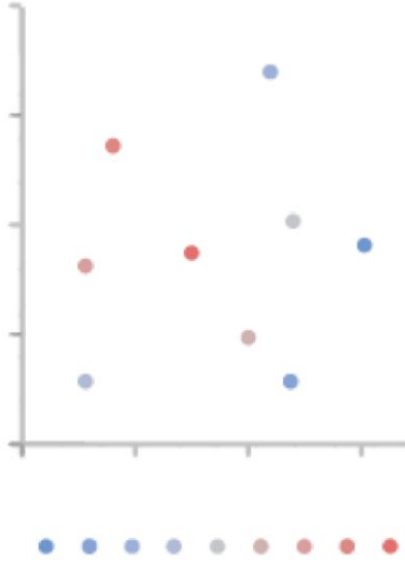


Applications

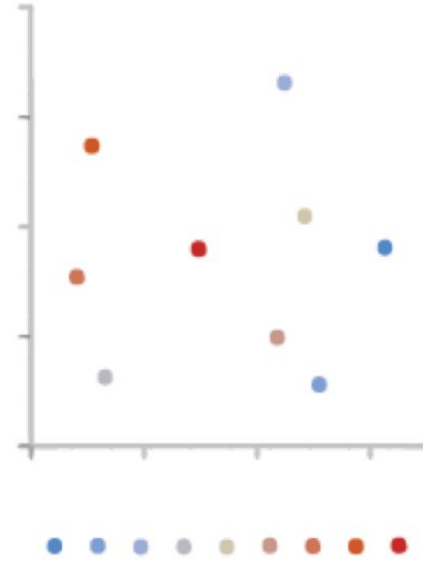
Large Points



Small Points



Boosted
Small Points



Limitations

Author:

- only two marks were coloured - contrast differences absent
- marks tested at fixed distances and aligned

Limitations

Author:

- only two marks were coloured - contrast differences absent
- marks tested at fixed distances and aligned

Amon:

- colour distance ΔE in CIEL*a*b* space is non-uniform to begin with
- rather than overfit to CIEL*a*b*, start with a raw colour space
- staircase method to sample more data around JND

Thanks!

paper page: <http://cmci.colorado.edu/visualab/VisColors/index.html>