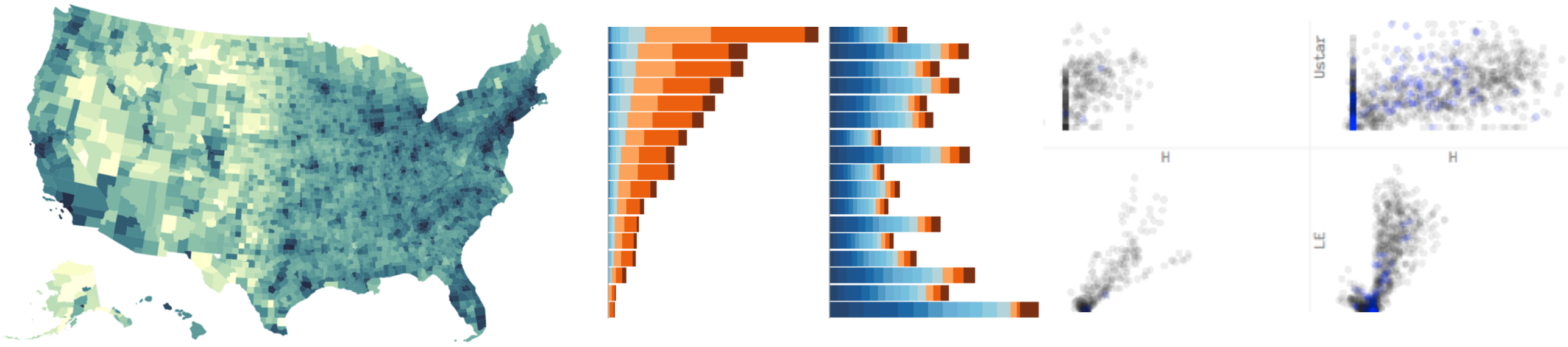


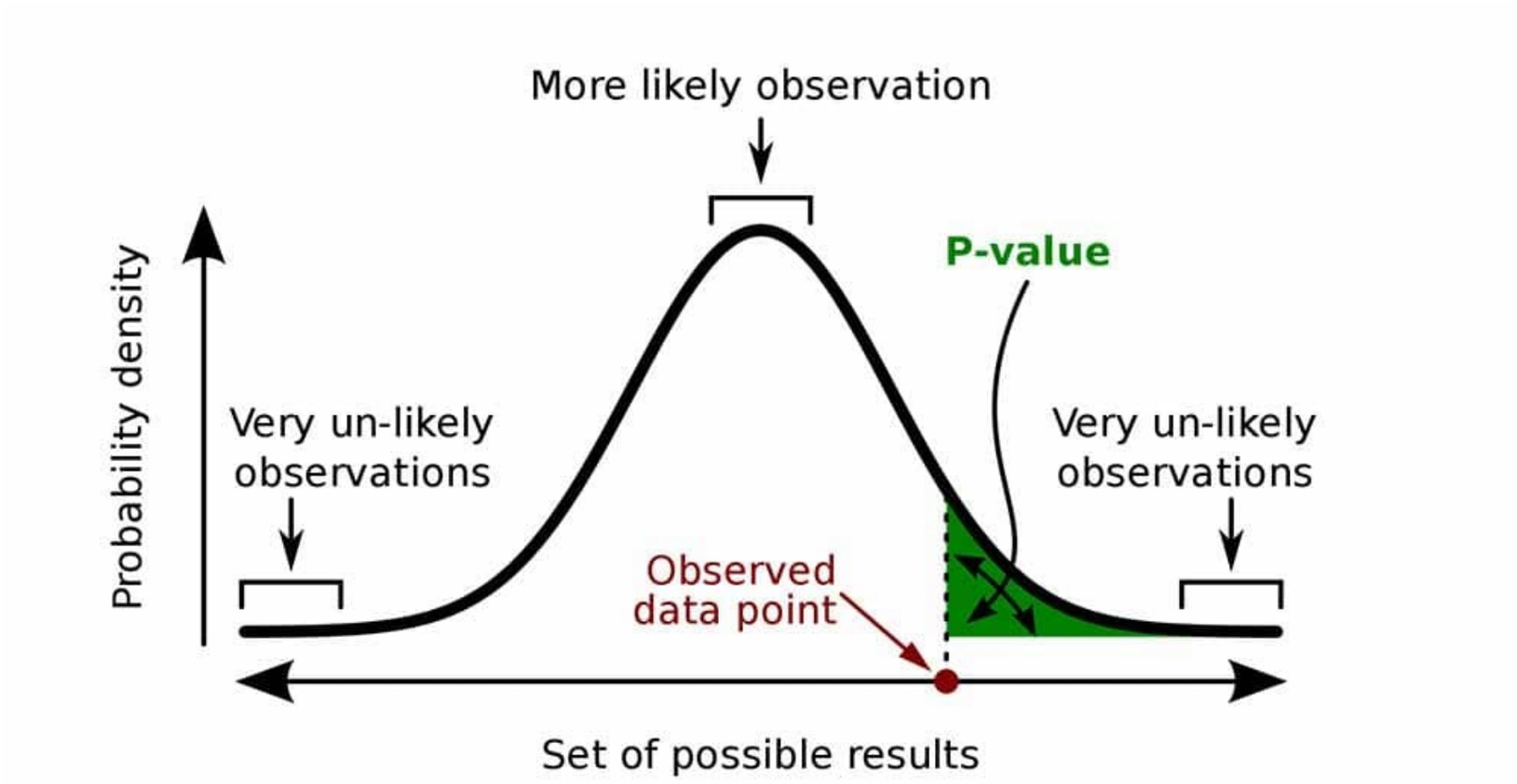
CS 526 Computer Graphics II

Graphical Inference & applications to Vis evaluation

Khairi Reda | redak@uic.edu
UIC CS

How do you know that you're looking at "noise", as opposed to a true data signal?

Statistics

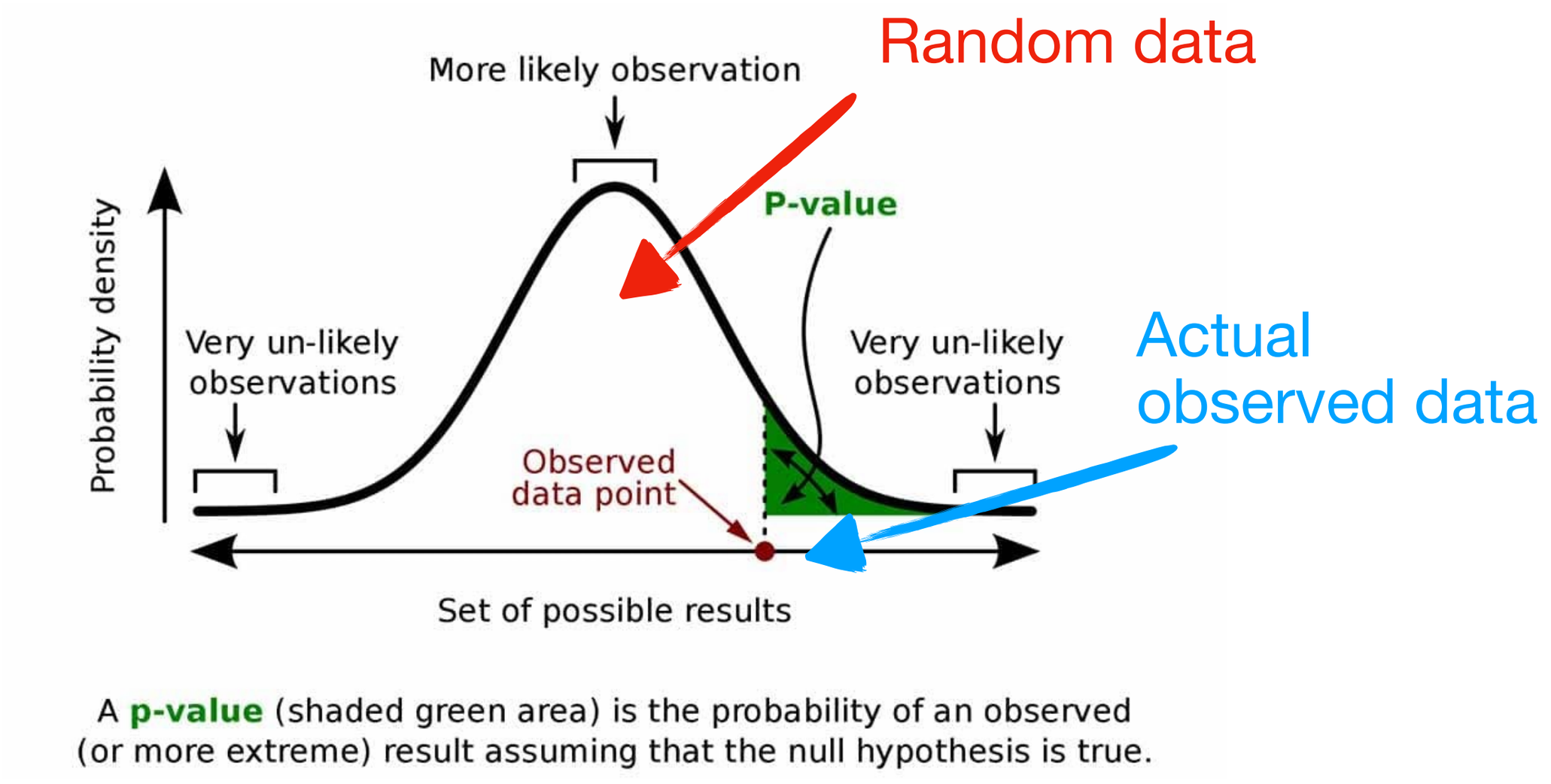


A **p-value** (shaded green area) is the probability of an observed (or more extreme) result assuming that the null hypothesis is true.

From SimplyPsychology

How do you know that you're looking at "noise", as opposed to a true data signal?

Statistics

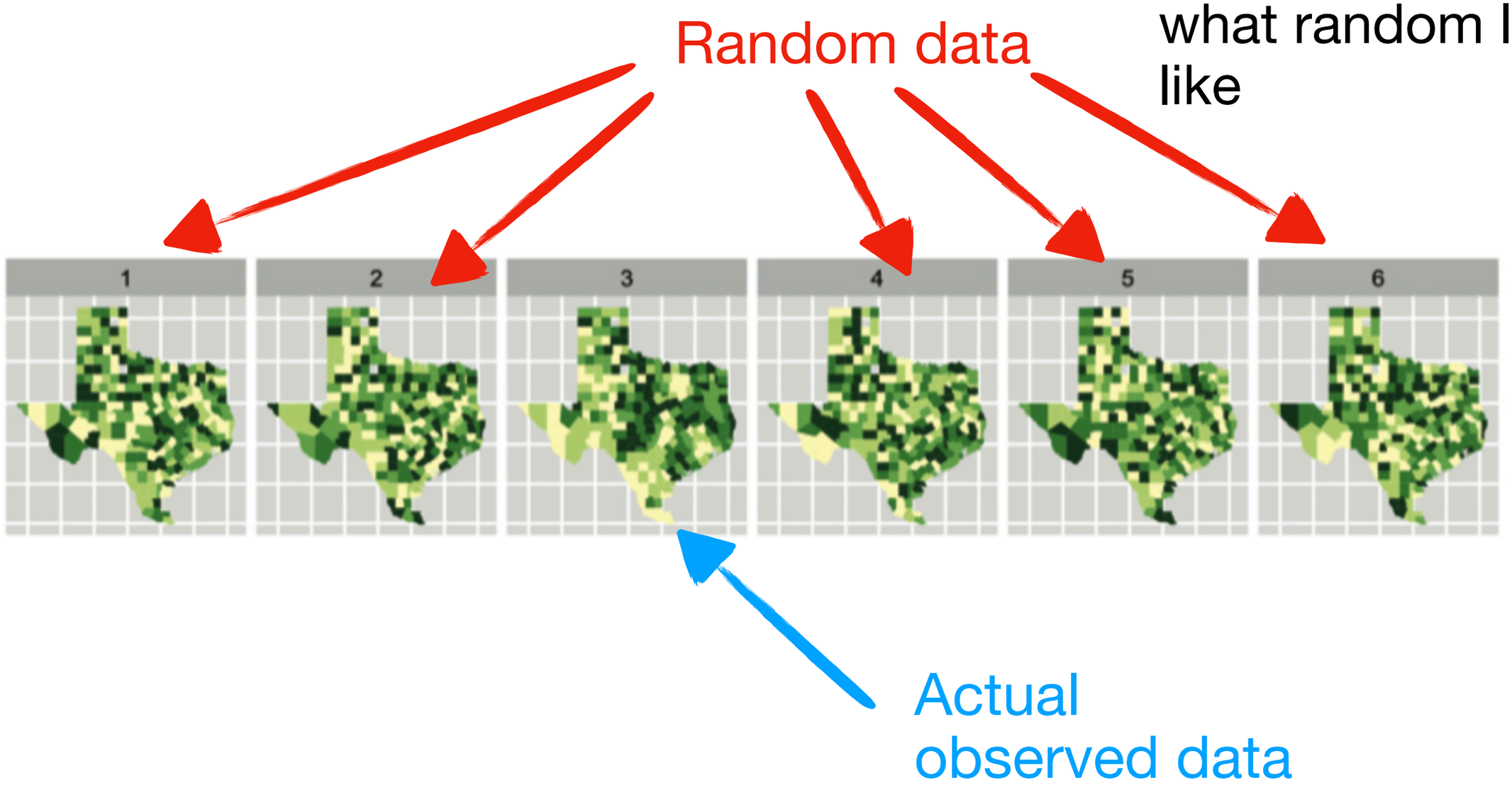


From SimplyPsychology

How do you know that you're looking at "noise", as opposed to a true data signal?

What about in visualization?

Need to defined what random looks like



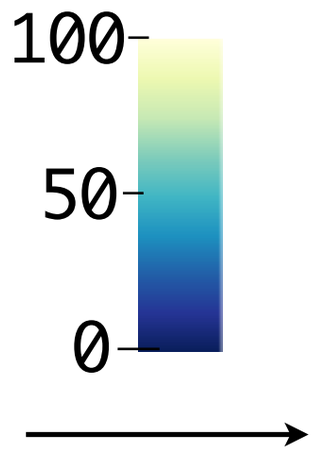
This approach can be used to evaluate visualization designs

Visualizations that afford better ability to detect true signal from “noise” are said to provide higher power

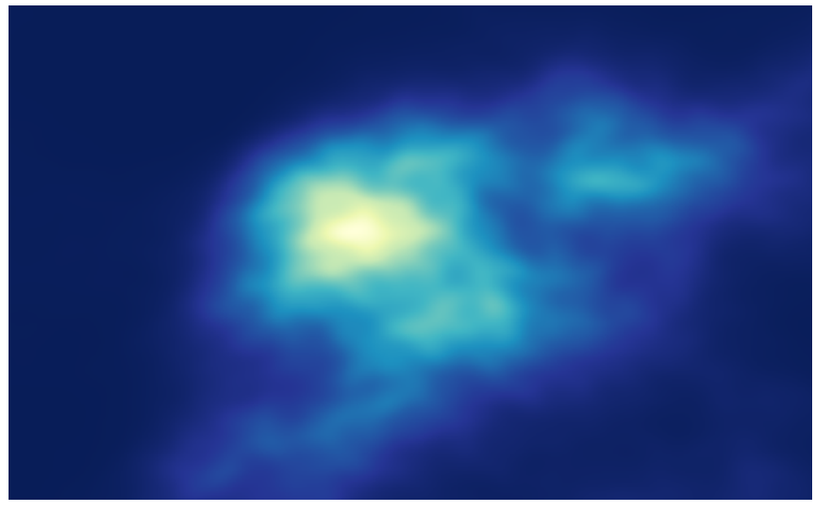
Evaluating colormaps for “graphical inference”

1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	1	2	2	3	6	6	4	2	2	4
0	0	0	0	0	0	4	8	18	15	15	19	26	16	11	10	9
0	0	0	0	1	14	31	44	51	50	33	28	35	36	32	19	8
1	1	1	1	6	34	66	80	73	52	26	30	30	29	19	12	7
1	1	1	2	10	30	65	79	70	52	39	26	18	13	11	3	3
0	0	0	2	14	28	42	44	47	56	55	29	20	14	7	2	1
0	0	0	2	7	13	19	31	39	37	33	22	15	9	5	2	1
0	0	0	2	7	12	16	27	30	19	10	8	6	4	2	4	3
0	0	1	5	12	20	21	22	11	7	5	3	2	3	3	5	2
0	0	1	6	11	12	14	9	4	3	2	3	5	5	4	6	4

scalar field



color map

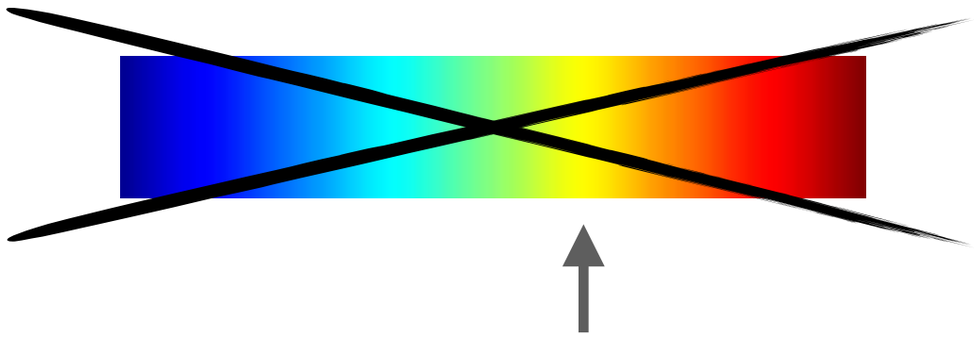


Color encoding guidelines

Smooth & perceptually uniform

viridis

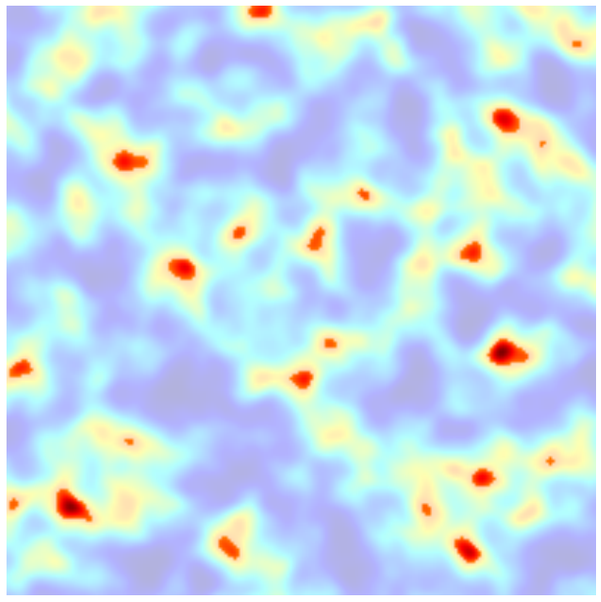
No **color bands**



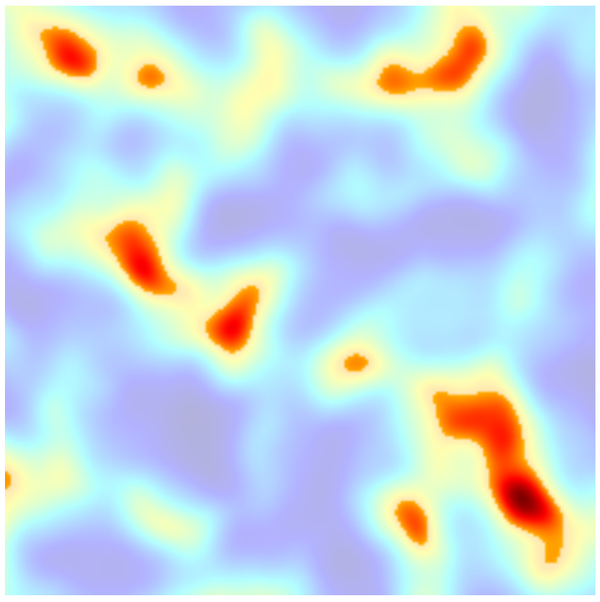
jet

Hypothesis: **color categorization helps** in tasks requiring inference across multiple percepts

Color segments aid the visual system in extracting summary ensemble statistics

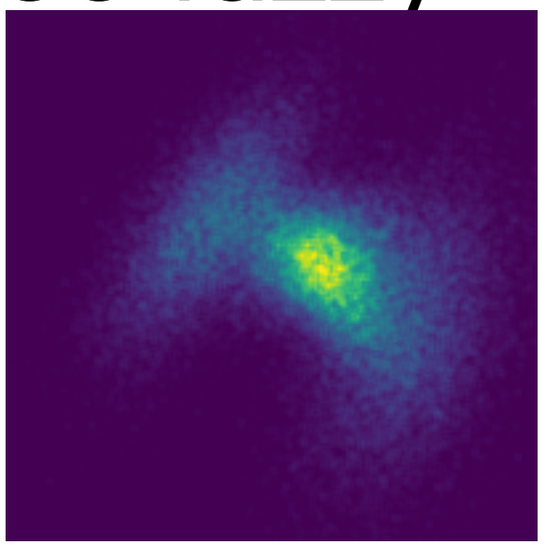


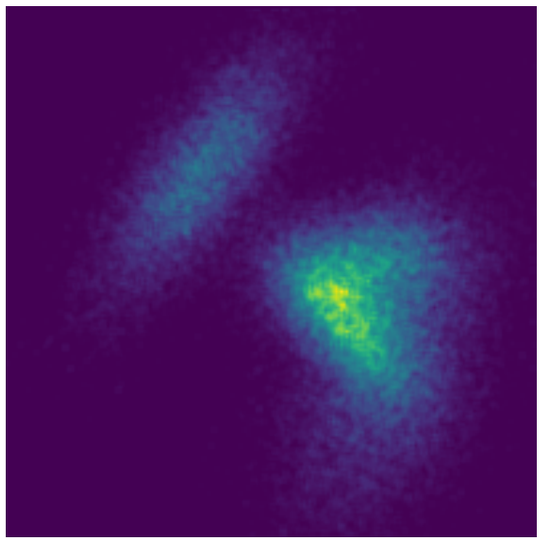
>



Hypothesis: **color categorization helps** in tasks requiring inference across multiple percepts

Color segments help compare features that might otherwise be too fuzzy

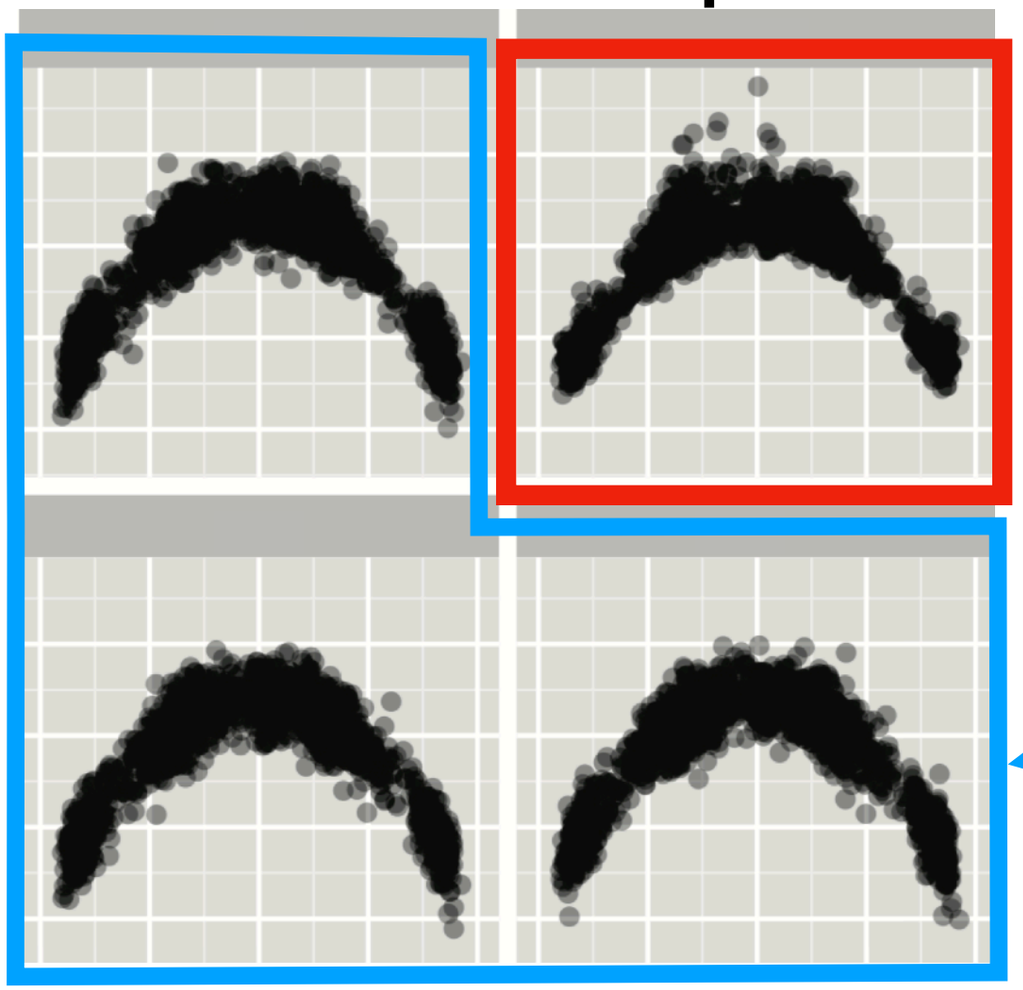




Model task: Graphical inference

Model task: Graphical inference

Which of the plots does *not* belong?



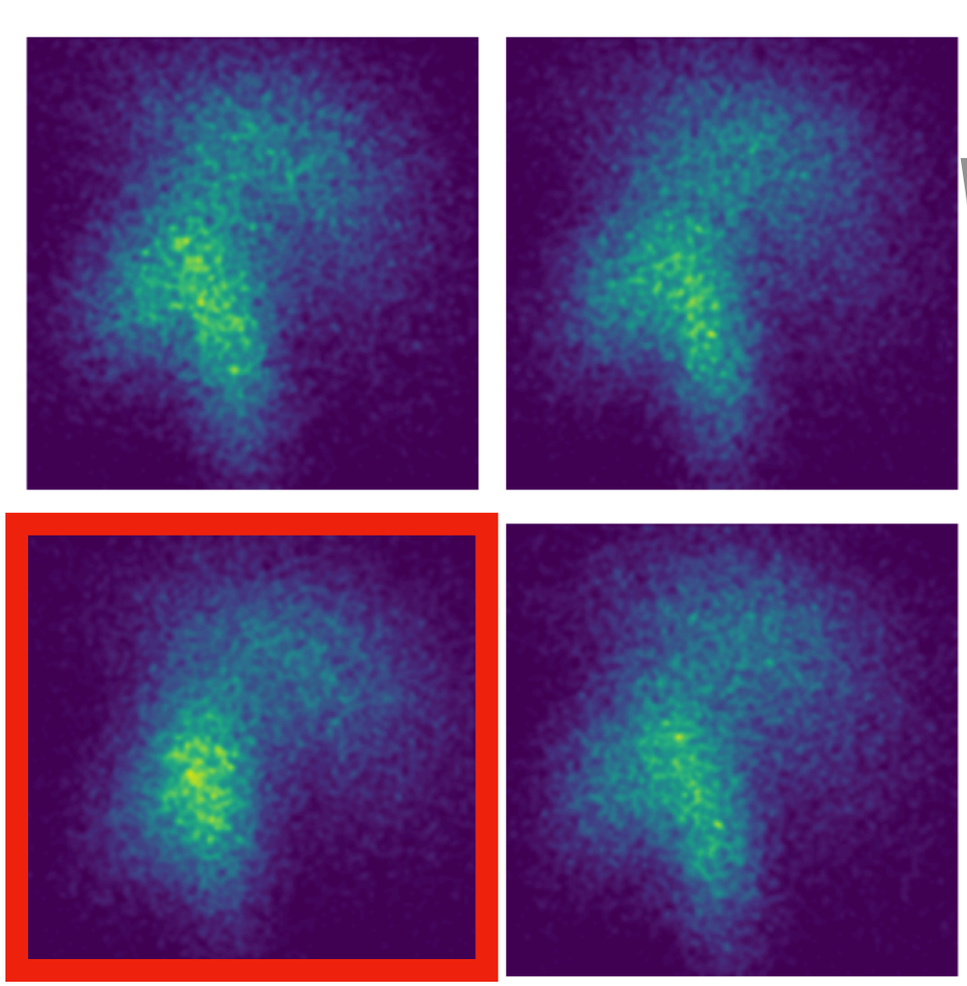
Model 1:
"Target"

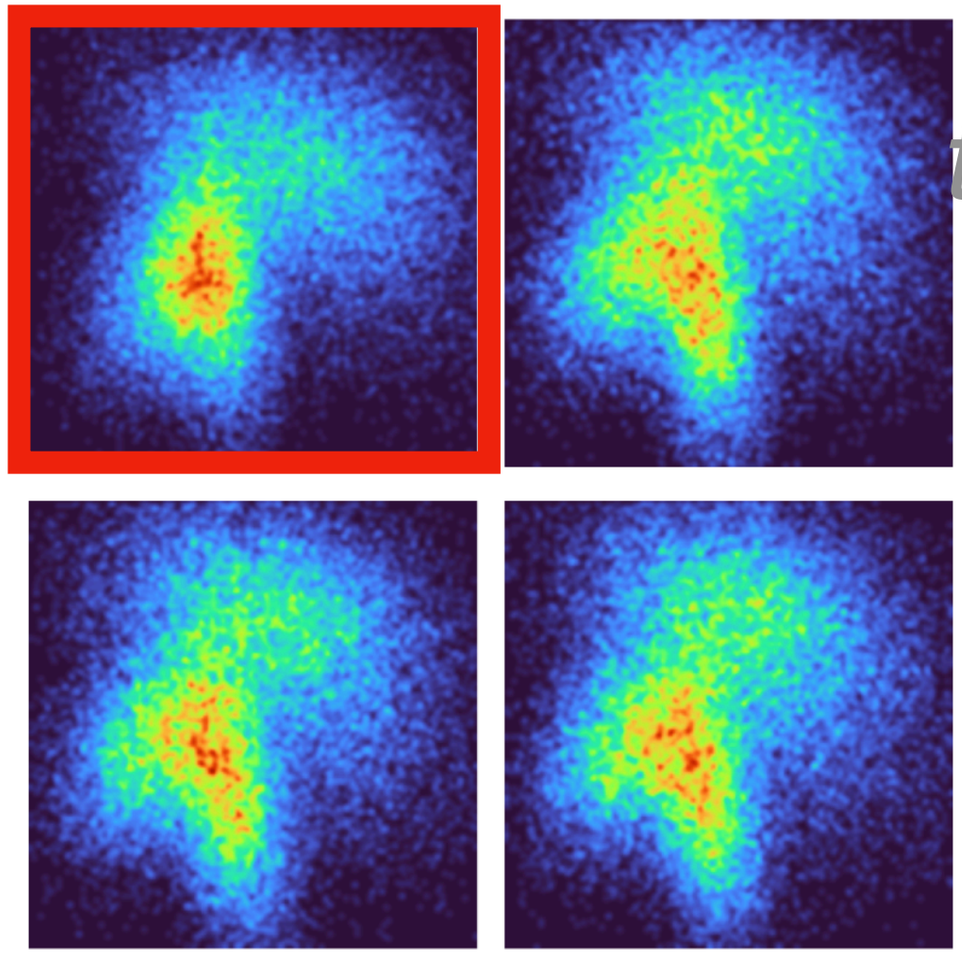
Model 2:
"Decoy"

[Buja et al., 2009]
[Wickham et al., 2010]

Model task: Graphical inference

Which of the plots does *not* belong?

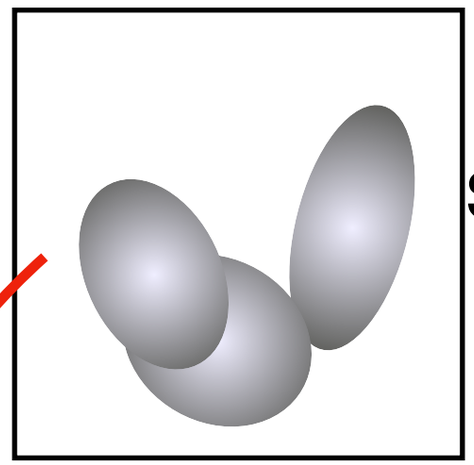


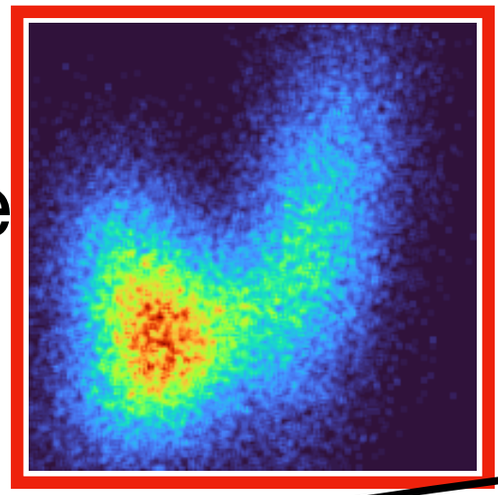


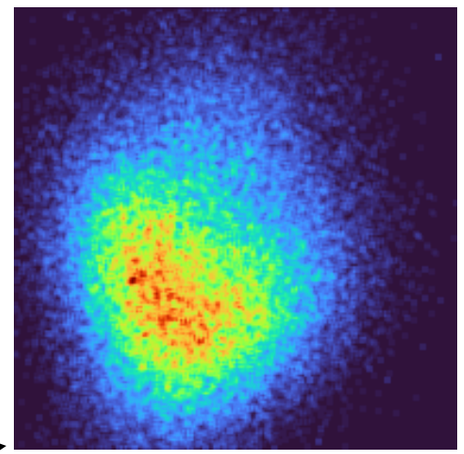
Target model

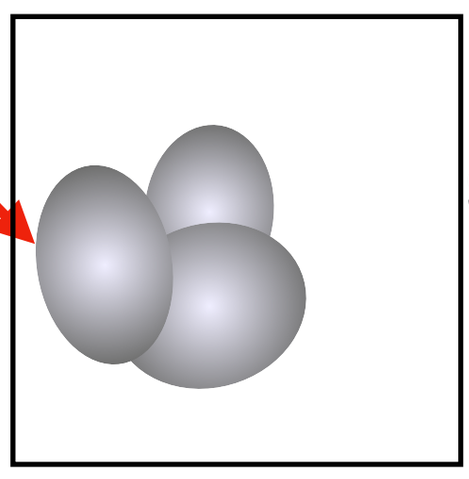
perturb Gaussians

sample

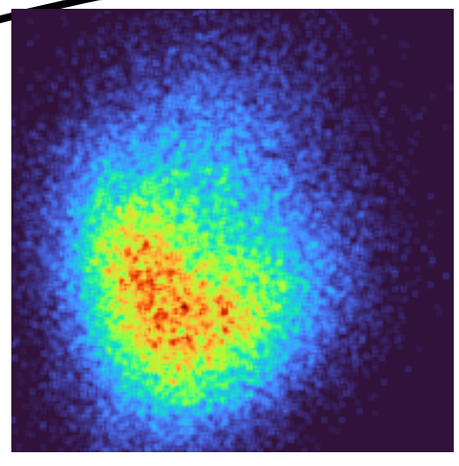


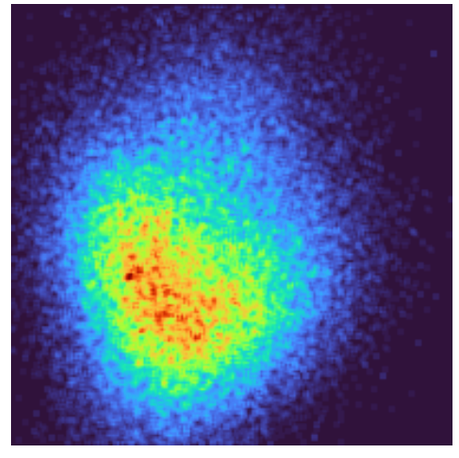






sample

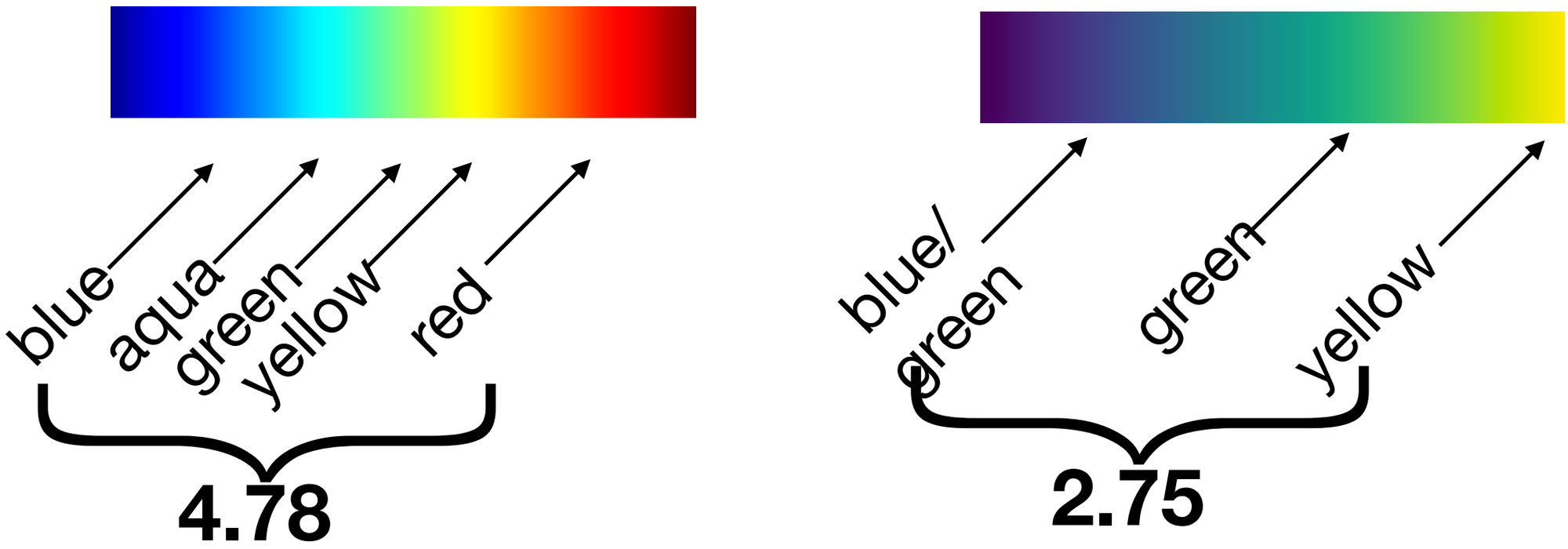


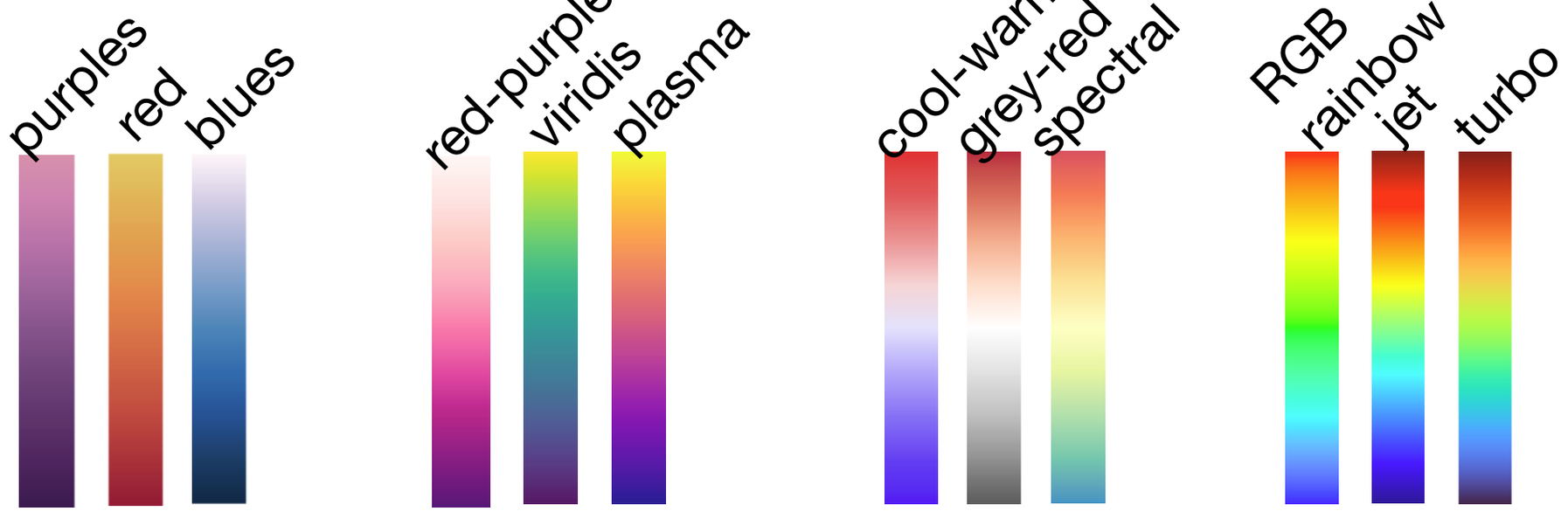


Decoy model

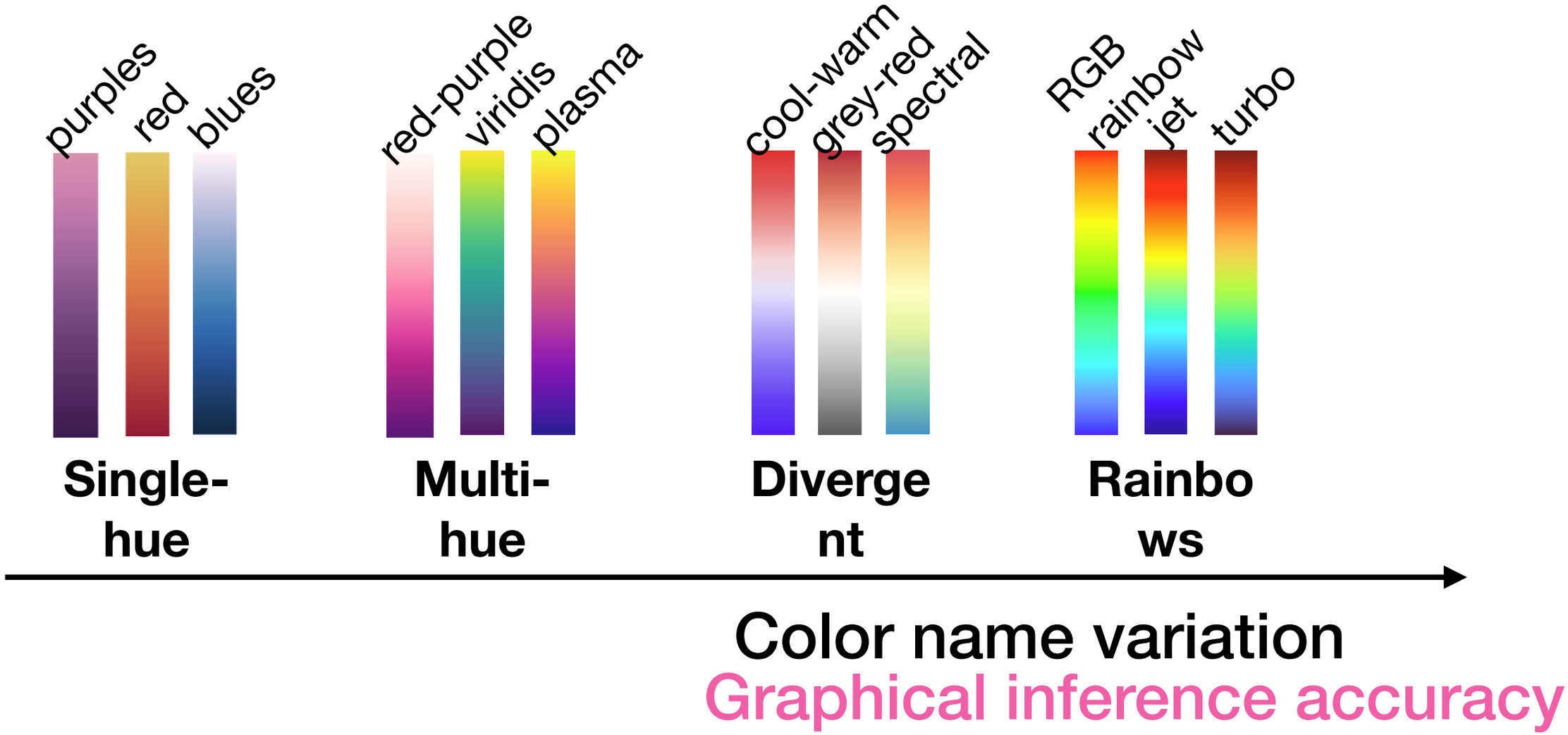
Measuring color categorization tendency

Color name variation: count the number of distinct color names in a continuous ramp [Heer & Stone]




purples
red
blues
red-purple
viridis
plasma
cool-warm
grey-red
spectral
RGB
rainbow
jet
turbo
Single-hue
Multi-hue
Divergent
Rainbows

H1: colormaps with **higher name variation**
will enable more accurate graphical inference



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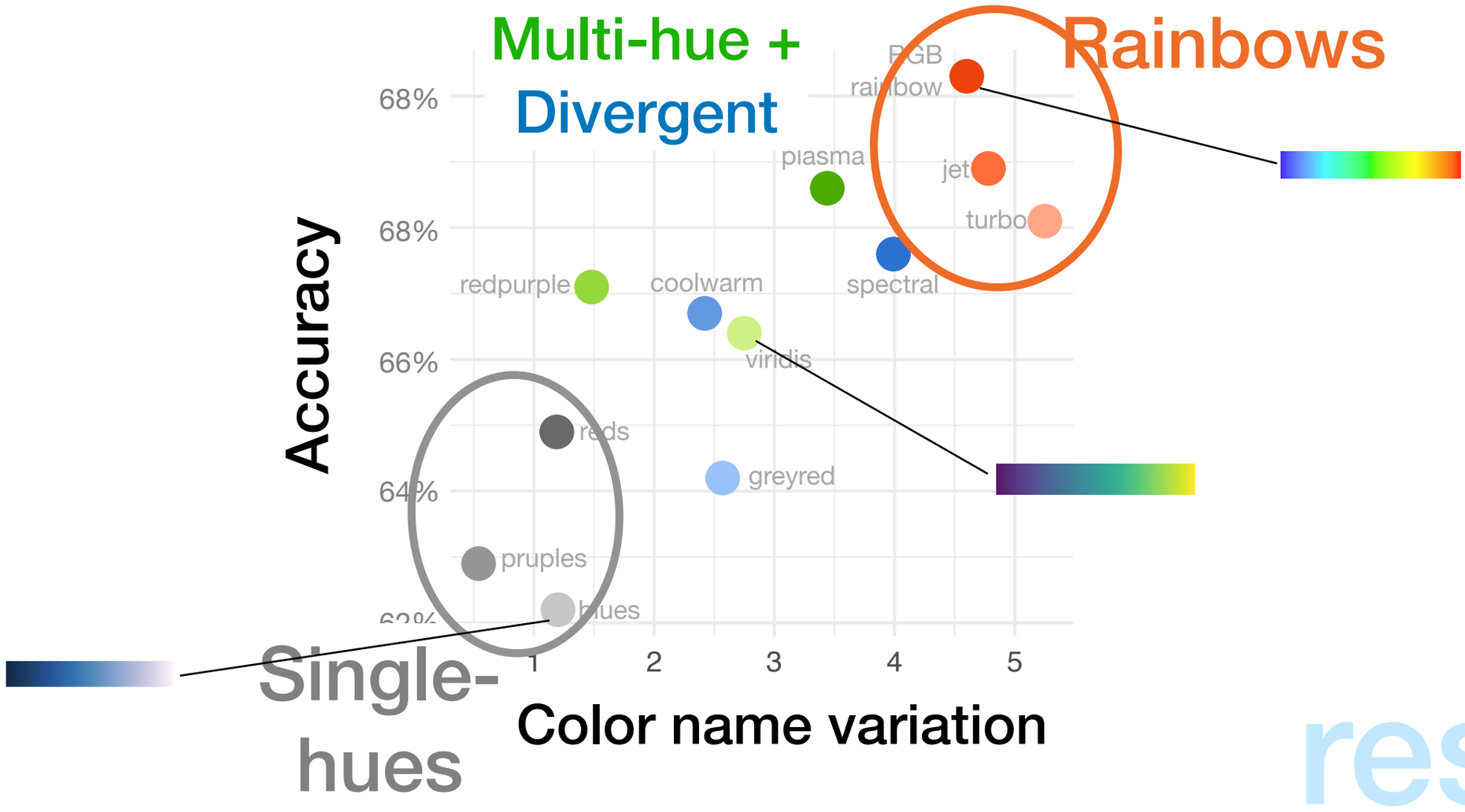
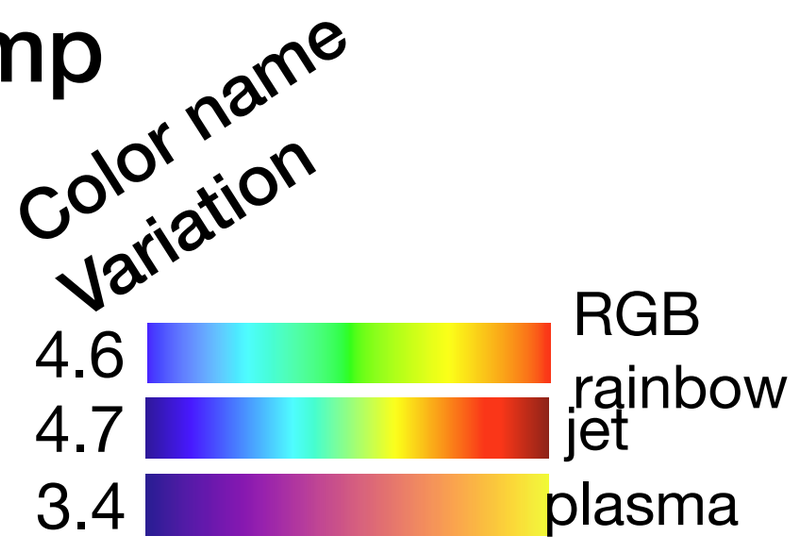


results

H1: colormaps with **higher name variation** will enable more accurate graphical inference

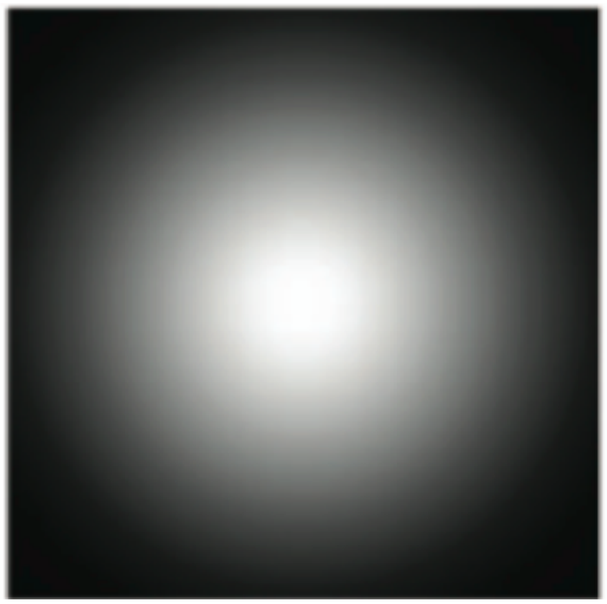
Accuracy linearly correlated with number of distinctly nameble colors in the ramp

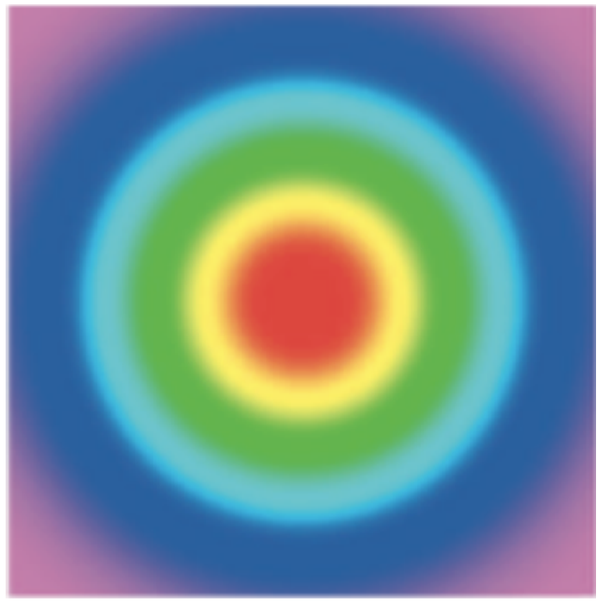
“Colorful” maps perform better



results

H2: color bands can cause people to infer false features

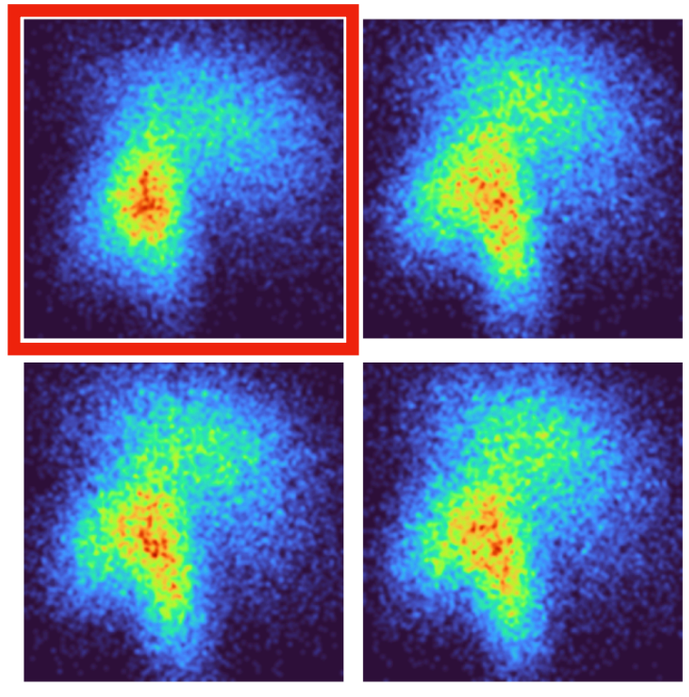




[Borland and Russell, 2007]

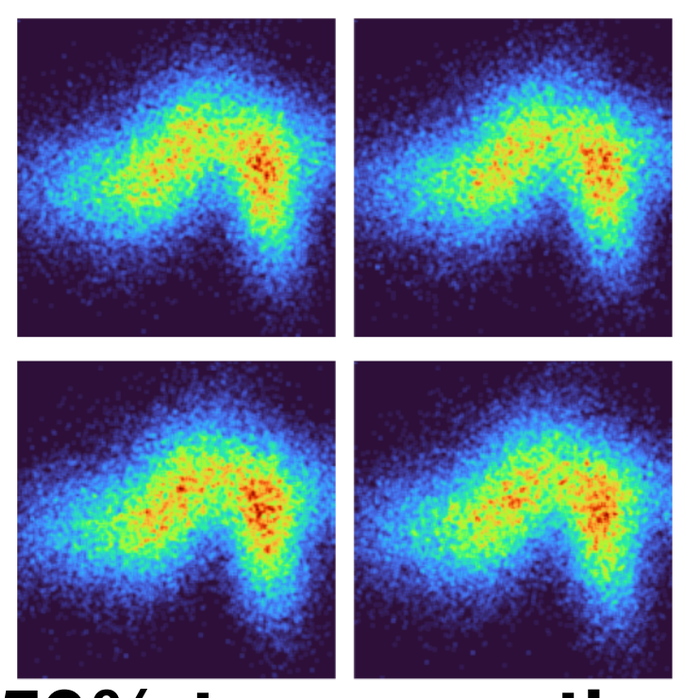
H2: color bands can cause people to infer false features

Do colorful maps trick people into reporting false differences?



No discernible difference between images

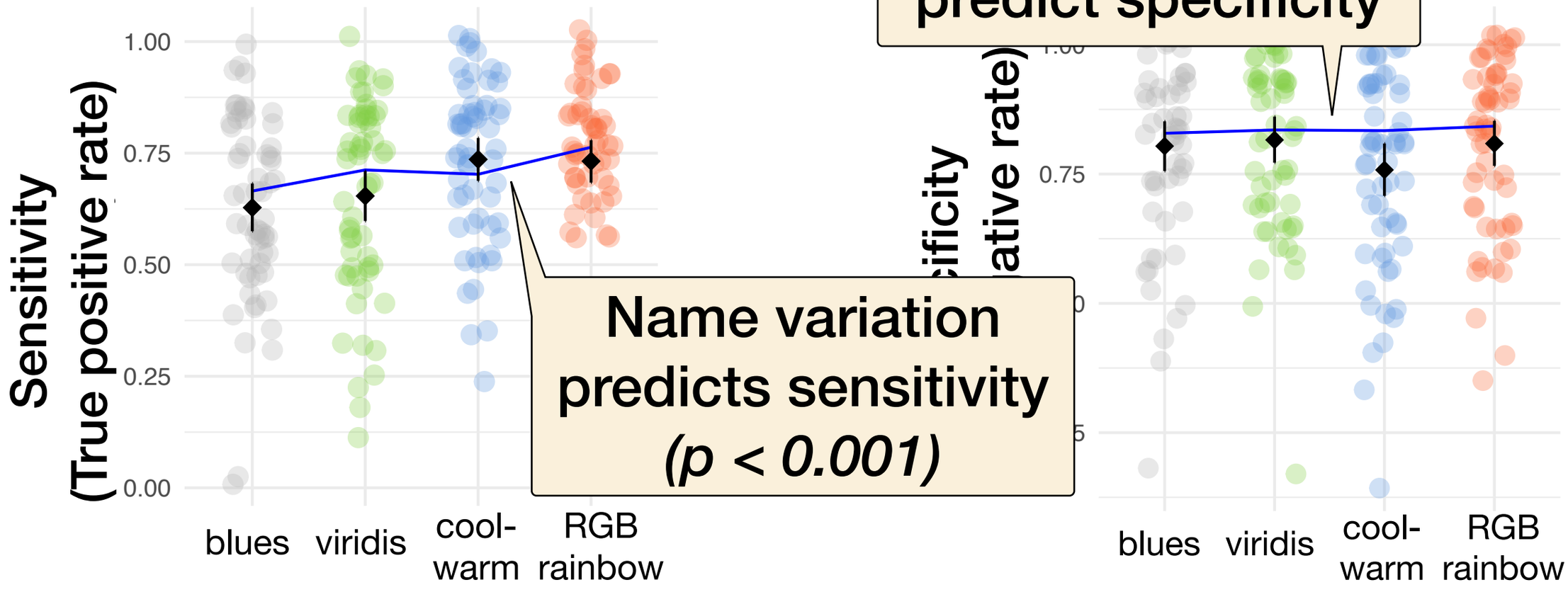
50% true positives



No discernible difference between images

50% true negatives (i.e., no decoys)

H2: **color name variation**
correlates negatively wit

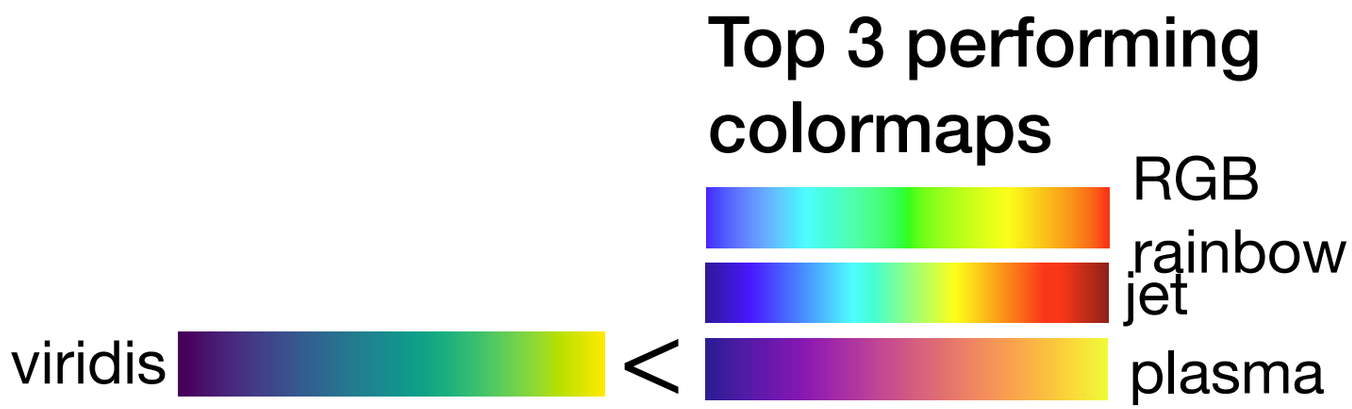


H2: color name variation
correlates negatively with specificity

Participants were no more likely to report false model differences when viewing a rainbow

Colorfulness improves sensitivity

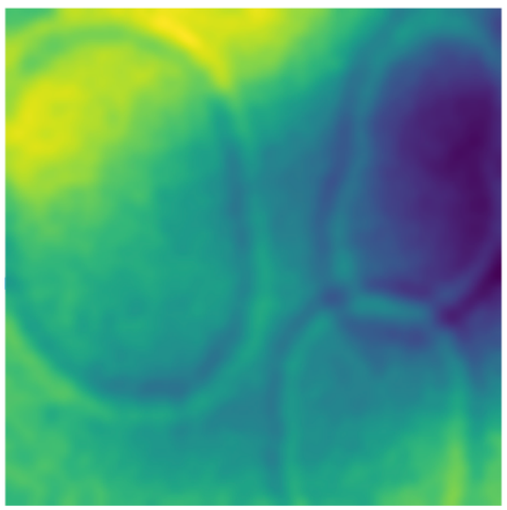
Color name variation
predicts performance in graphical inference



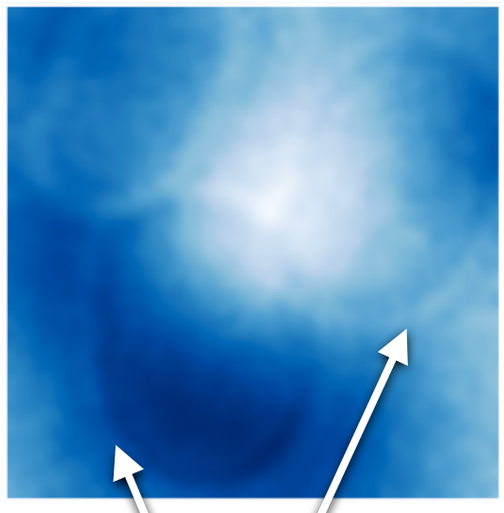
Traditional perceptual properties (e.g., uniformity, lightness monotonicity) don’t seem to affect inference

Heuristic: maximize colormap’s curve length in LAB space *(details in paper)*

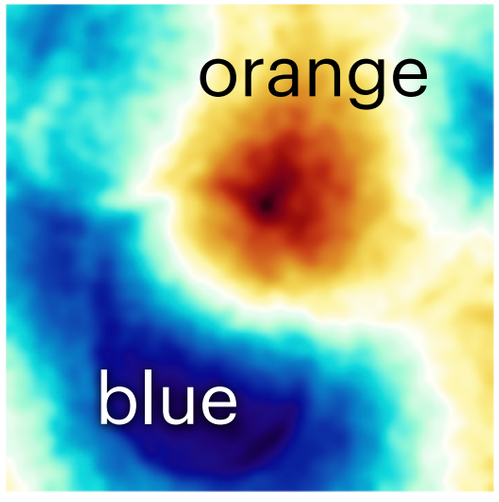
Hypothesis: Rainbows (and other colorful maps) are useful for highlighting global, distributional features



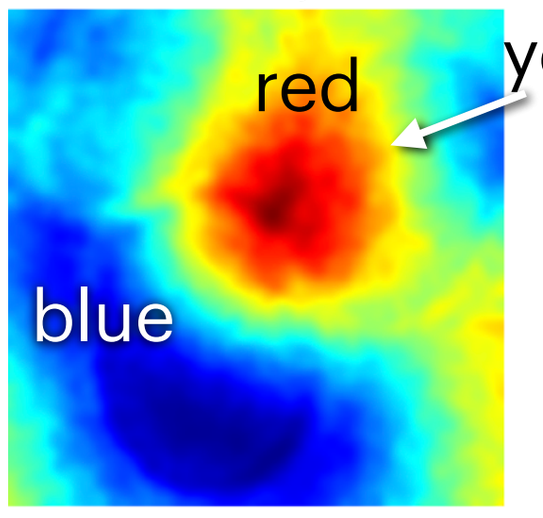
The cost: “local” features become less visible



blue-orange



jet



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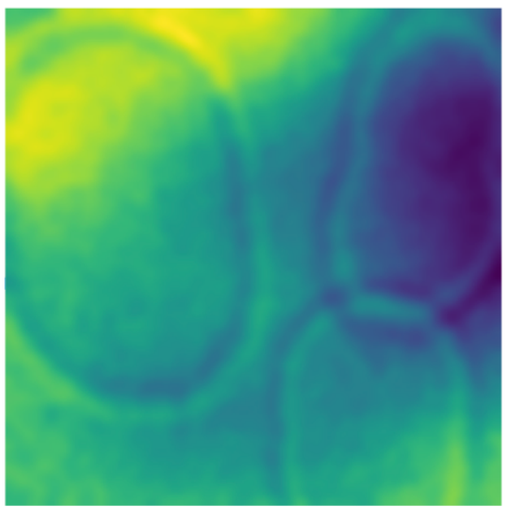

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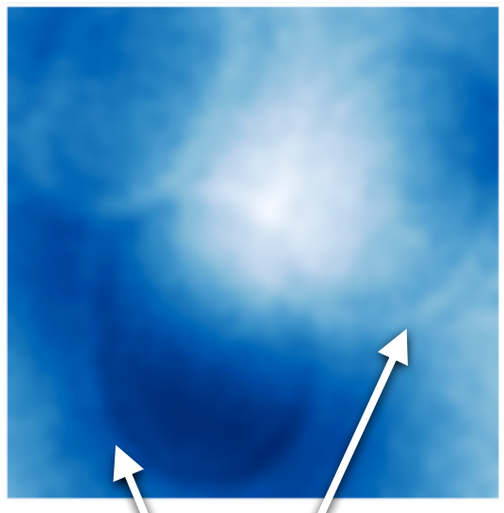
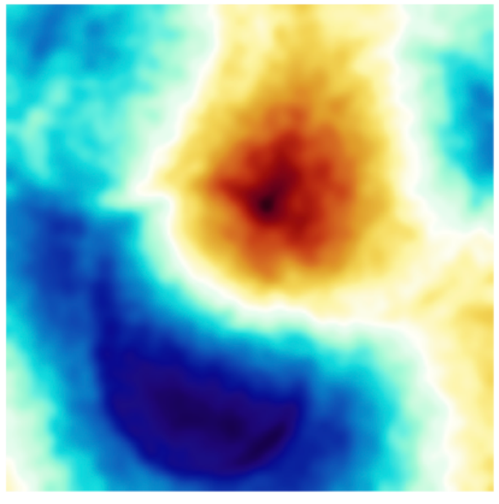
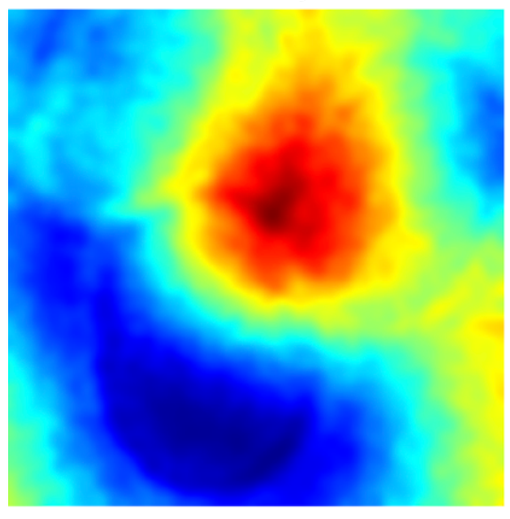


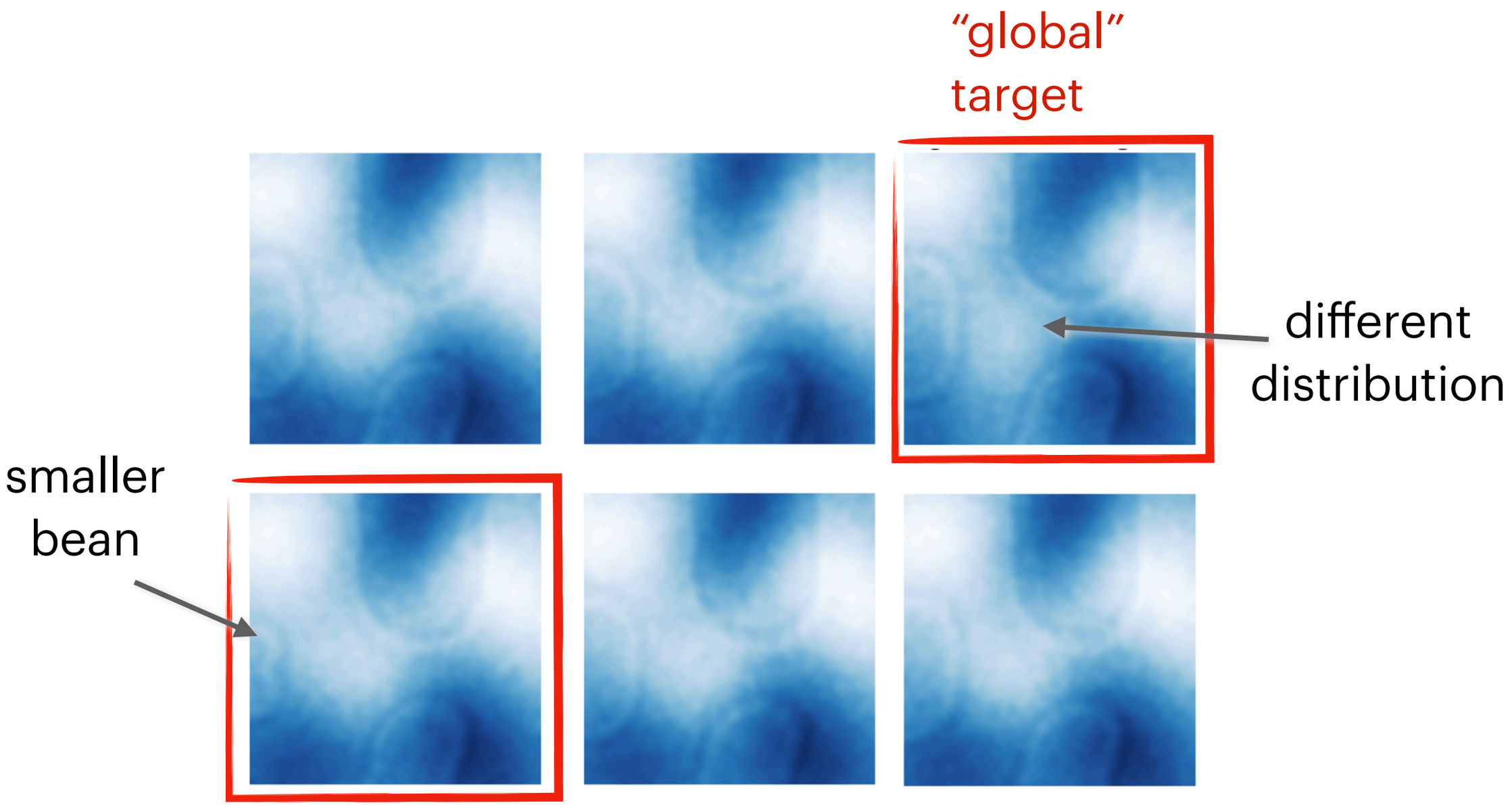




fewer colors — more “colorful”

How do we test this empirically?

Select the visualization that doesn't belong (aka lineup test)



Reda & Sz ...s Revisited, VIS'20

"Clusters beat Trends?"
VanderPlas & Hoffman. 2015

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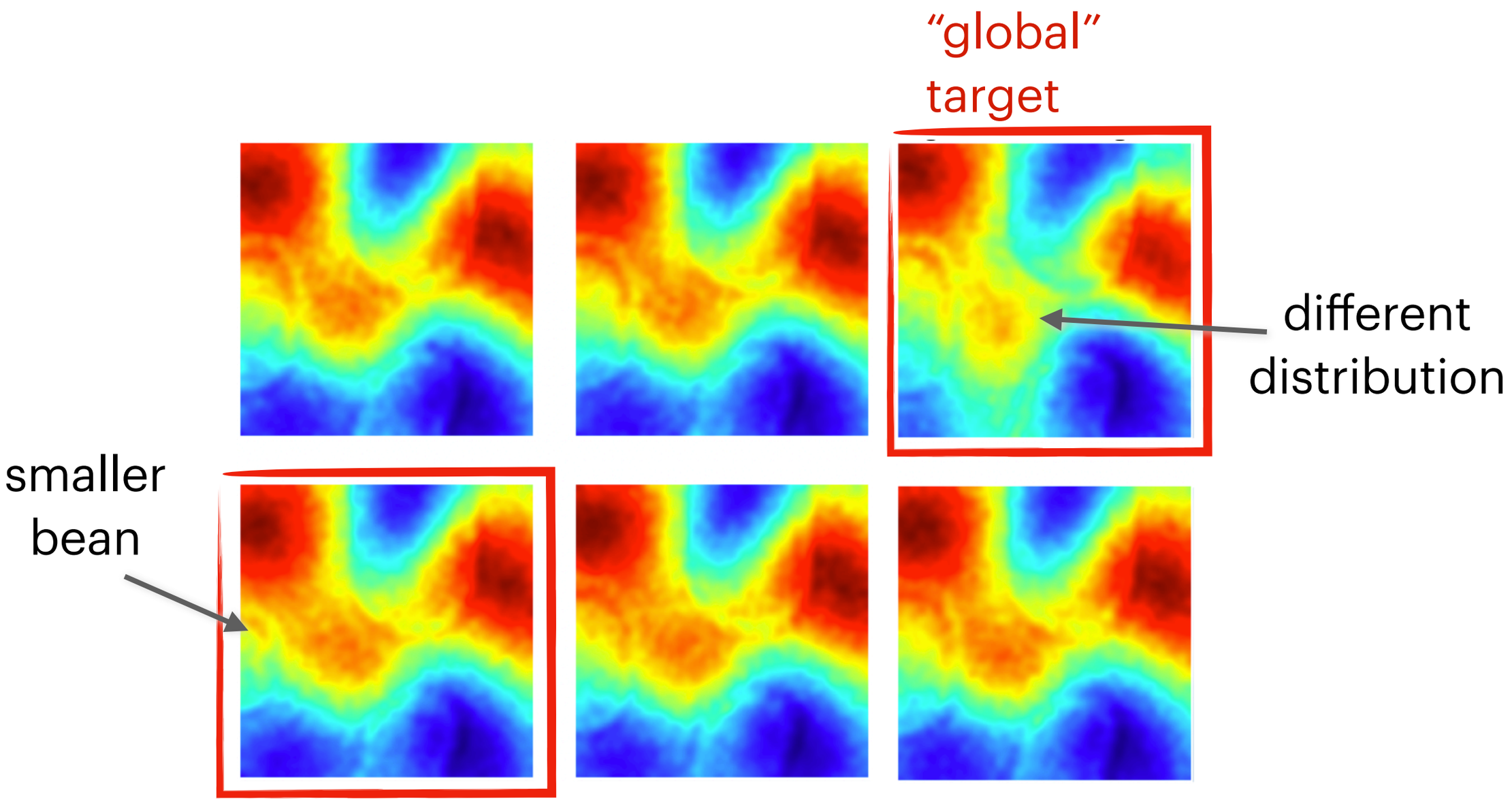


Reda & Sza ited, VIS'20

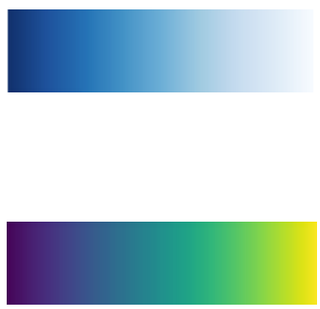
"Clusters beat Trends?"
VanderPlas & Hoffman. 2015

Expectation

more likely to see differences in “beans" (***local features***)

50-50 chance

more likely to report differences in distribution (***global features***)



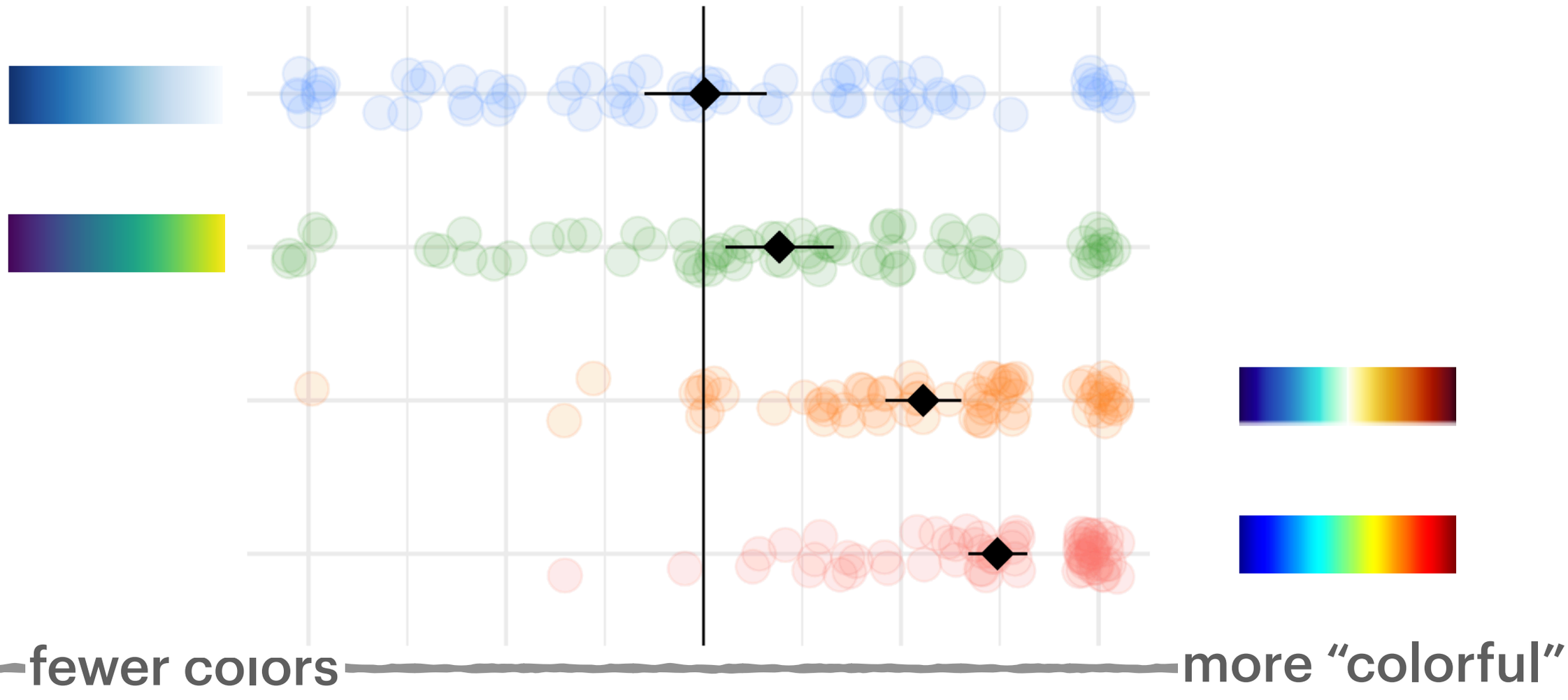
fewer colors — more “colorful”

Results

more likely to see differences in “beans" (***local features***)

50-50 chance

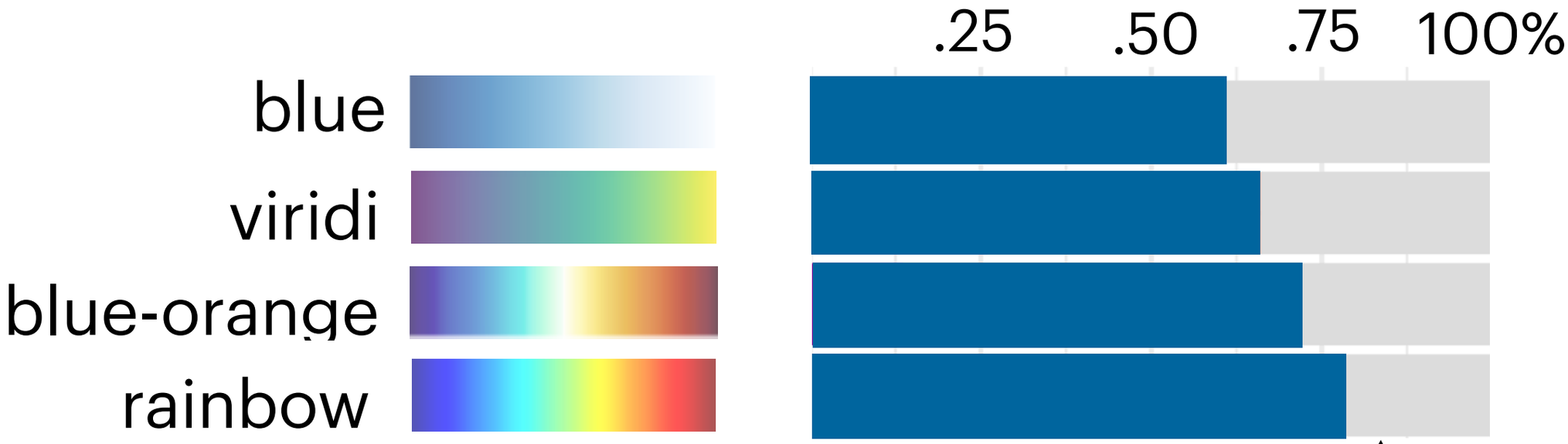
more likely to report differences in distribution (***global features***)



fewer colors

more “colorful”

Results (overall sensitivity)



More colorful designs afford better sensitivity (**rainbow is best overall**)

Results (bias)