# Effect of Test Patch Location on Color Appearance, in the Context of 3D Objects

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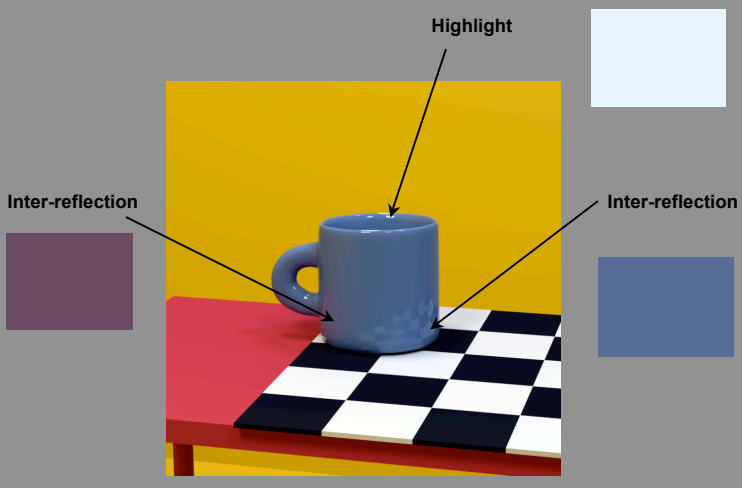
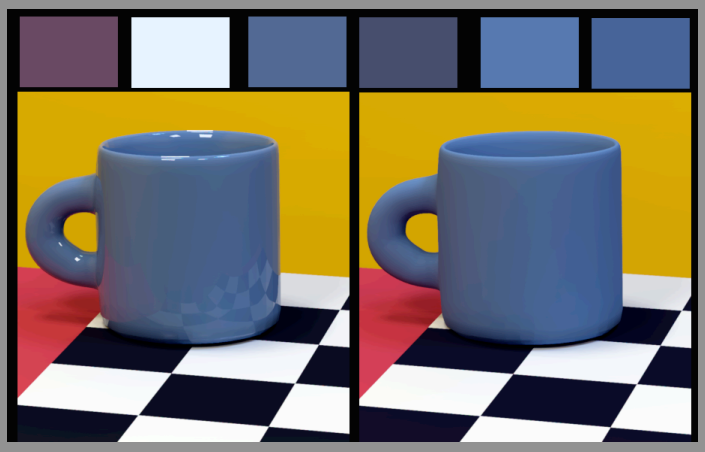
What Color is the Mug?

## Most Appearance Studies Consider Flat Uniform Patches

## A Complex Pattern of Light is Reflected from 3D Objects



## Surface Gloss Increases the Variation of Reflected Light



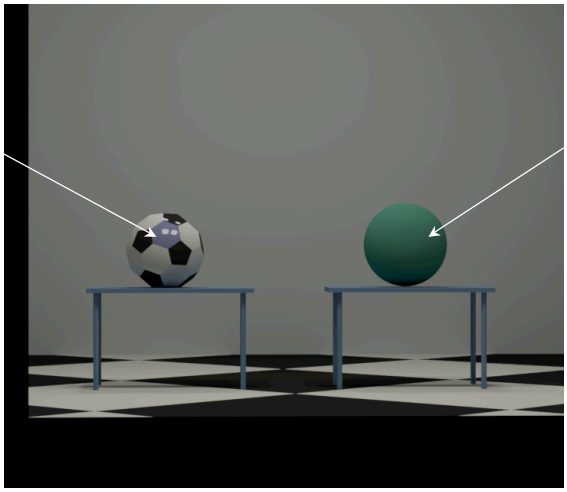
## Questions

How do people perceive the color of different parts of an object?

How do material properties of the object affect color perception?

## Task: Asymmetric Color Matching

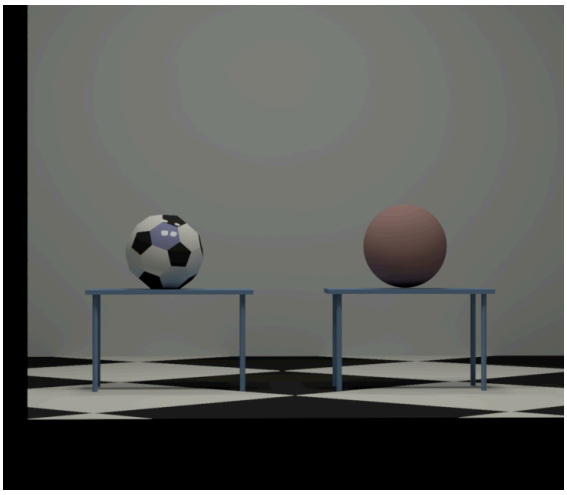
Test



Match

## Task: Asymmetric Color Matching

Test



Adjusting!

Match

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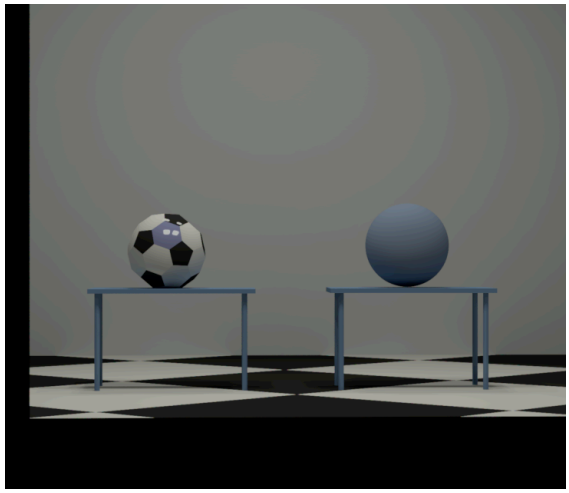

Adjusting!

Match

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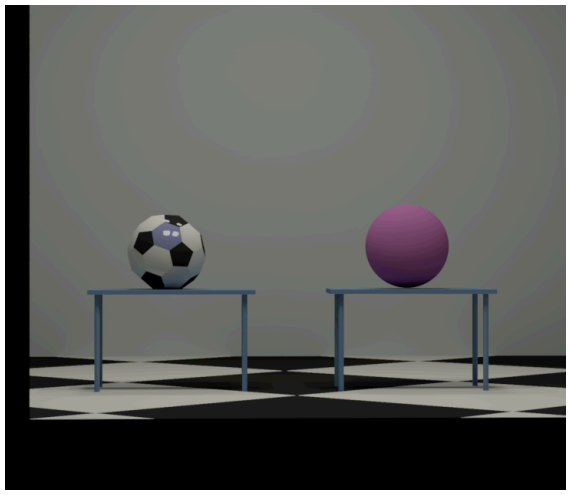

Adjusting!

Match

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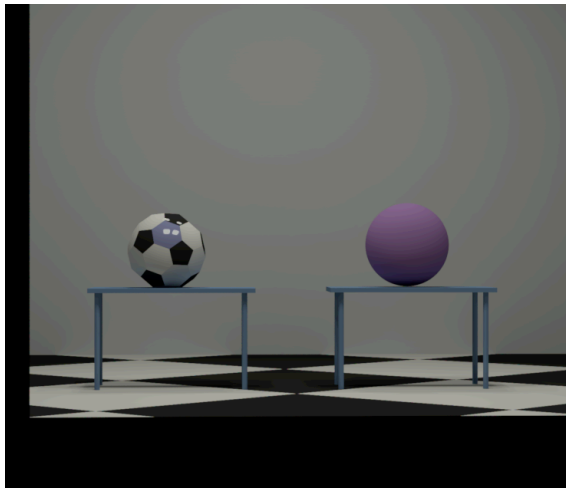

Adjusting!

Match

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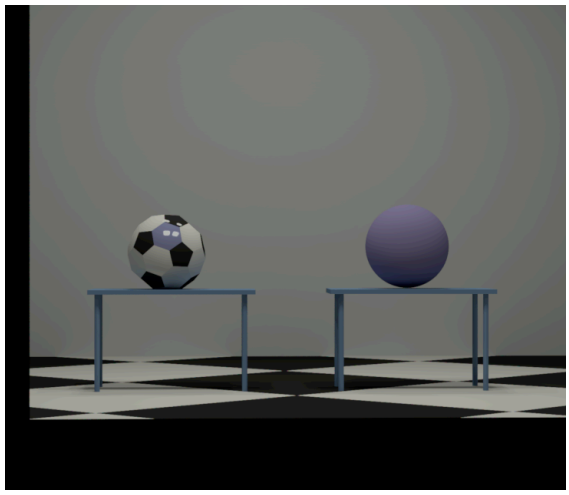
Test

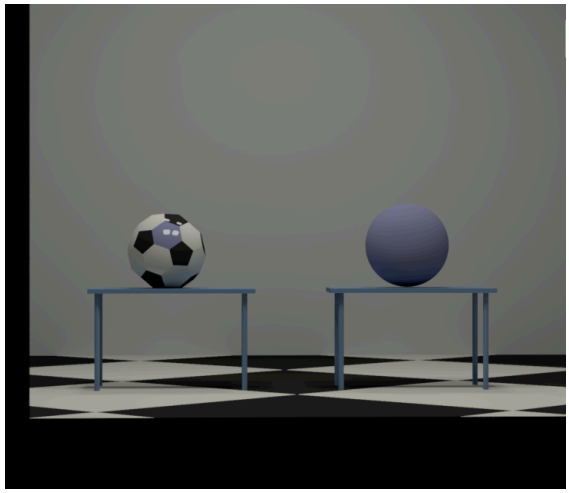


Adjusting!

Match

## Task: Asymmetric Color Matching

Test



Match

Done!

## Rendering Methods

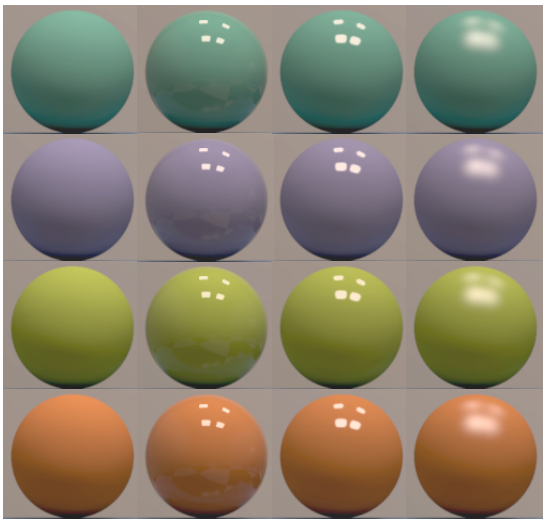
Images are rendered wavelength by wavelength using customized Matlab software (RenderToolbox). The underlying renderer is Radiance.

RenderToolbox is available at www.rendertoolbox.org.

## Ward Model of Surface Reflection

Specular Component (material properties)

Diffuse Component (body color)



## Experimental Variables: Location, Material, Color

Location

Material

Color

## Results: Pictorial Representation

Test Up

Test Bottom

## Results: Pictorial Representation

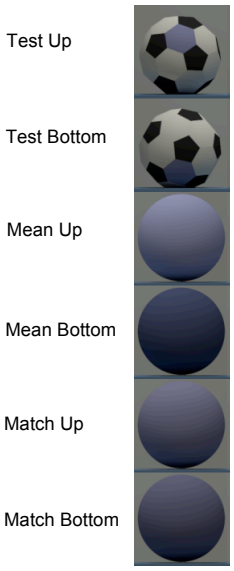
Test Up

Test Bottom

Mean Up

Mean Bottom

## Results: Pictorial Representation

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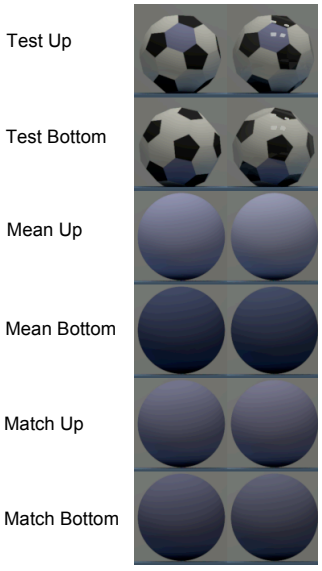

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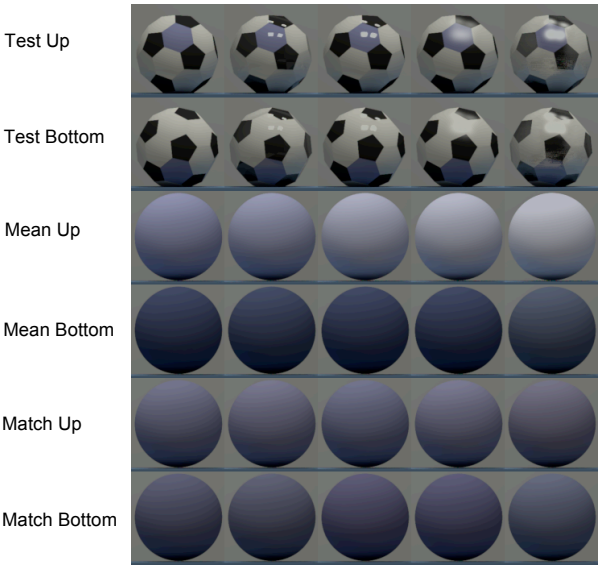


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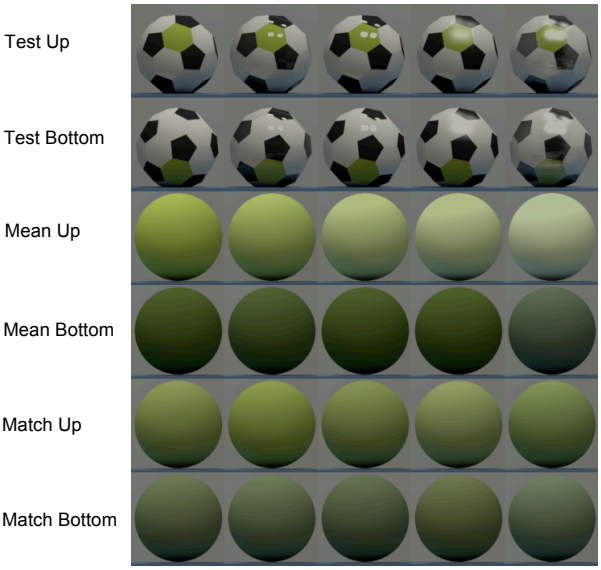


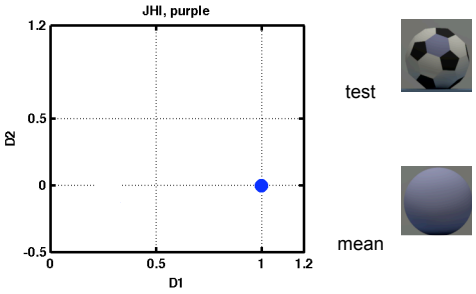
## Preliminary Conclusions

Changing test patch location of an object has a small effect on color perception of the patch.

This is not predicted by the average of the light reflected from the patch.

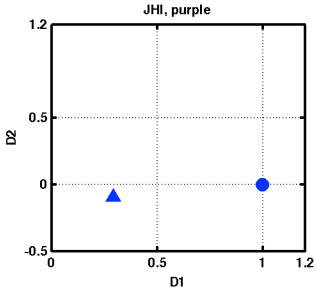
Effect of surface material properties on color perception of the patch is also small.

## Quantitative Data Representation



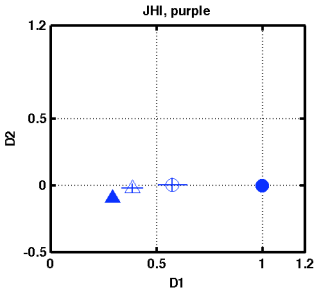

Xiao, B. and Brainard, D.H. (under review) Visual Neuroscience

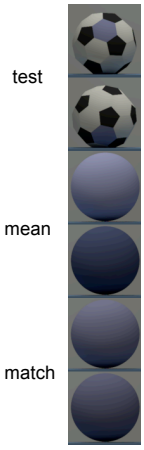
## Transformed Data Representation





## Transformed Data Representation



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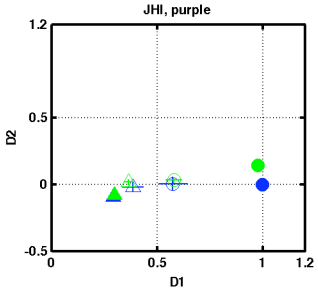


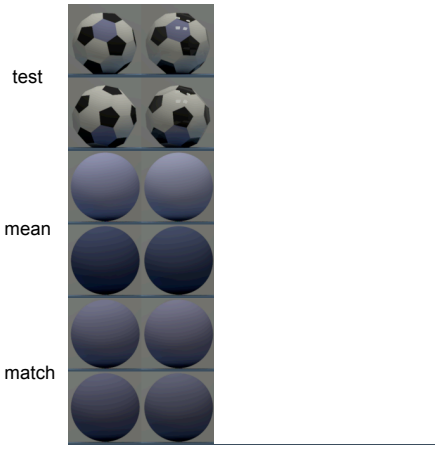


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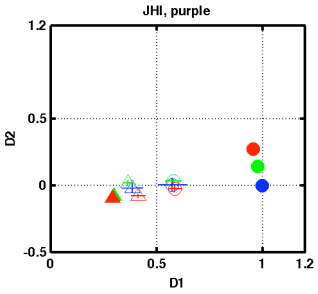


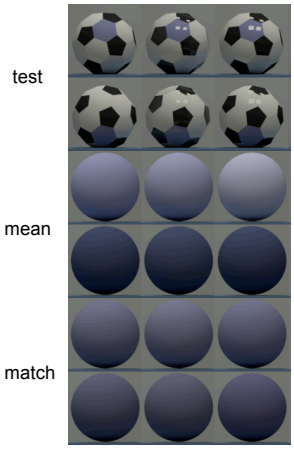

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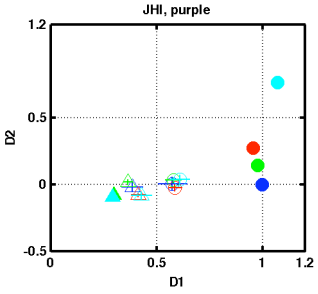


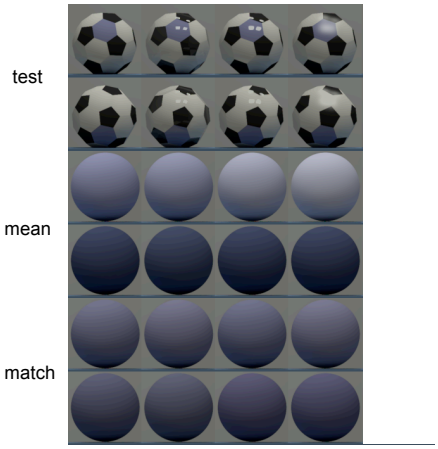


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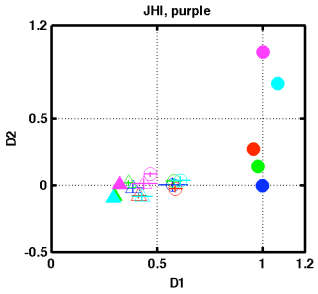
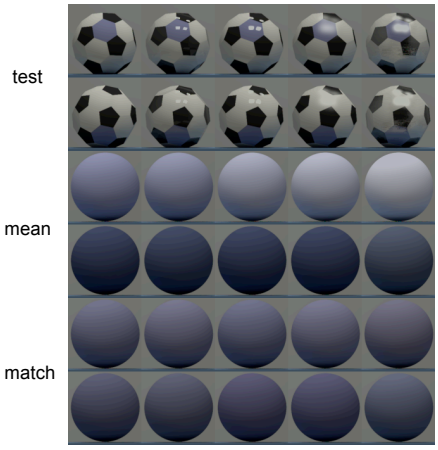
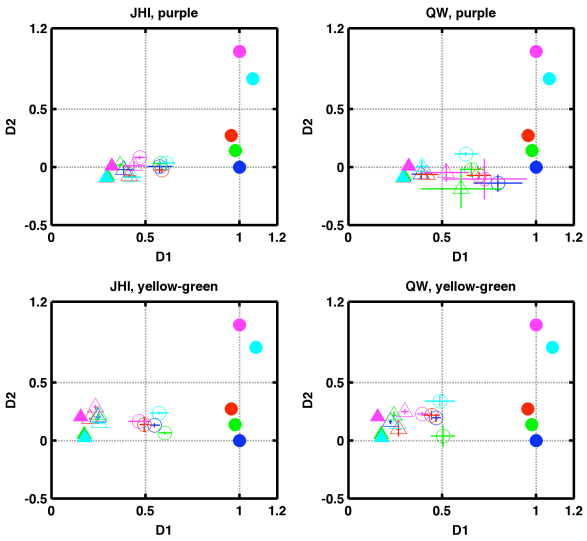
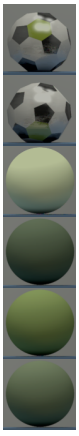


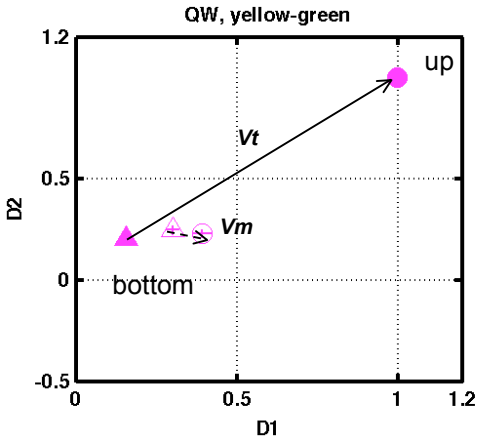



## Soccer Ball Experiment, More Data



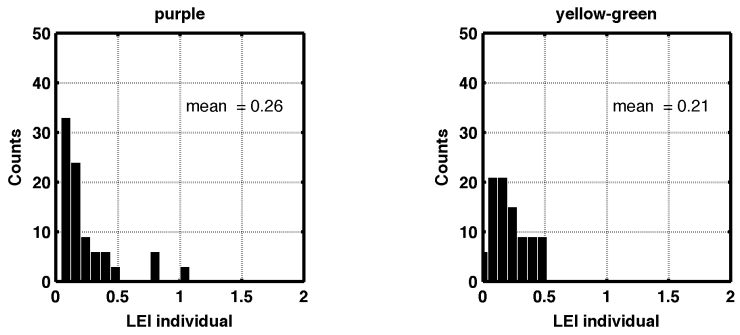

## Location Effect Index (LEI)




**For each material condition: LEI = [ |*Vm*| / |*Vt*| ]**

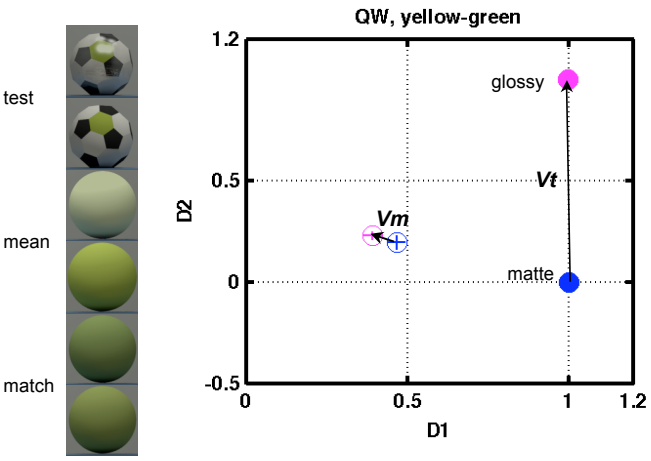
## LEI Histograms




Corrected mean: Purple = 0.09

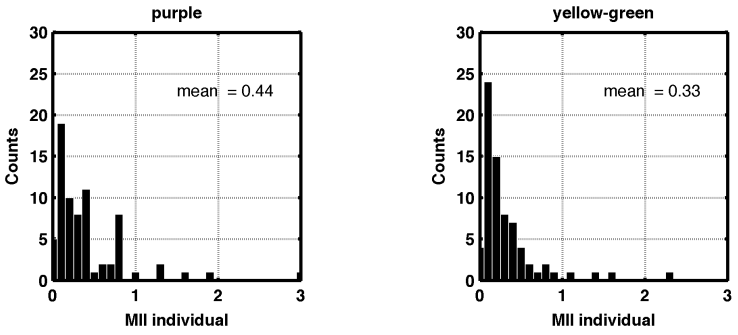
Yellow-green = 0.13

## Material Influence Index (MII)




**For each mach: MII = [ |*Vm*| / |*Vt*| ]**

## MII Histograms




Corrected mean: Purple = 0.17

Yellow-green = 0.13

## Conclusions

We're interested in the color appearance of 3D objects in rich scenes.

Effect of location is small in comparison with the mean prediction. This suggests color appearance is stable across different parts of an object.

Surface gloss has a small effect on color perception of the test patch on 3D objects when the diffuse component is constant.

Matches are not predicted by the average of the light reflected across the image of the object.

## Acknowledgement

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Lu Yin

Dr. Sarah Allred

Dr. Robyn Oliver

Chris Broussard

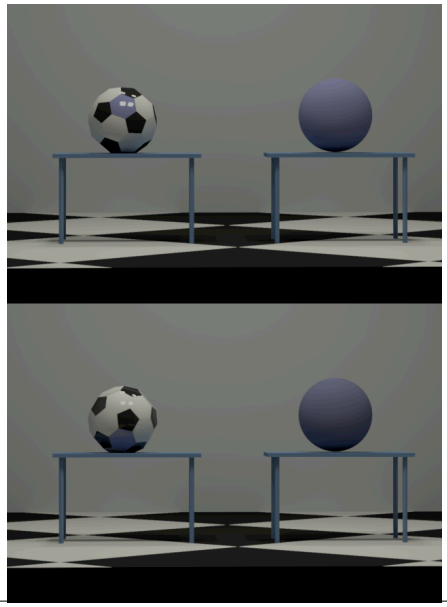
Prof. James Hillis

## Implications For Models

Image-statistics: Use image mean, skewness, percentiles to estimate diffuse reflectance (body color).

Inverse-optics: estimating geometry of the light source and use the estimated geometry to infer diffuse reflectance.

## Design: Test Patch Location Effect

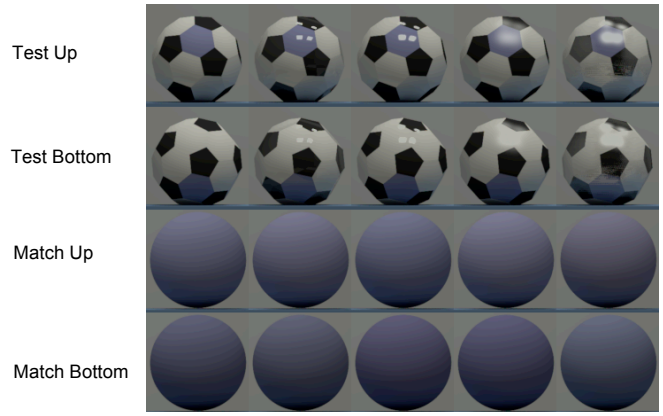


## Results: Pictorial Representation

Test Up

Test Bottom

## Results: Pictorial Representation

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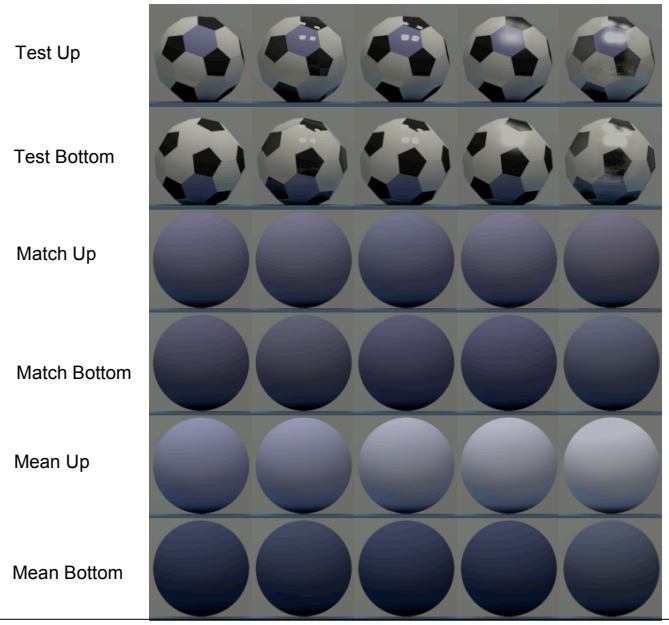
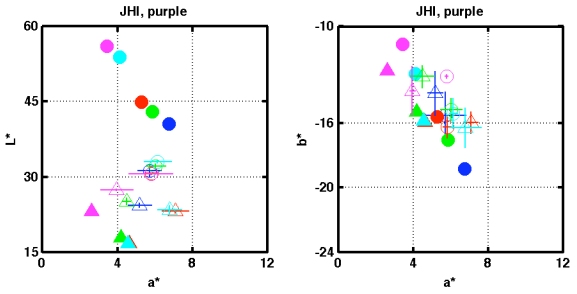
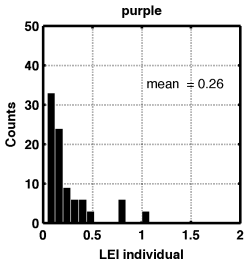
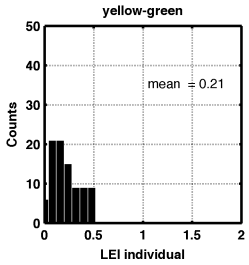


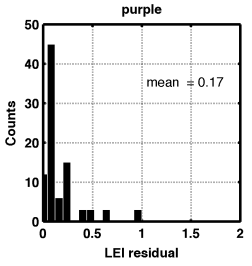
## CIELAB Representation of Test Stimuli

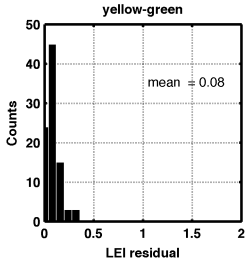



## LEI Histograms, Compared with Residuals



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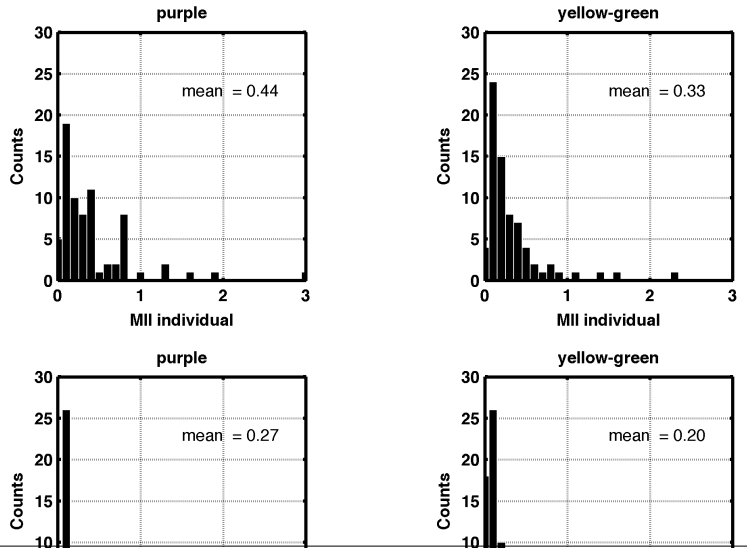

## Results: Pictorial Representation


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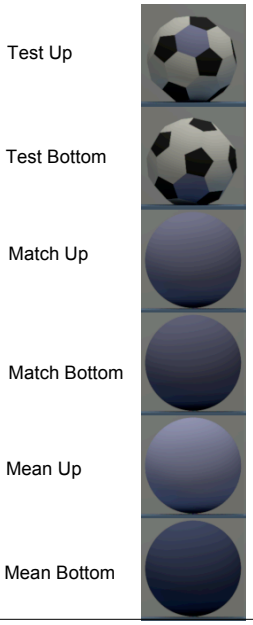


## Results: Pictorial Representation

Test Up

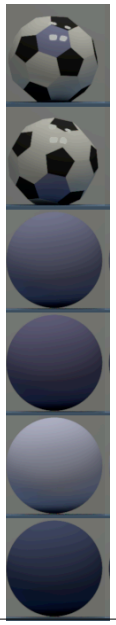
Test Bottom

Match Up

Match Bottom

Mean Up

Mean Bottom



## Results: Pictorial Representation

Test Up

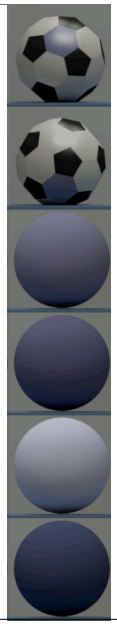
Test Bottom

Match Up

Match Bottom

Mean Up

Mean Bottom



## Results: Pictorial Representation

Test Up

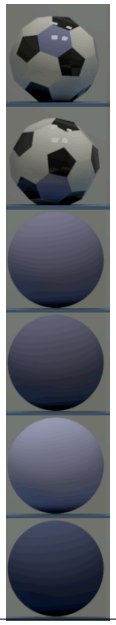
Test Bottom

Match Up

Match Bottom

Mean Up

Mean Bottom



## Results: Pictorial Representation

Test Up

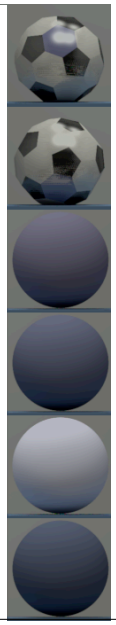
Test Bottom

Match Up

Match Bottom

Mean Up

Mean Bottom



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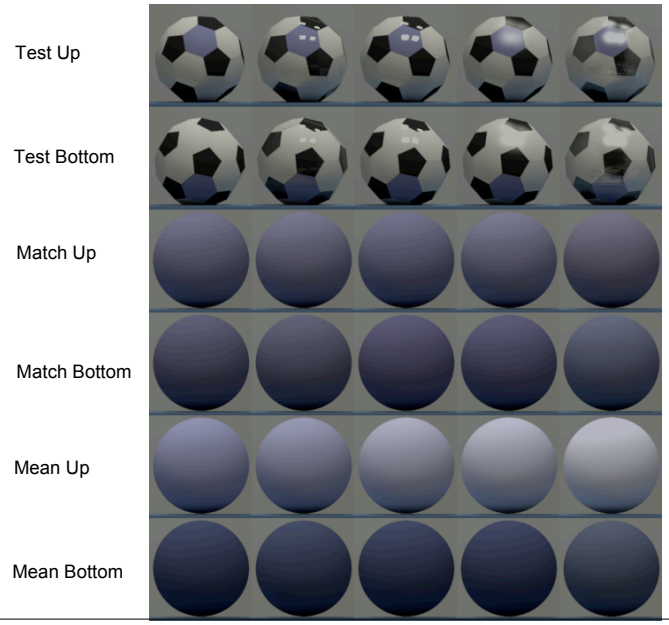


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