

Shape, Color and Perception of Translucency

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Edward Adelson, Todd Zickler, Kavita Bala

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Translucency is important



Translucency of unfamiliar objects

Pyrawax

Paraffin wax

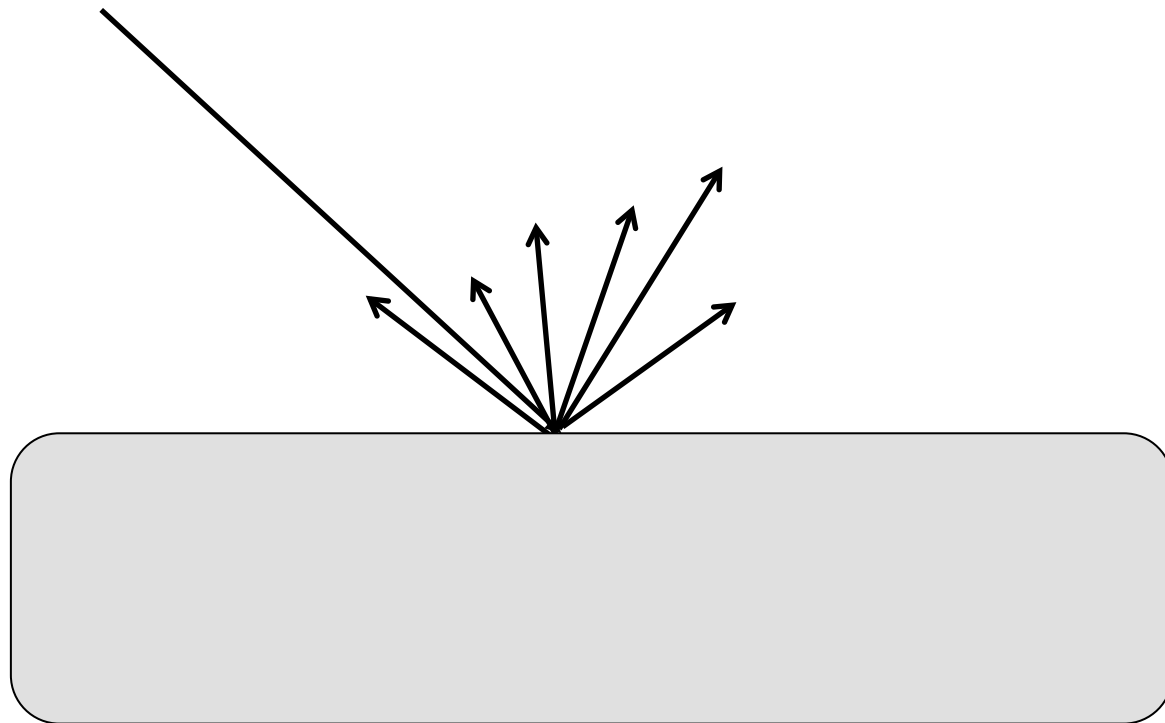
Glycerin soap



Reflection from an opaque object

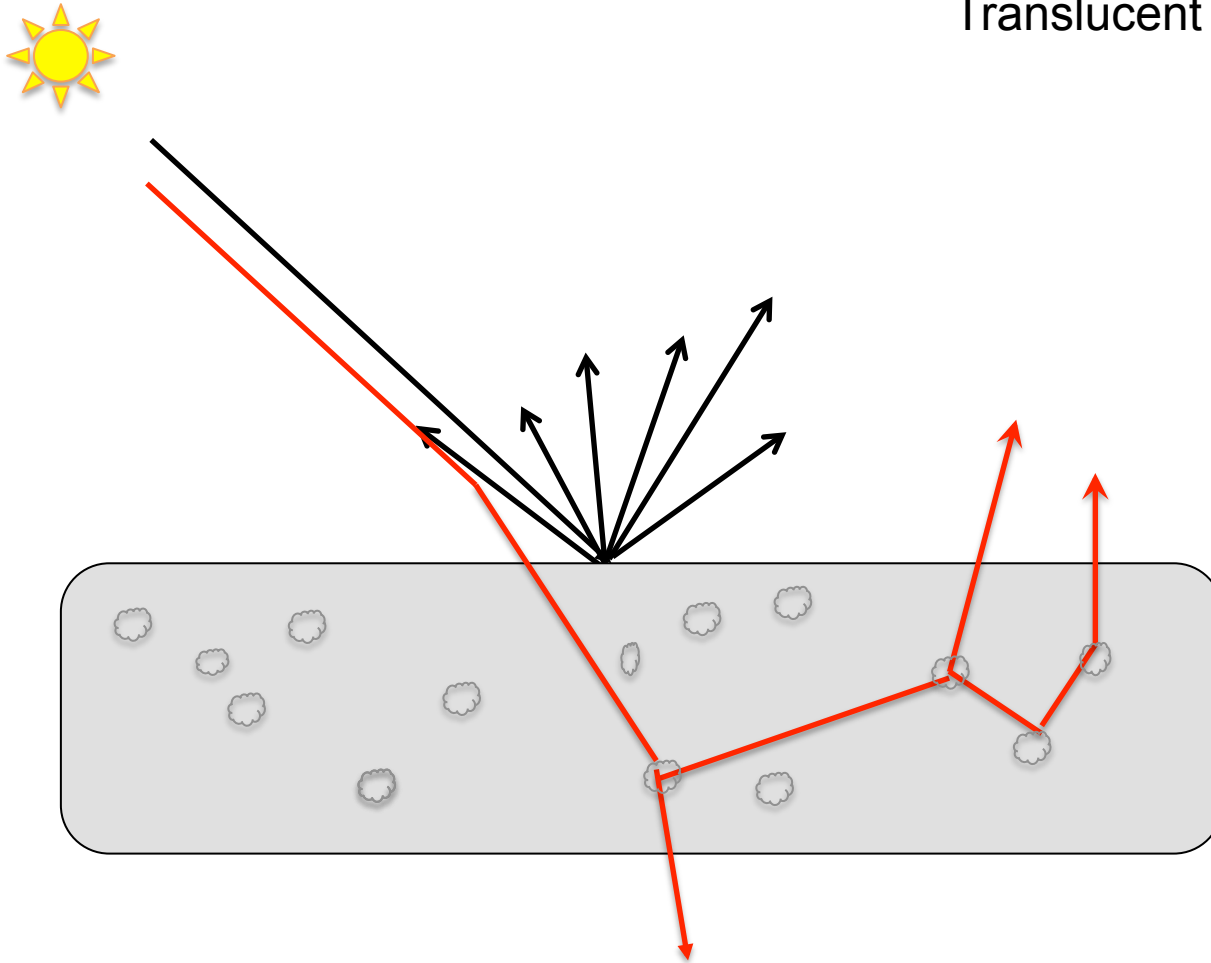


Opaque material



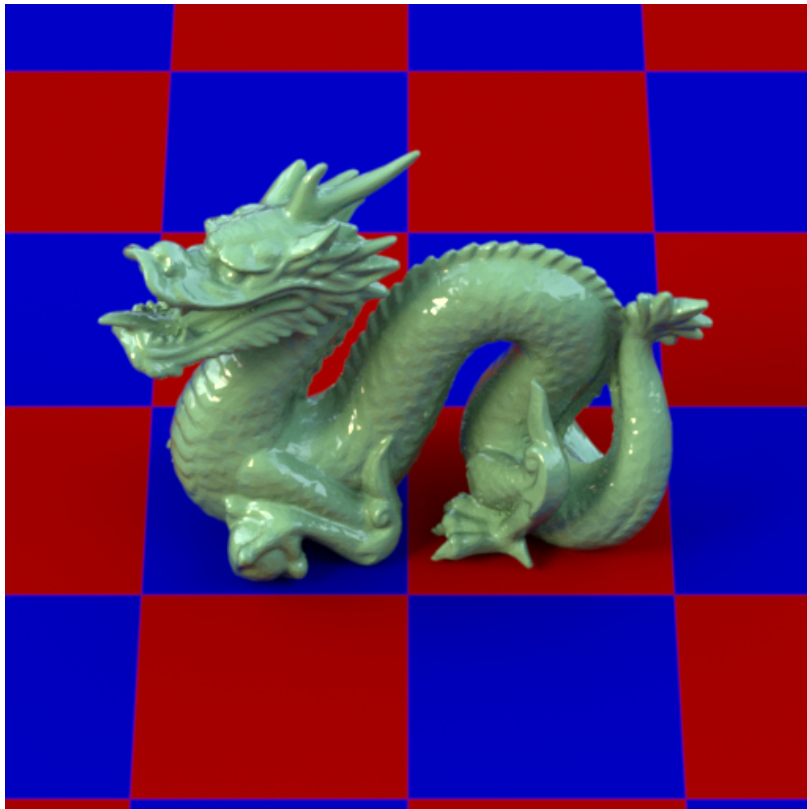
Subsurface scattering

Translucent material

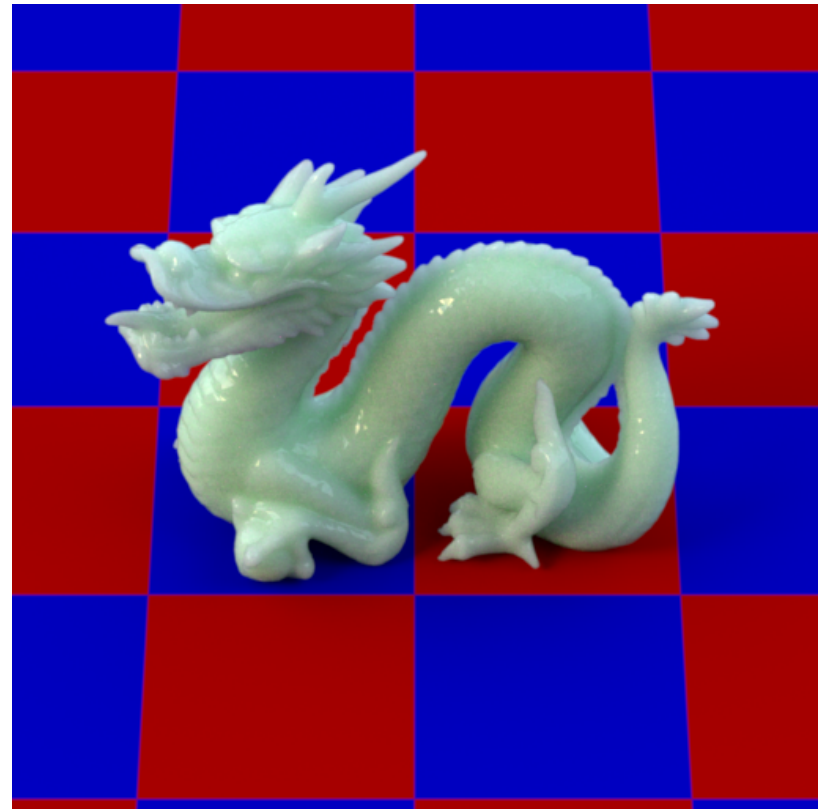


Renderings with subsurface scattering

Opaque (BRDF)



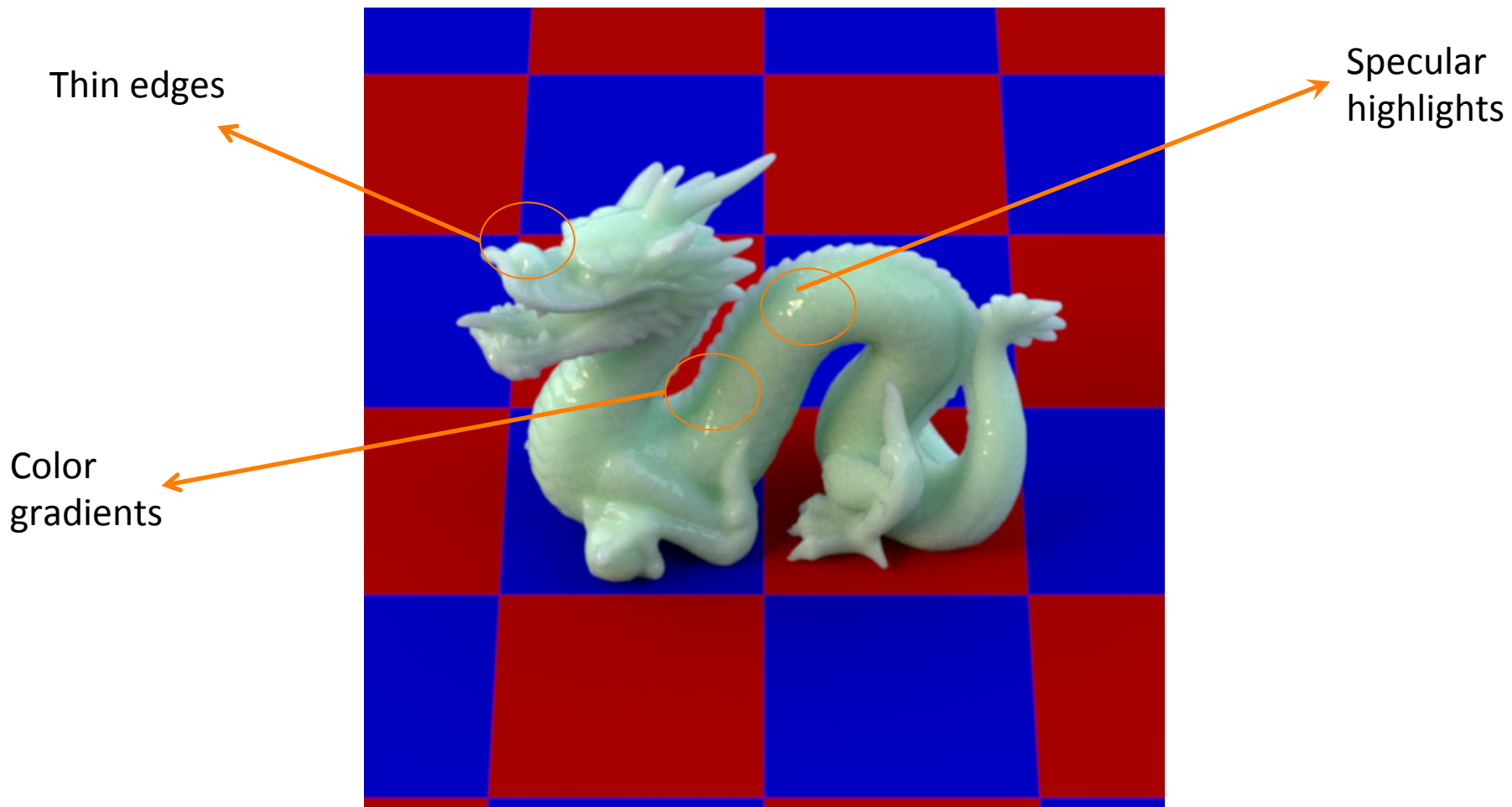
Translucent (BSSRDF)



Suggested cues for perception of translucency

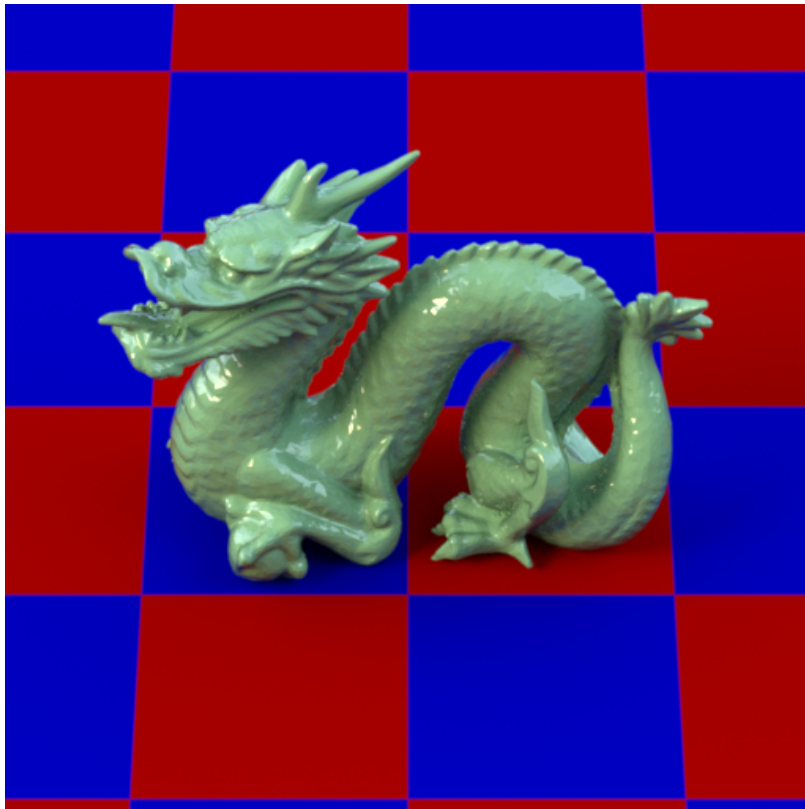
- Highlights and shading relationship
- Luminance histograms
- Local luminance gradients
- Color saturation
- Lighting direction, such as backlighting
- RMS contrasts

There are many cues to translucency

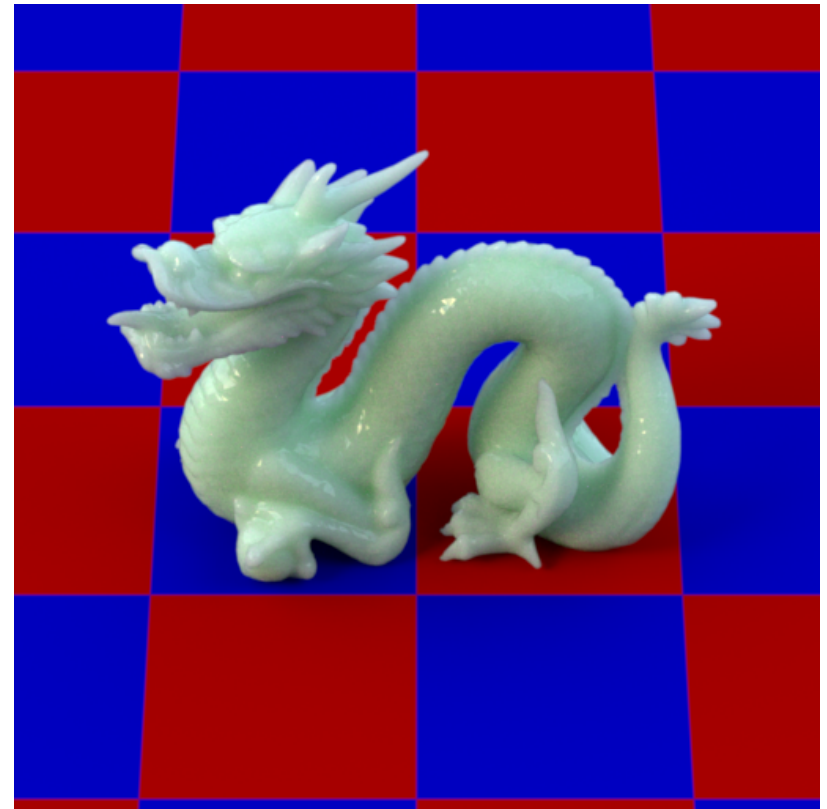


How does translucency affects shape perception

Opaque (BRDF)



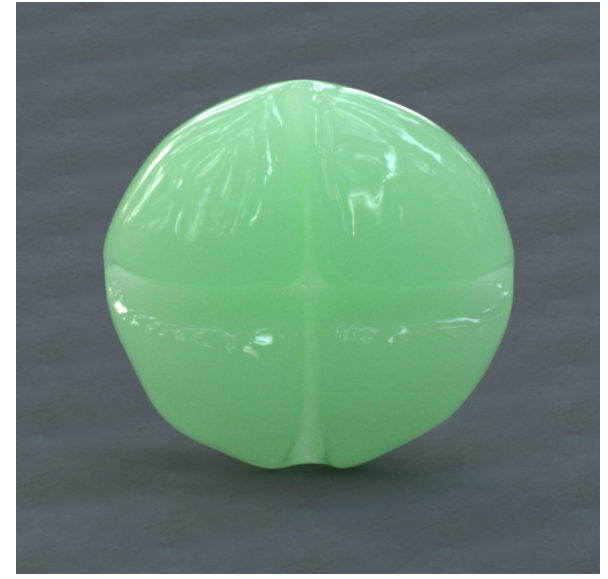
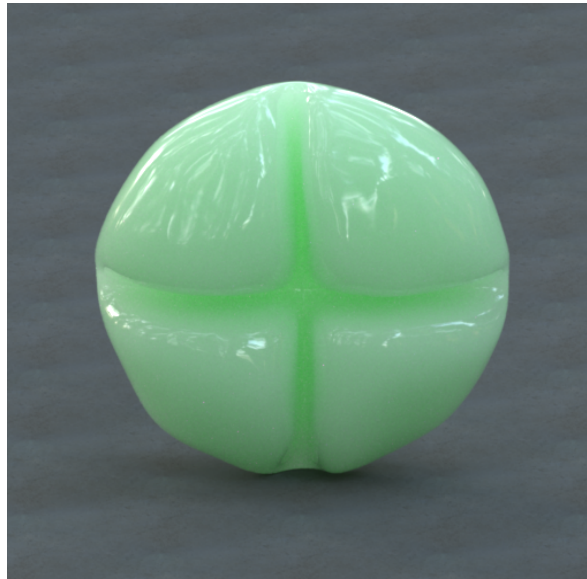
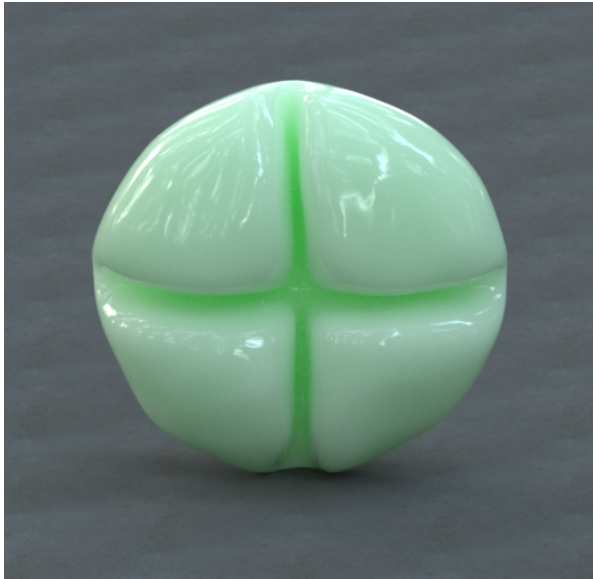
Translucent (BSSRDF)



Question: How does translucency affect shape perception?

Experiment 1: Effect of translucency on perceived shape

Bun object: Constant physical shape

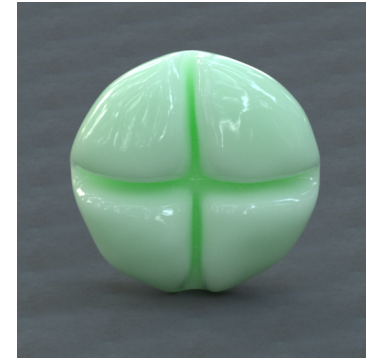
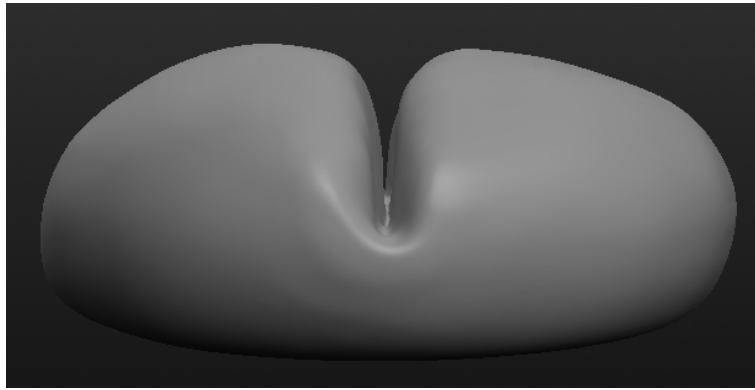


Increasing Physical Translucency

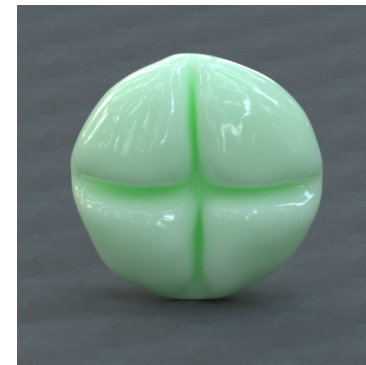
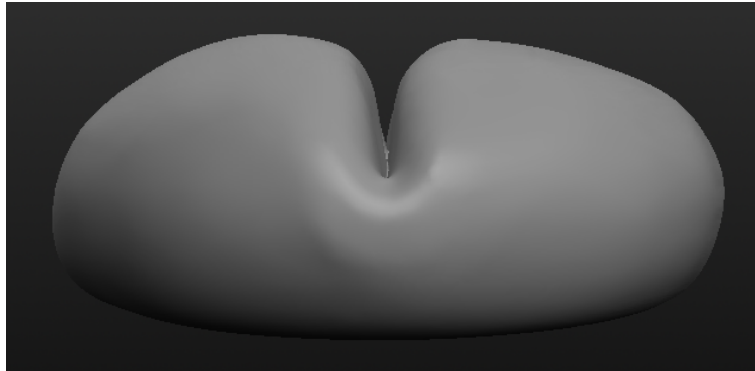
Rendered by Ioannis Gkioulekas

Models with different depths

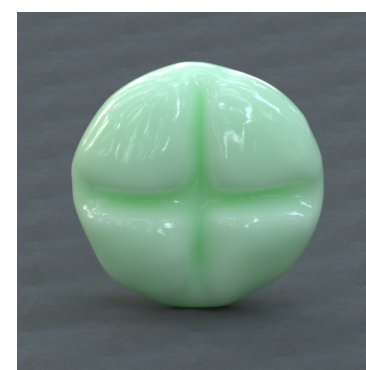
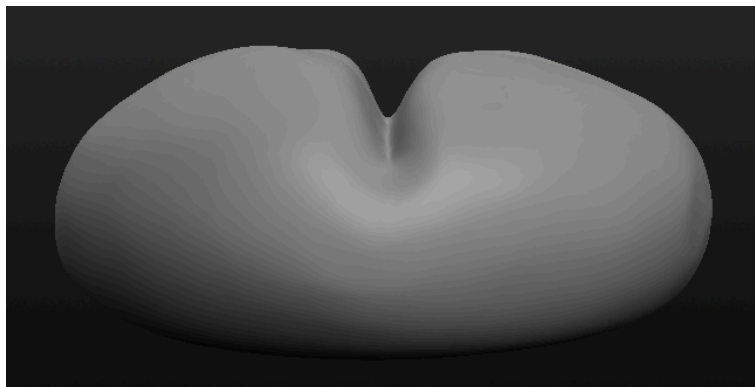
Deep



Medium

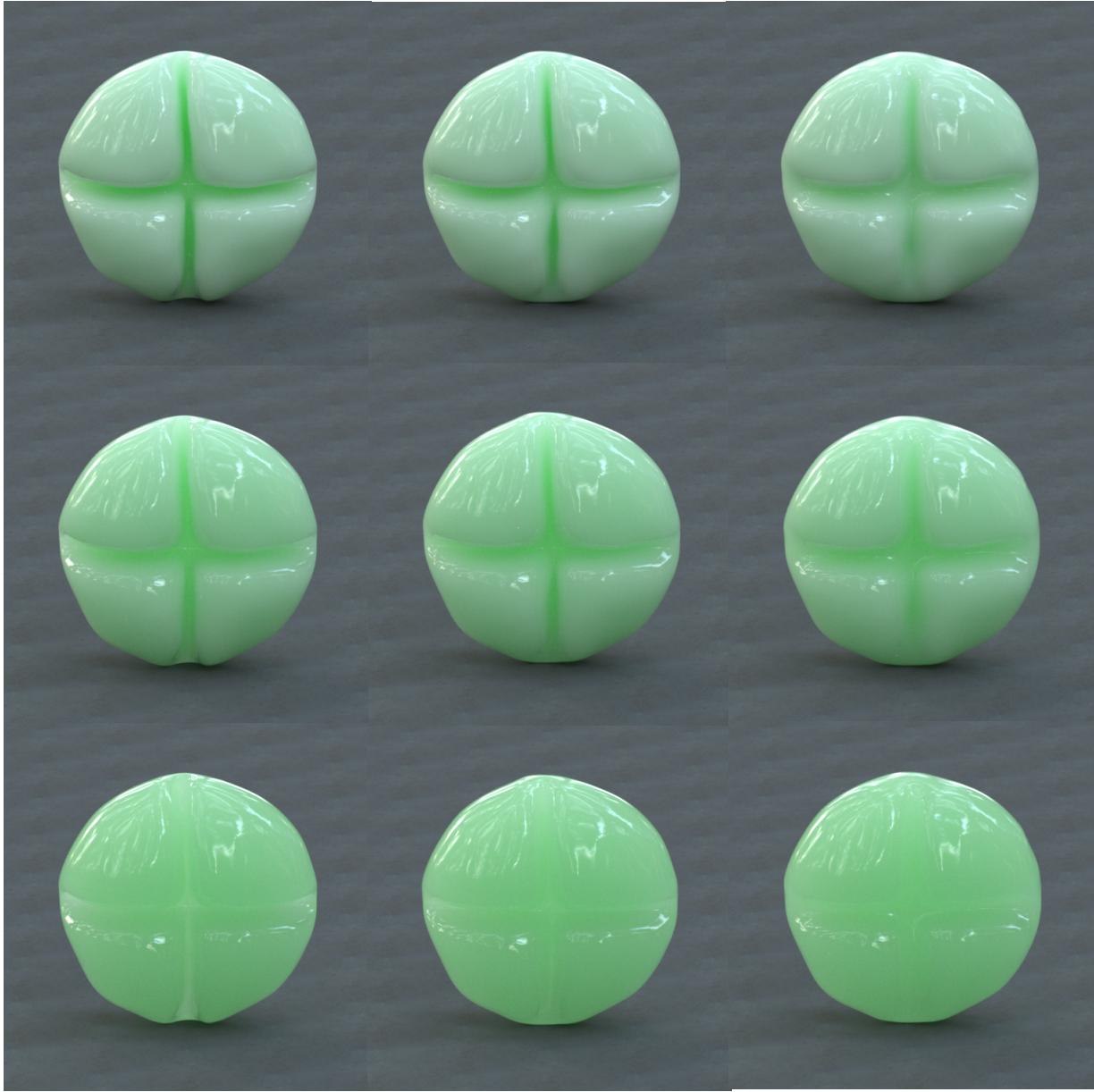


Shallow



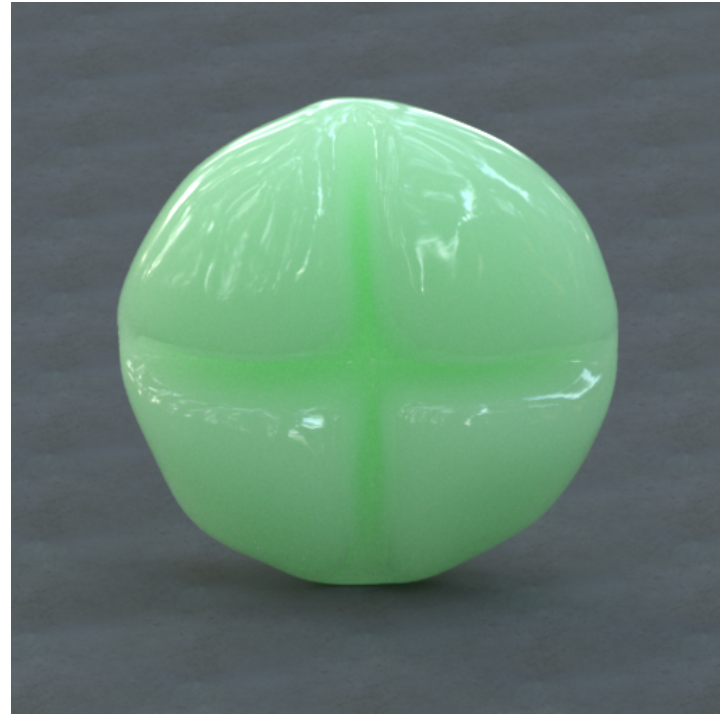
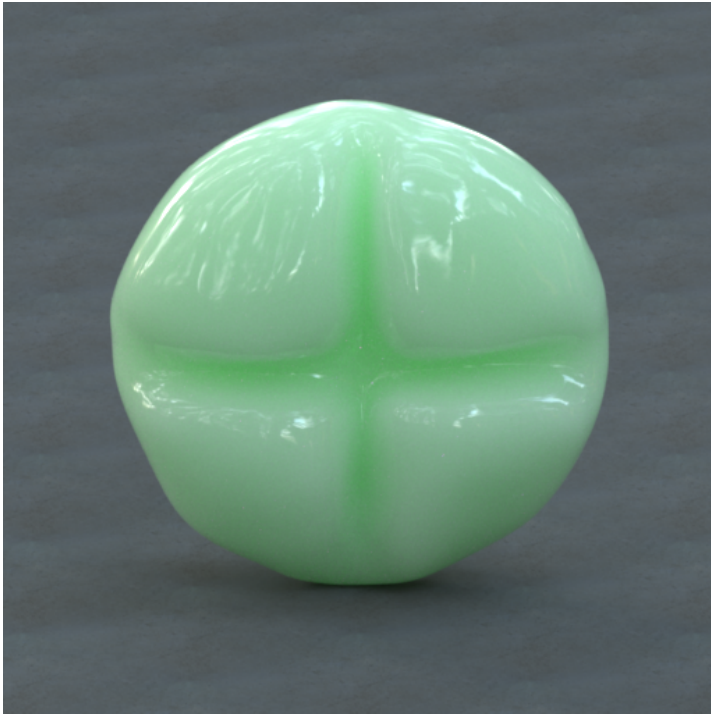
Cross Cut Depth

Physical Translucency



Task: Paired comparison

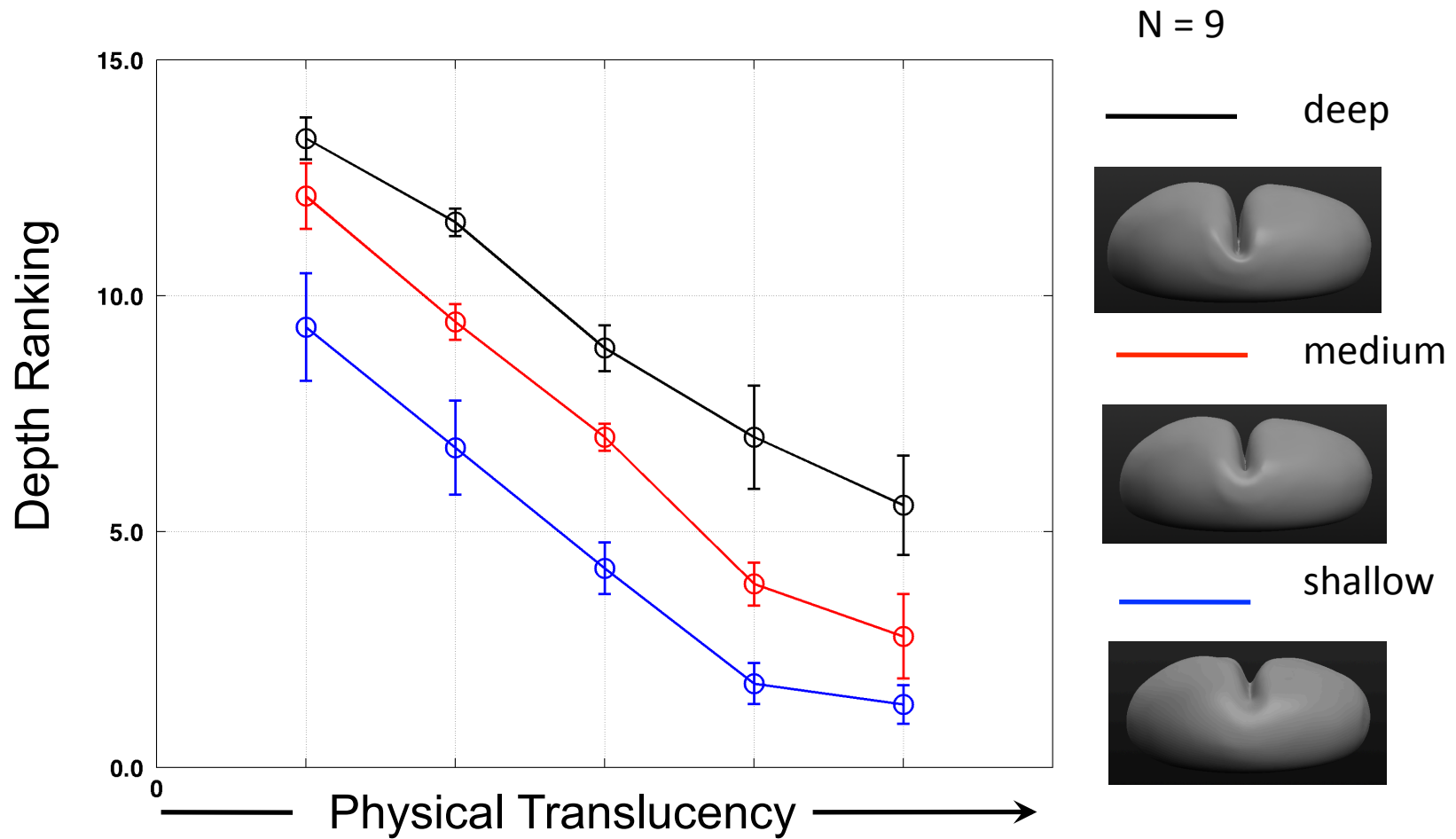
Which bun has the deeper cut?



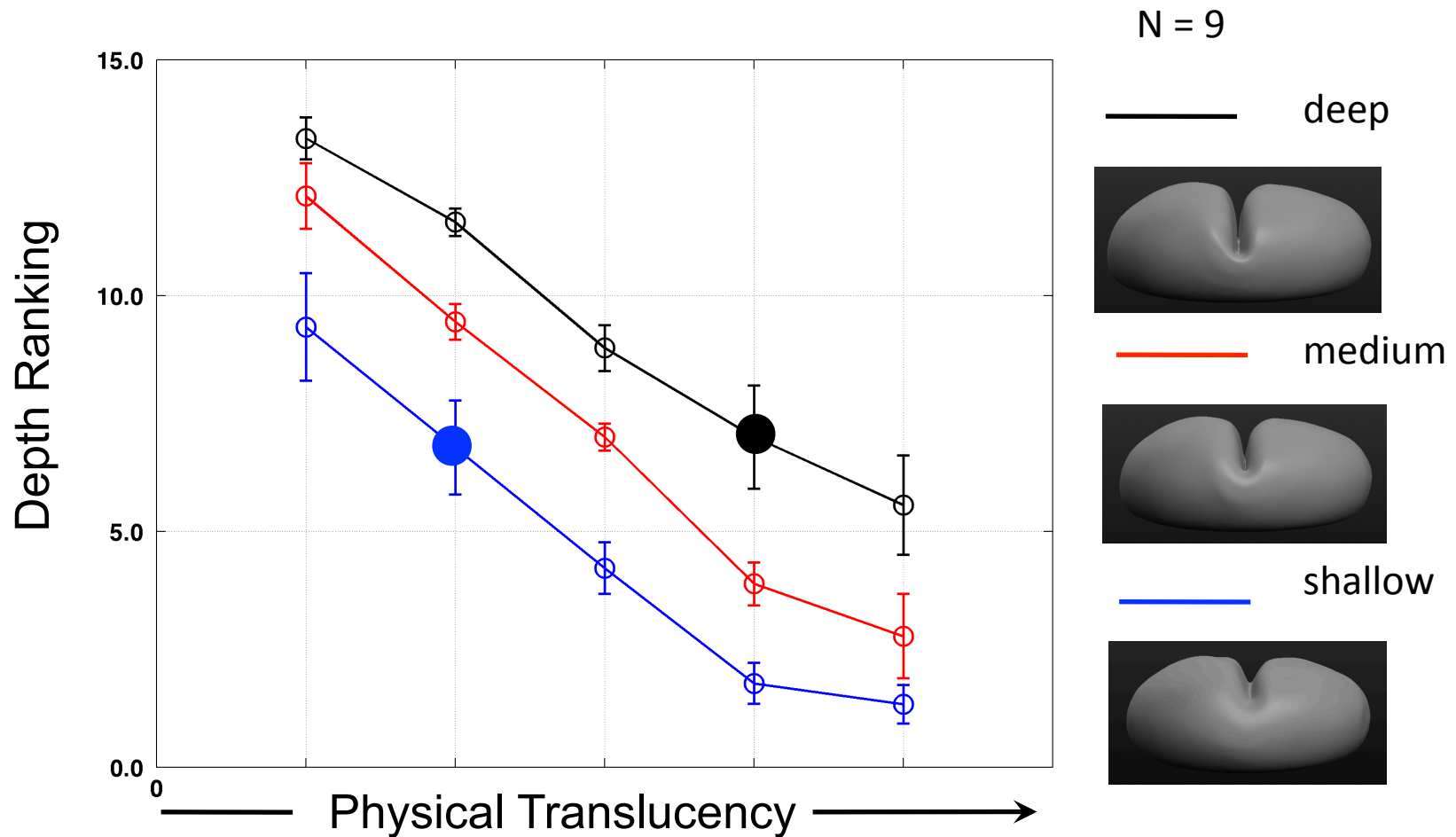
Summary of Conditions

- 3 depth conditions (deep, medium, shallow)
- 5 physical translucency parameters
- Grayscale and colored “green” conditions (same luminance contrast)
- Environment map: Grove and Campus (From Debevec database)
- Ranking of depth was constructed from paired comparisons (L.L.Thurstone)

Results: Effect of translucency on depth ranking (across different depths)

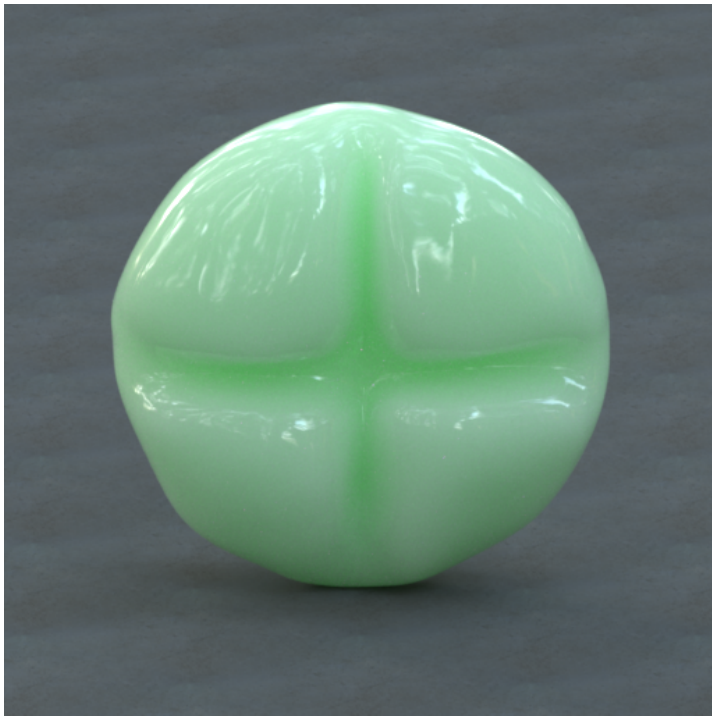


Results: Effect of translucency on depth ranking (across different depths)

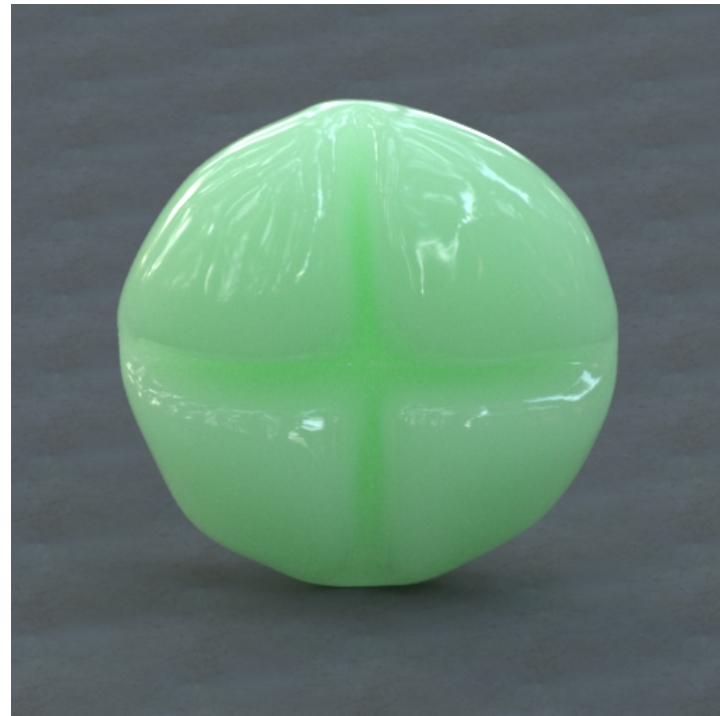


Summary: Translucency affects 3D shape perception

Shallow physical depth



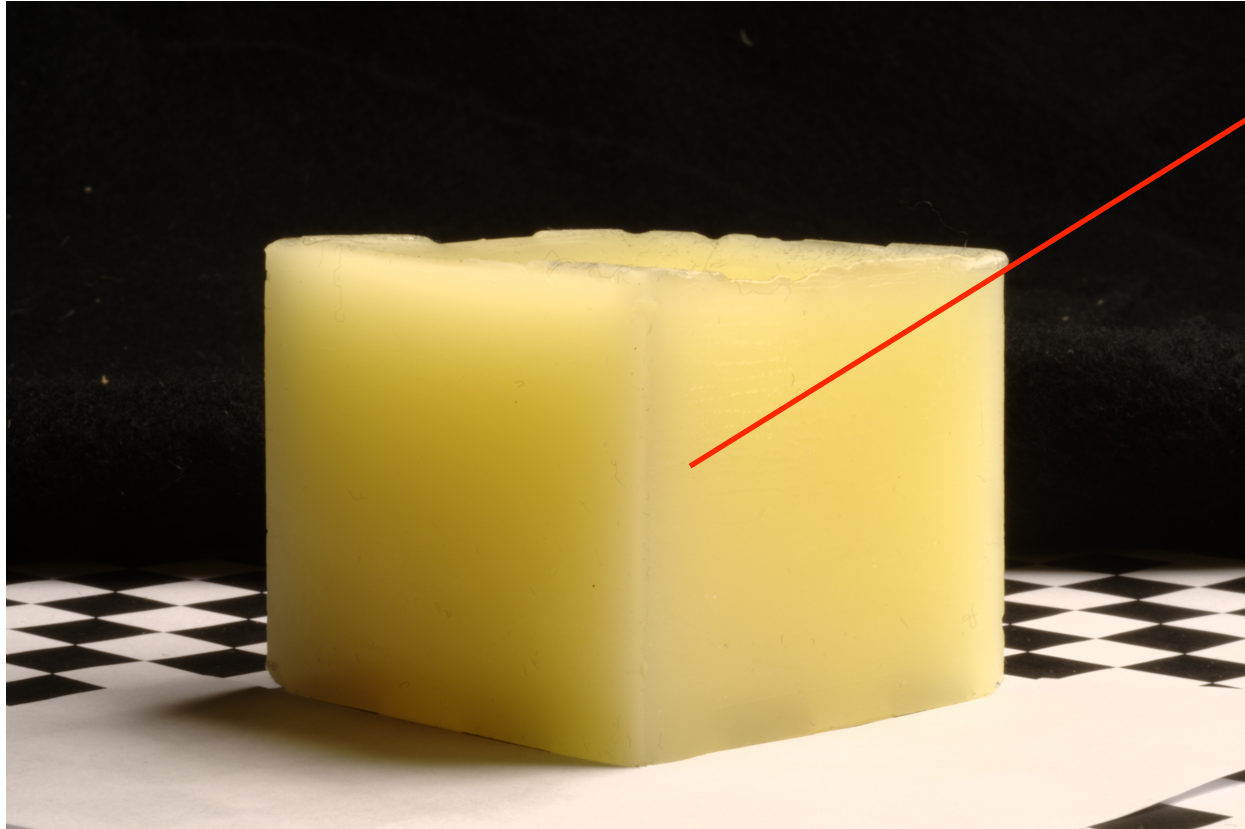
Deep physical depth



Questions

- How does translucency influence perception of 3D shape?
- How does 3D shape, especially sharp edges, influence perception of translucency?

Dramatic gradient at sharp edges

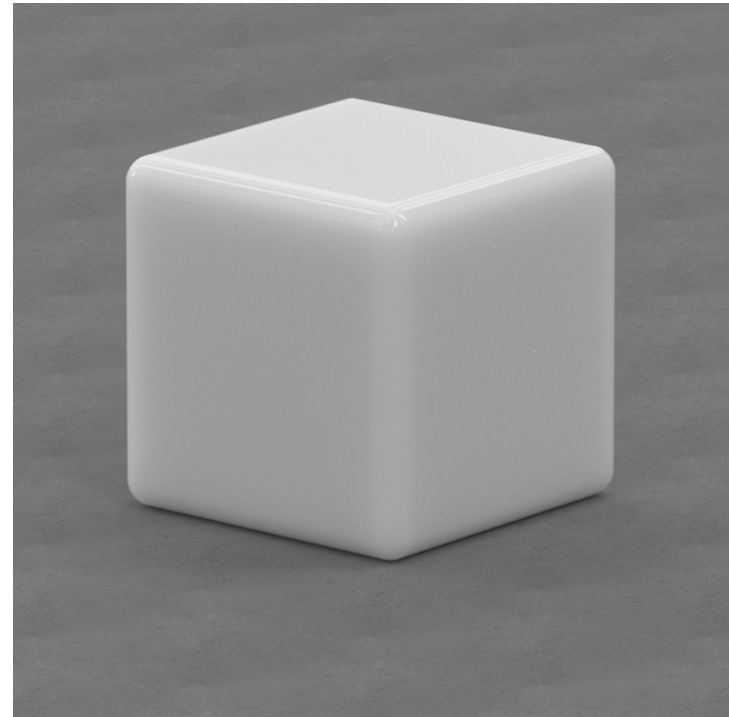
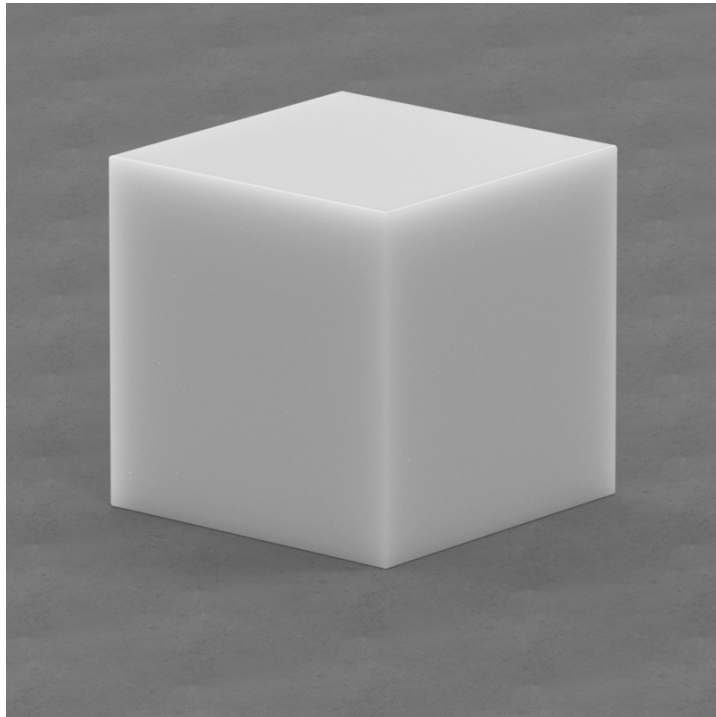


Sharp edge

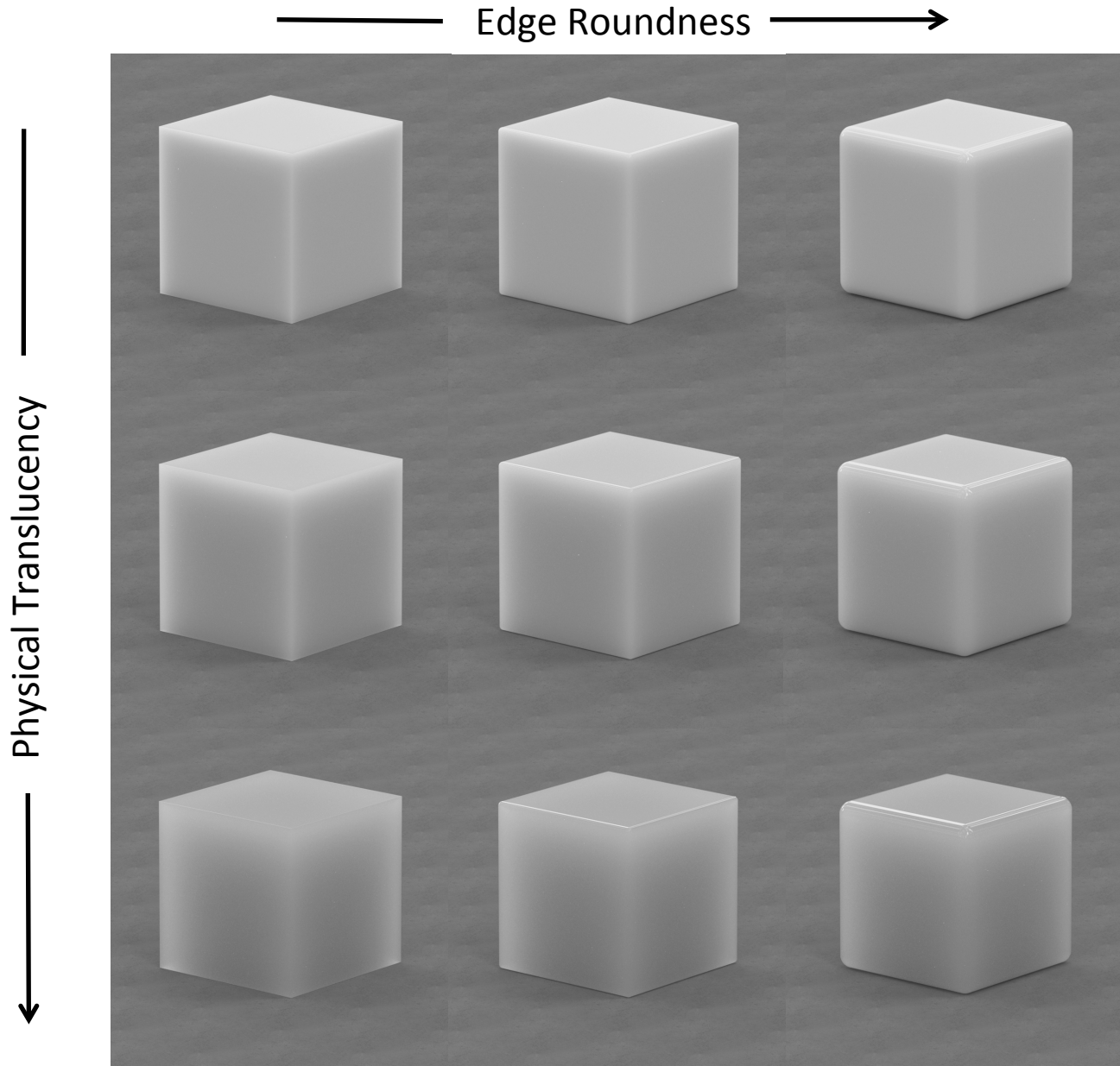
Material: Pyrawax

Effect of edge roundness on perception of translucency

Cube object: Constant physical translucency

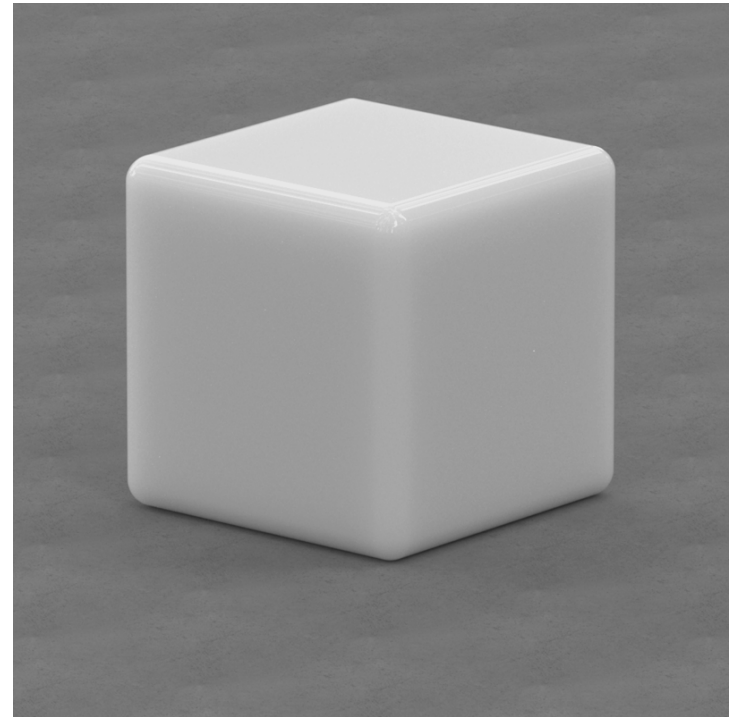
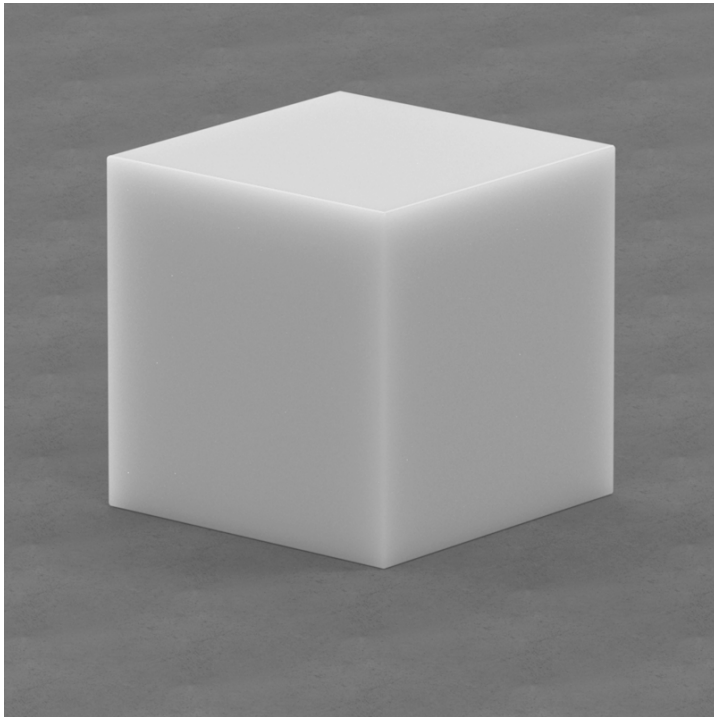


Experiment 2: Effect of edge sharpness on translucency



Task: Paired comparison

Which cube looks more translucent?

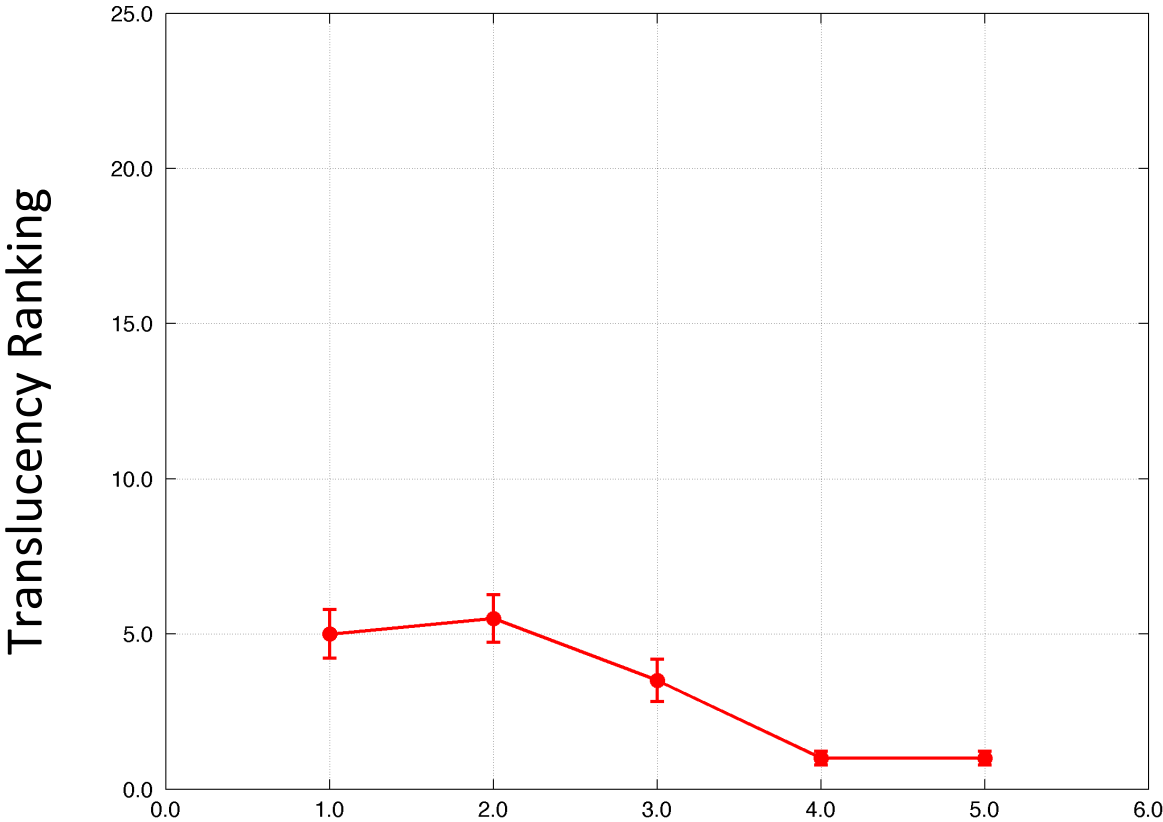


Summary of conditions

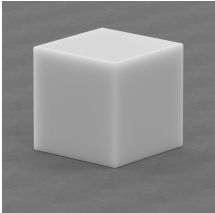
- 5 edge roundness parameters
- 5 physical translucency parameters
- Environment map: Grove and Campus
- Ranking of translucency was constructed from paired comparisons (L.L. Thurstone)

Results: Effect of edge roundness on the ranking of translucency

N= 9

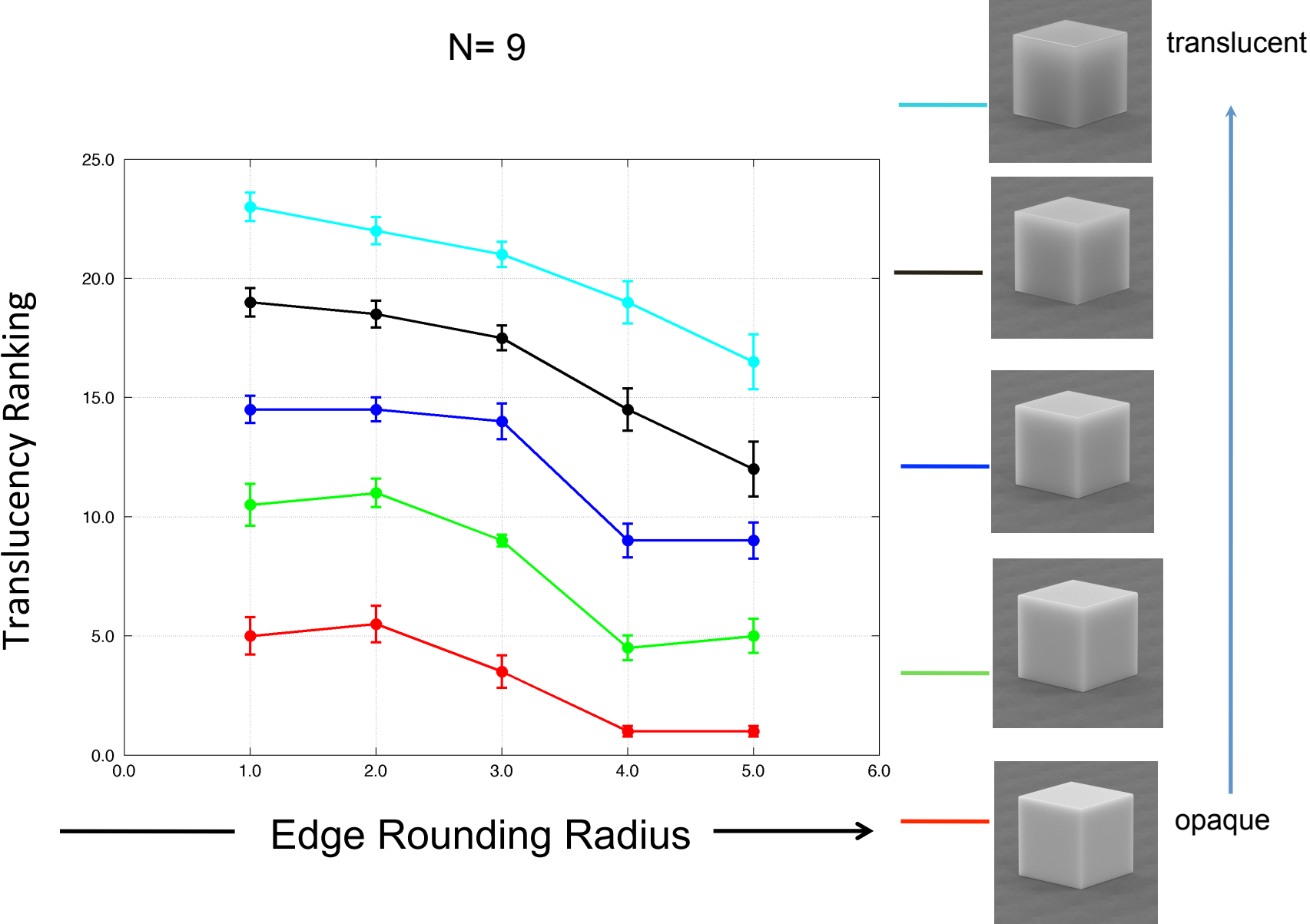


Edge Rounding Radius



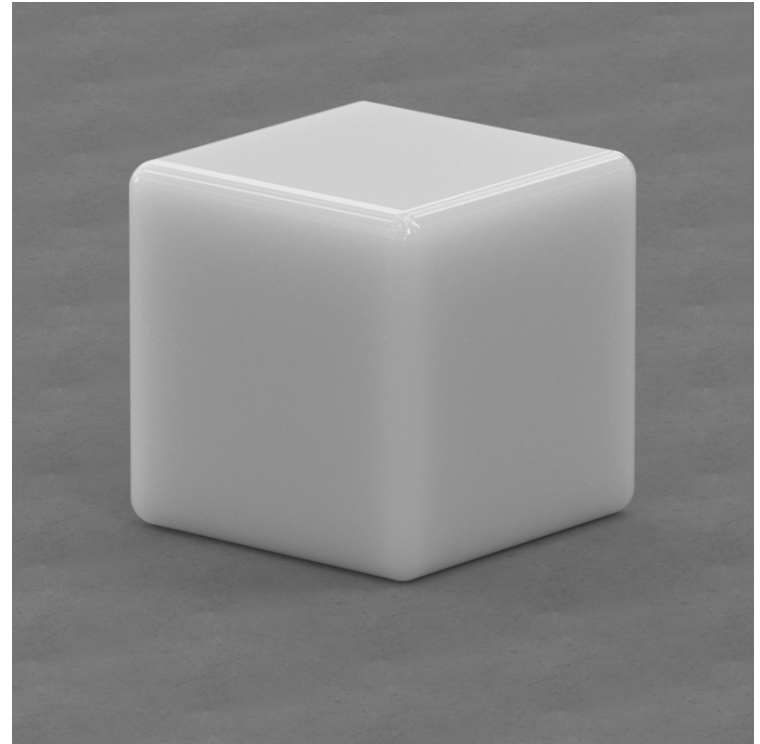
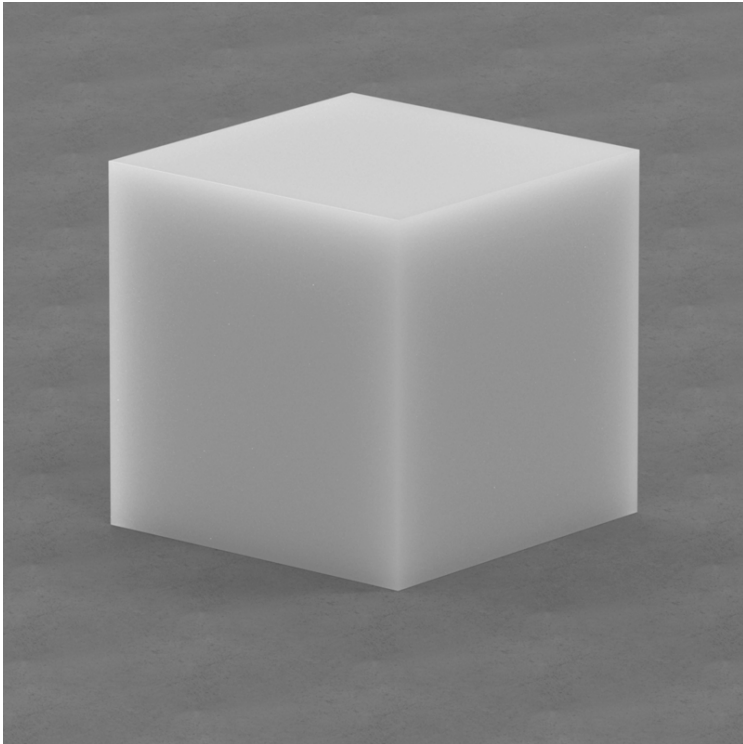
opaque

Results: Effect of edge roundness on the ranking of translucency



Summary

Shape influences the perception of translucency: objects with sharper edges look more translucent than ones with rounder edges.



Color variation is an important cue for translucency



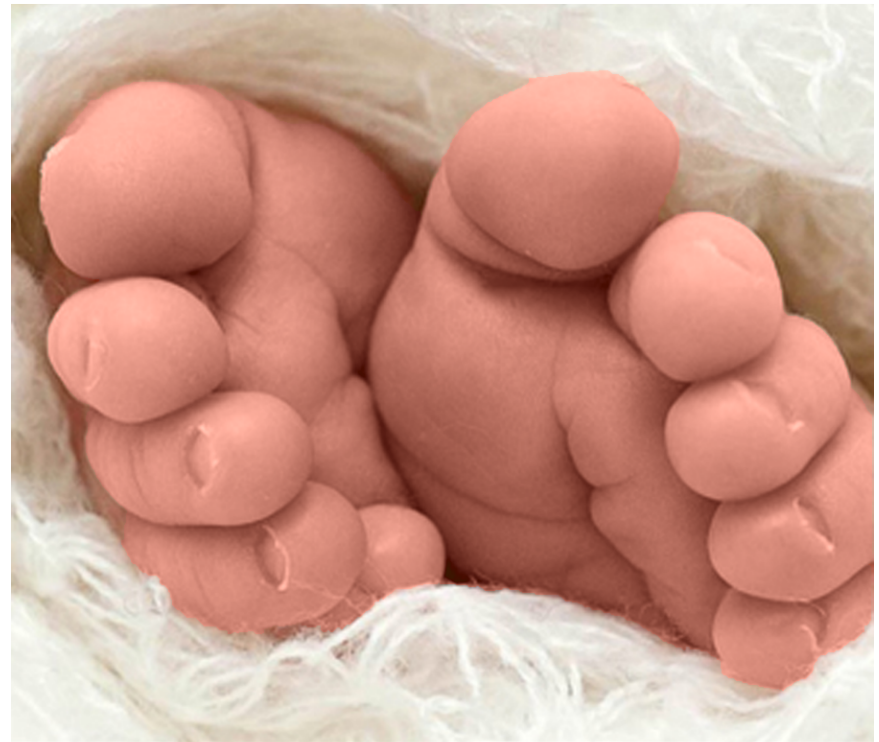
No babies were harmed in the making this talk!

Color variation is an important cue for translucency

Original



Constant Hue and Saturation



No babies were harmed in the making this talk!

Conclusions

- Physical translucency influences the perception of object shape: translucent convex objects look more shallow than opaque ones.
- Shape influences the perception of translucency: objects with sharper edges look more translucent.

Acknowledgement

Ioannis Gkioulekas



Shuang Zhao



Asher Dunn



Todd Zickler



Ted Adelson

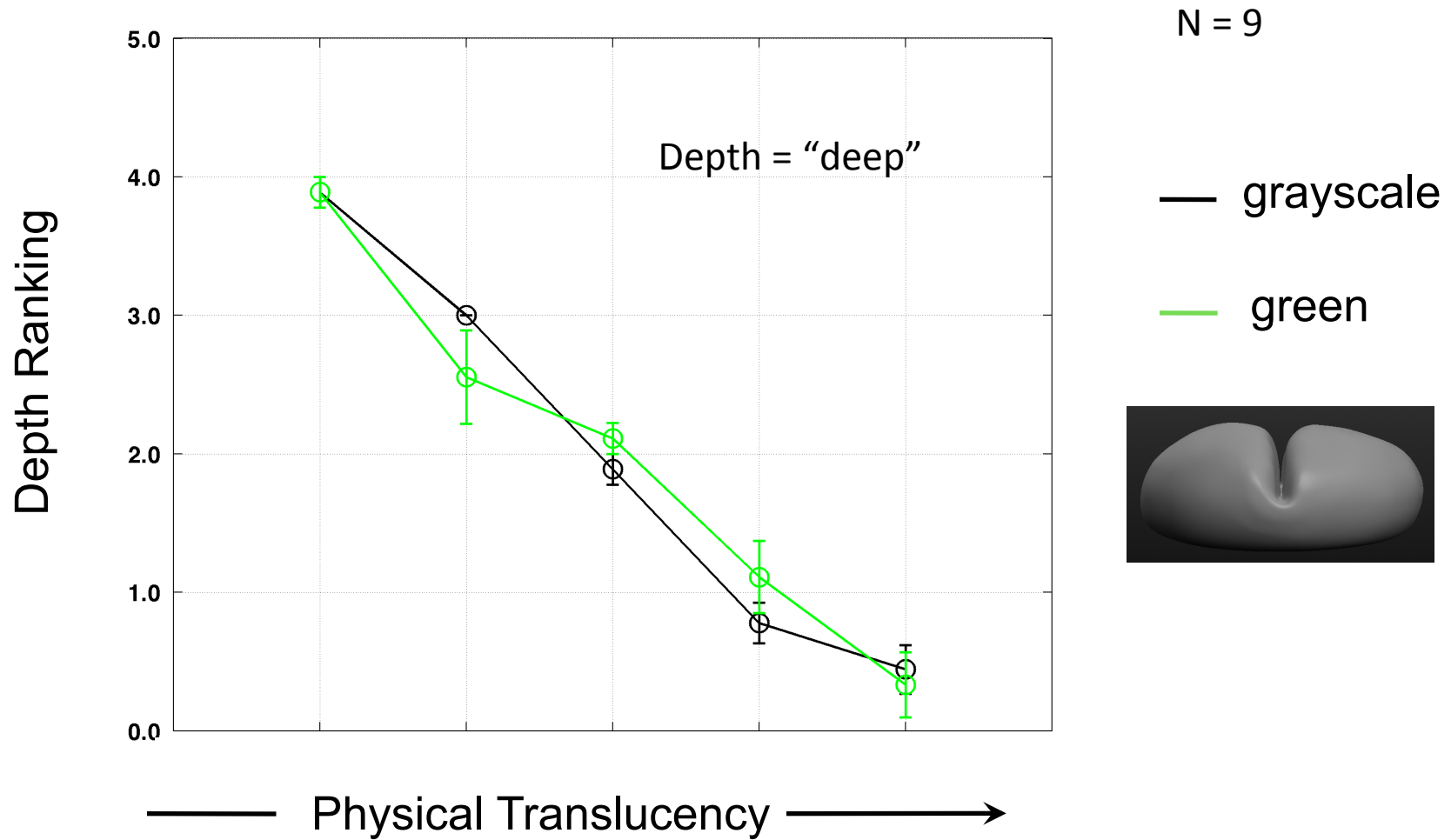


Kavita Bala

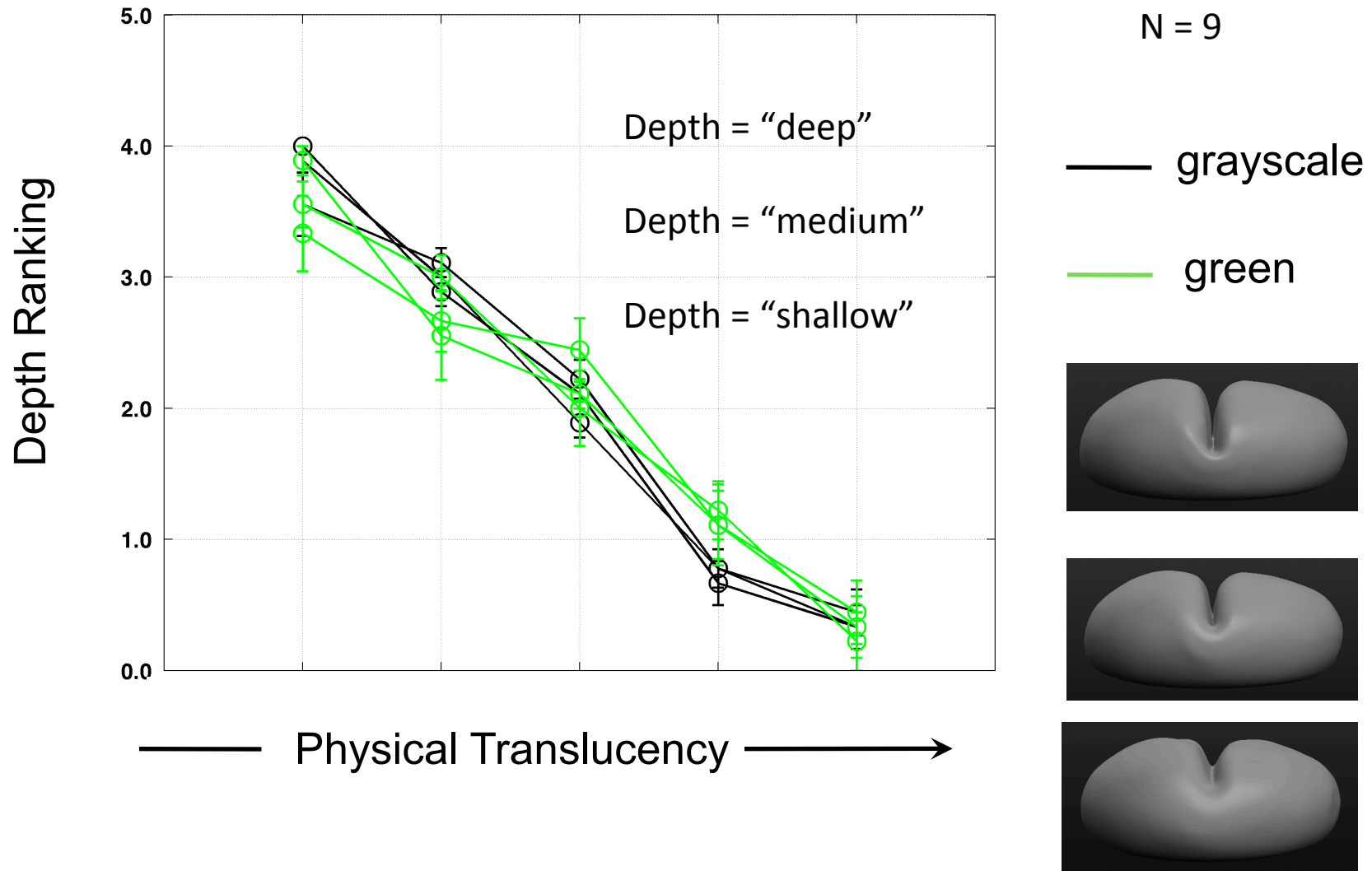


end

Results: Effect of translucency on depth ranking (same physical depth)

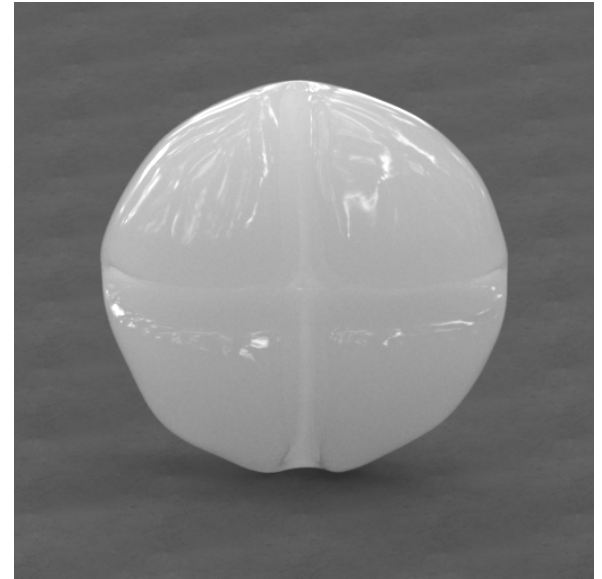
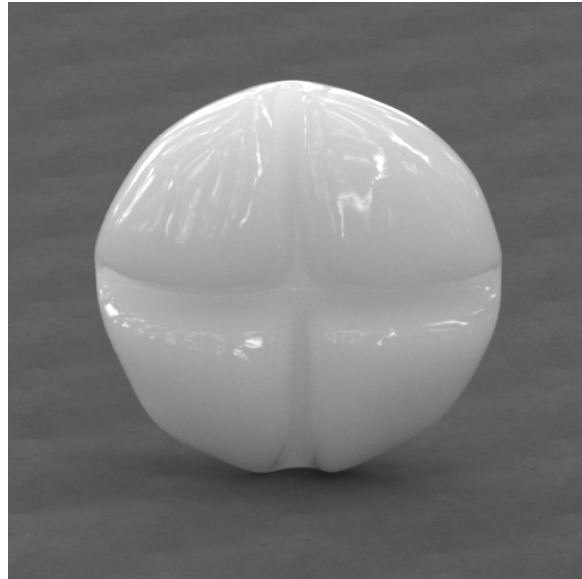
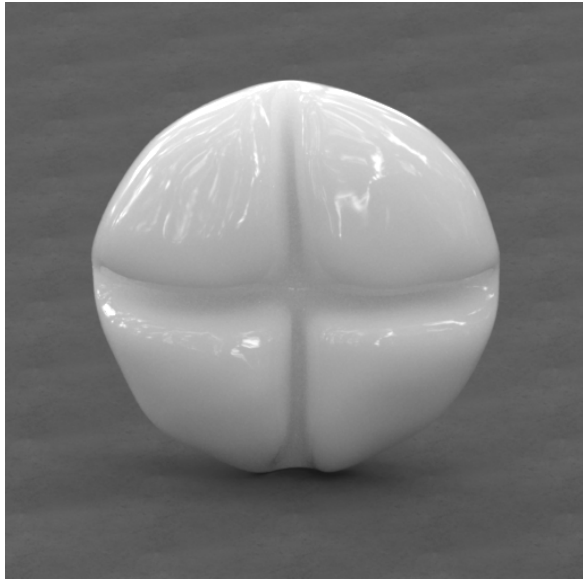


Results: Effect of translucency on depth ranking (same physical depth)



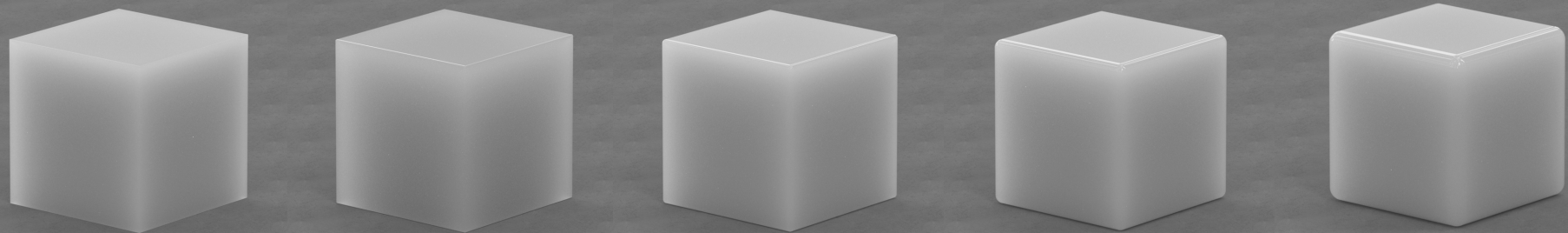
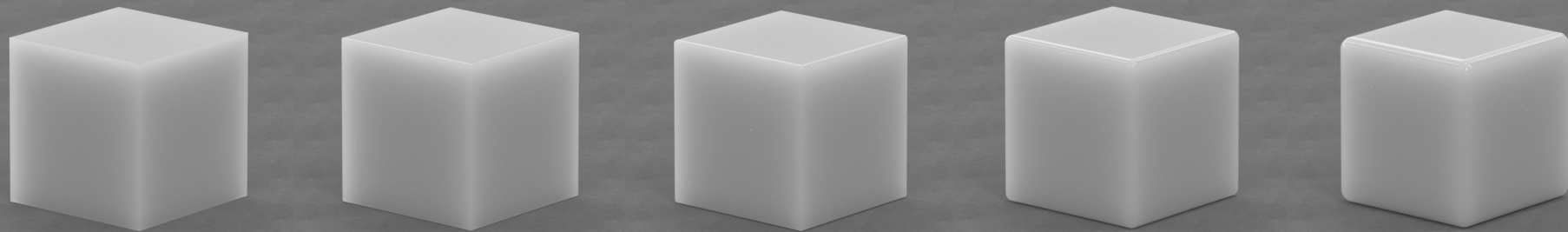
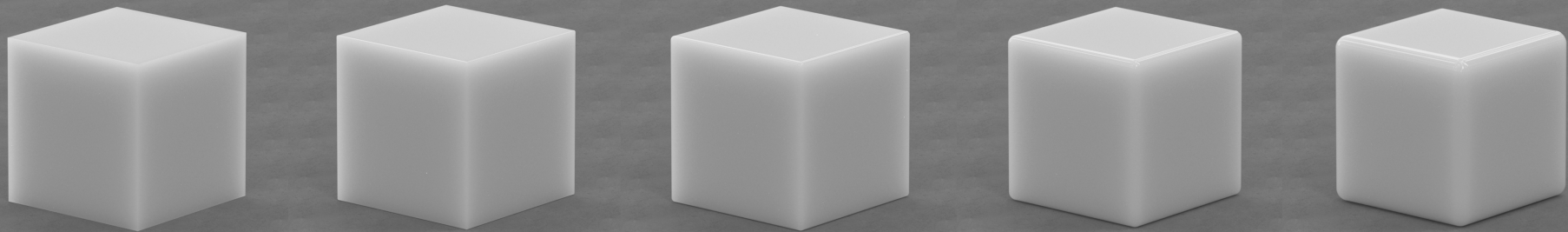
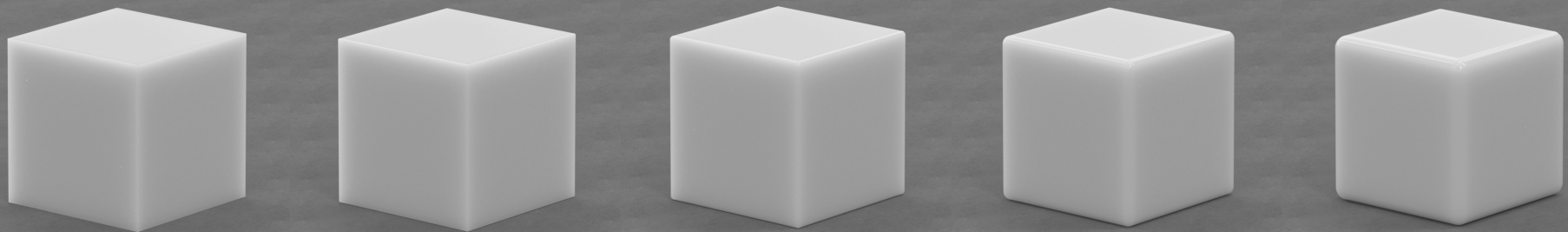
Experiment 1: Effect of translucency on perceived shape

Bun object: Constant physical shape

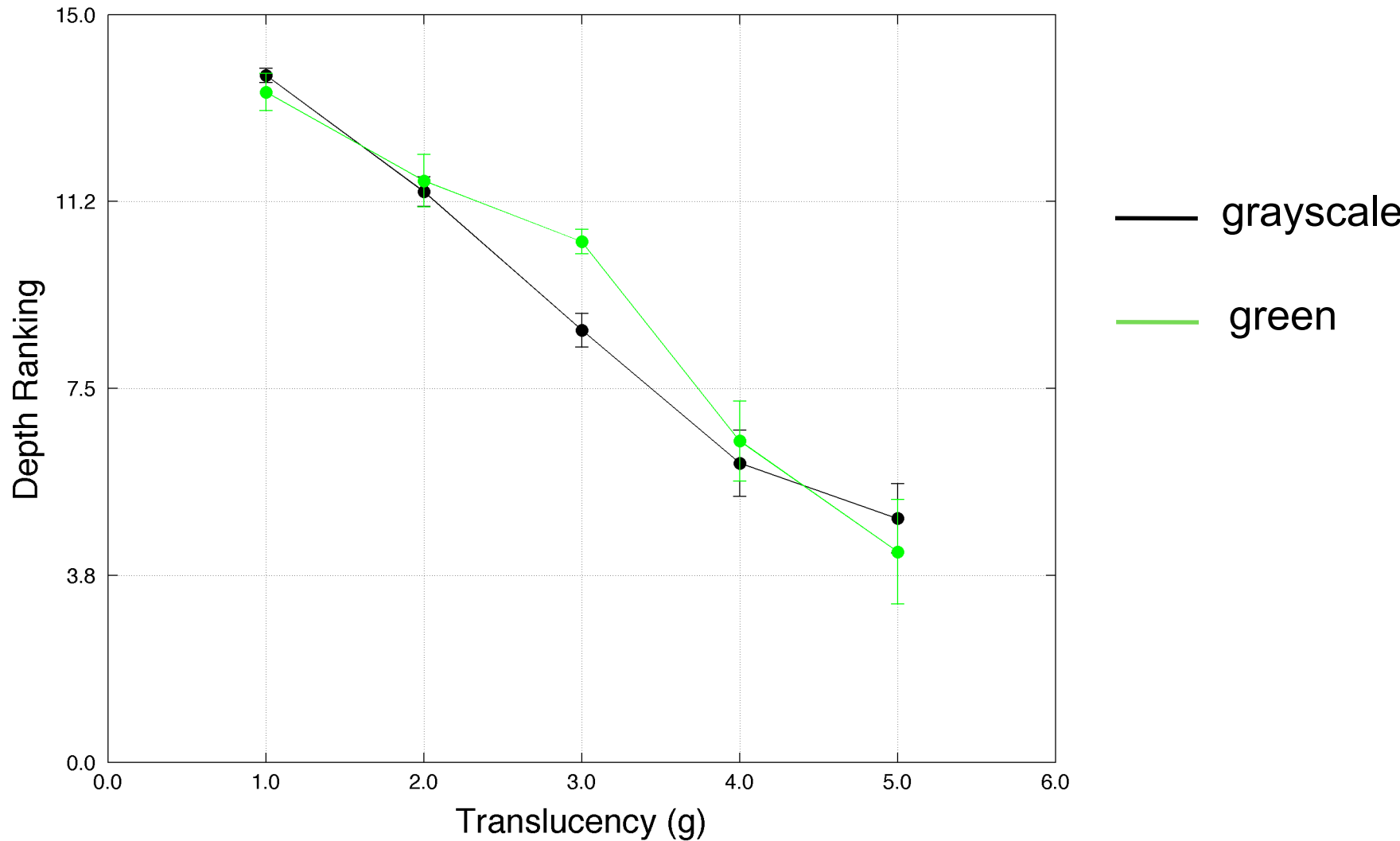


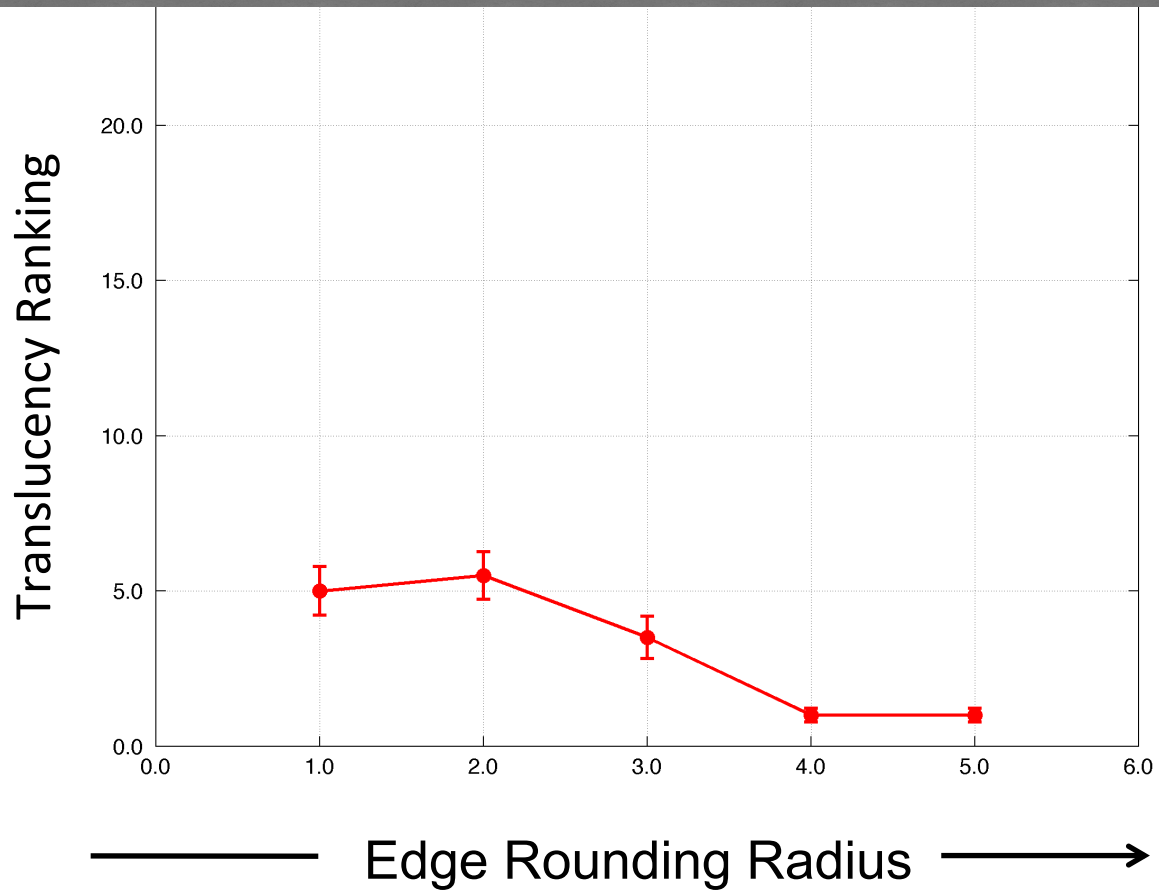
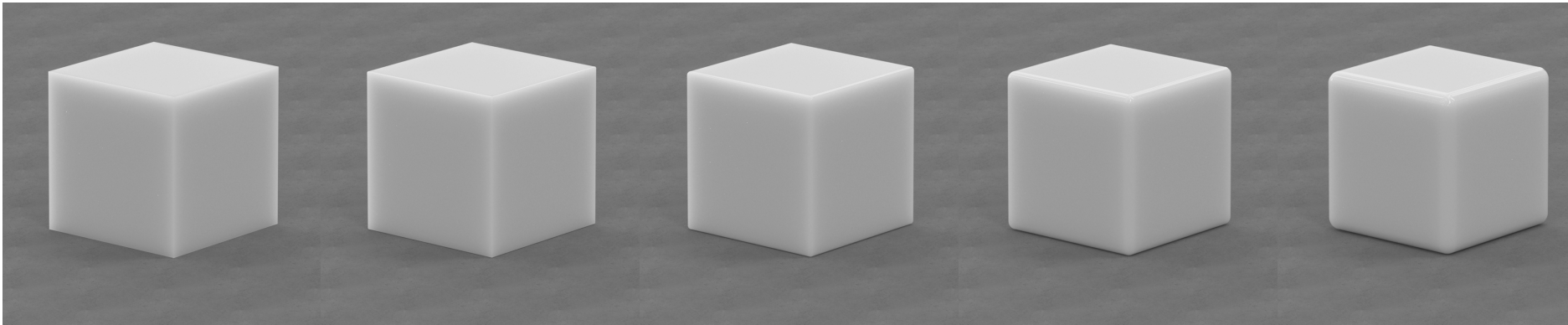
————— Increasing Physical Translucency —————>

Rendered by Ioannis Gkioulekas



Effect of translucency on depth ranking (including 3 depths)





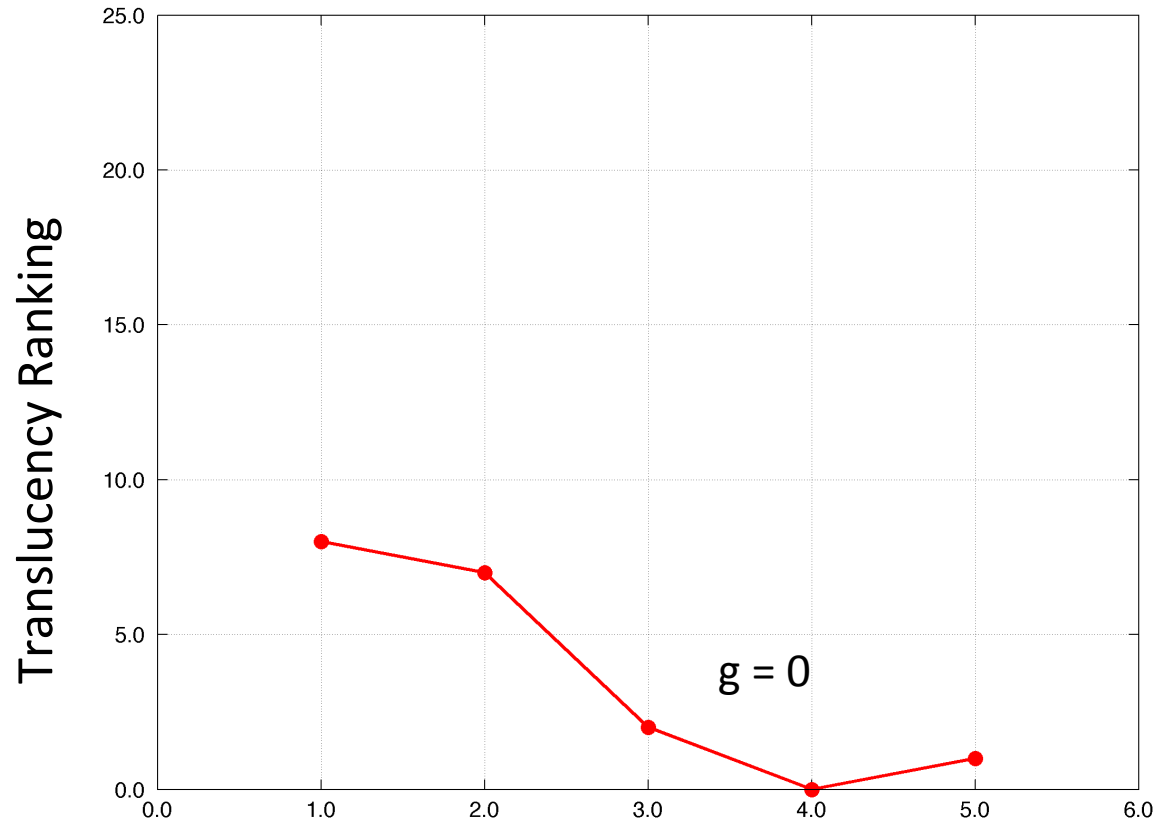
Does color influence shape and material perception?



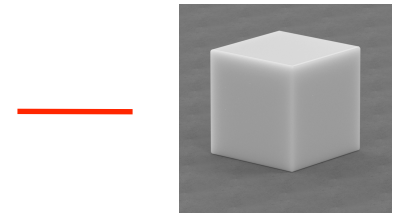
From Ted Adelson

Effect of edge roundness on the ranking of translucency

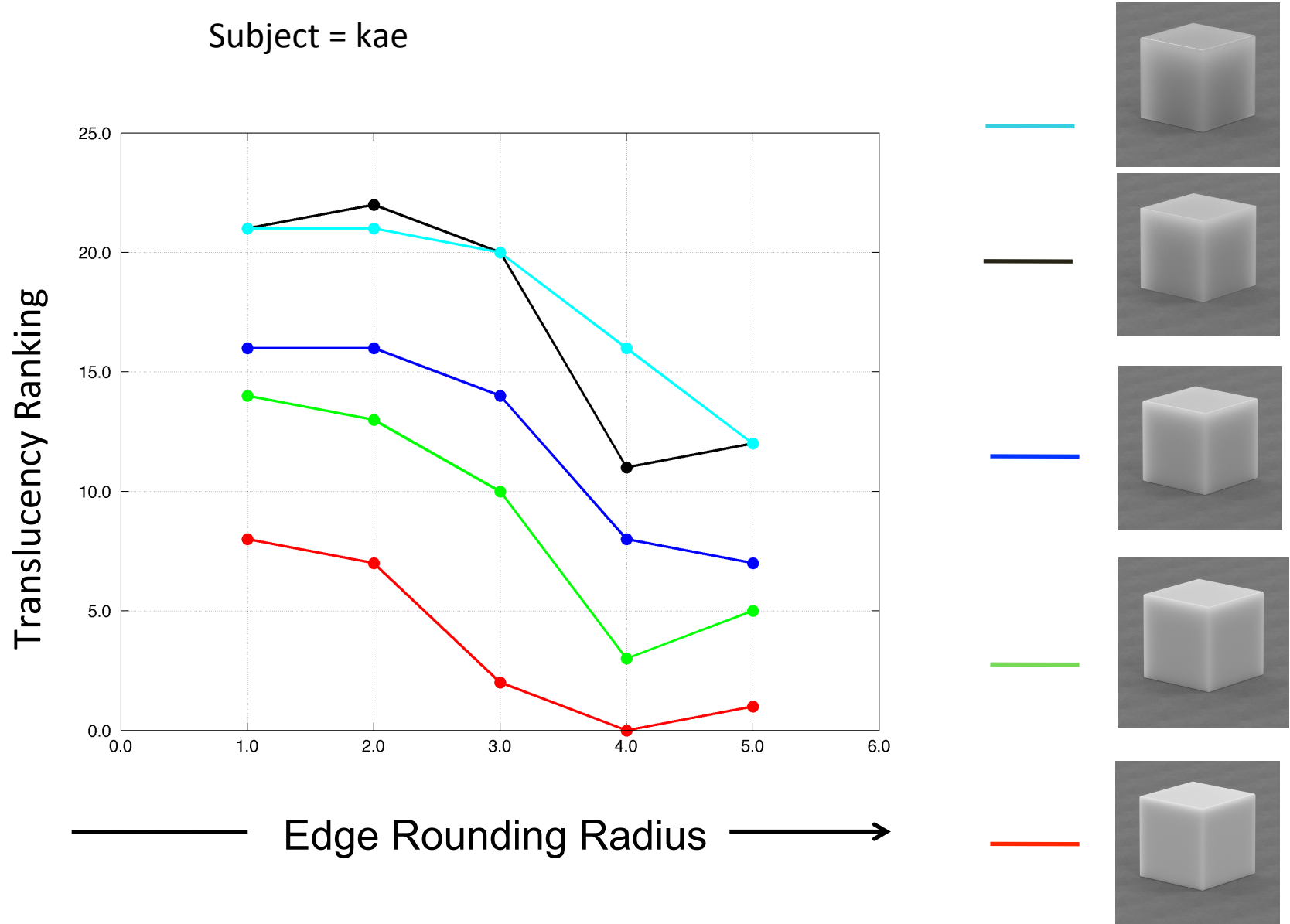
Subject = kae



————— Edge Rounding Radius —————>



Effect of edge roundness on the ranking of translucency

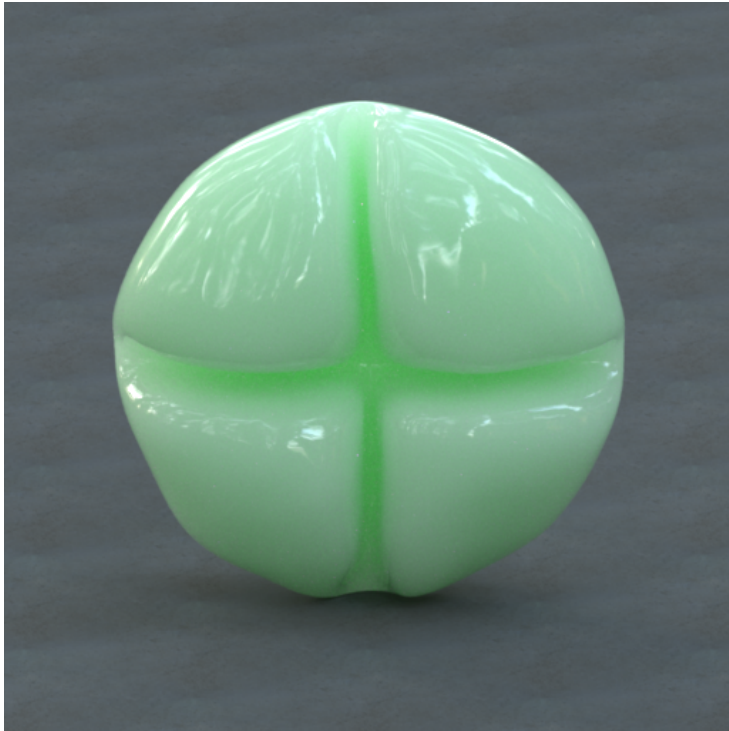


3. Color Variation improves shape perception

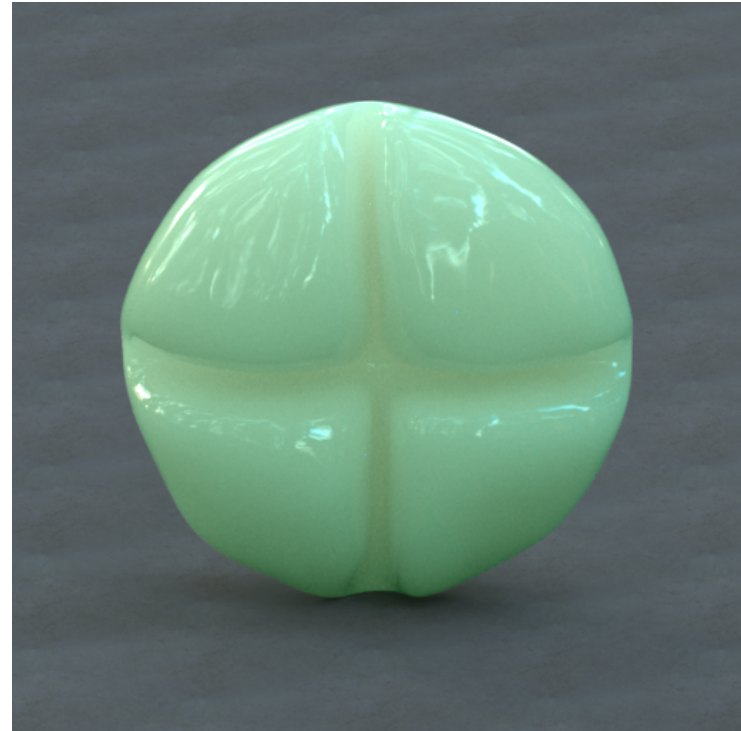


3. Color Variation improves shape perception

Full color



Constant Chroma



Cues: Gradients of luminance and color

Pyrawax

Parafin wax

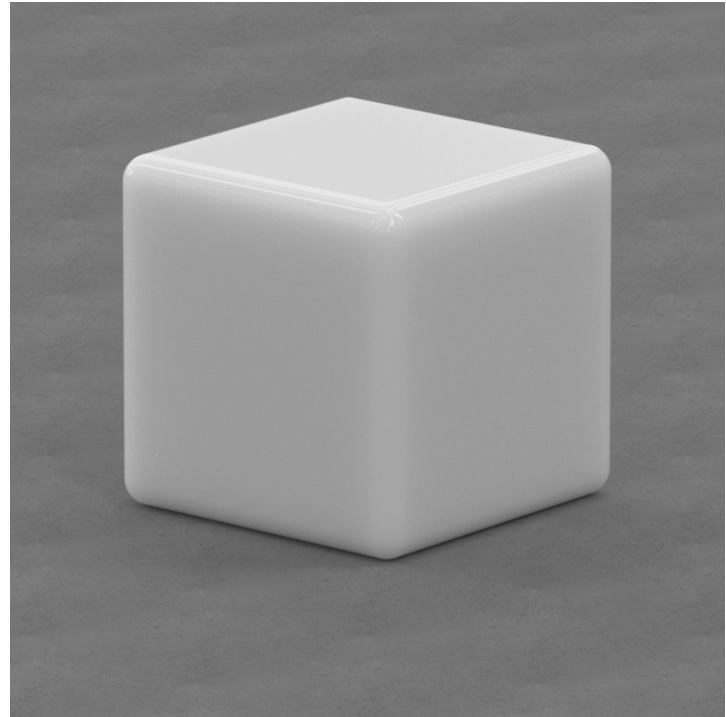
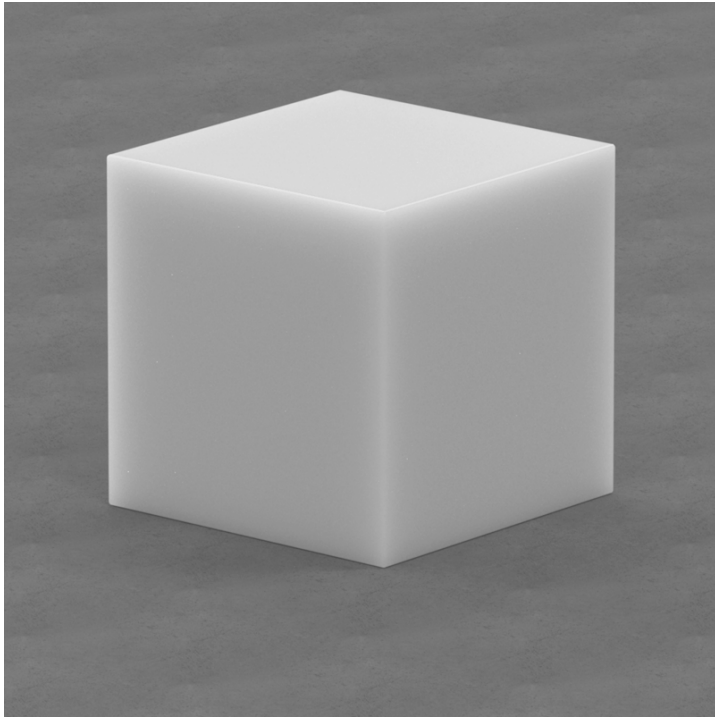
Soap



Translucent Materials



Experiment 1: Effect of edge sharpness on translucency



Rendered by Ioannis Gkloulekas

Different types of translucency



Source: flickr

Color variation in translucent materials



From Ionanis Gkiouslekas

Color variation in translucent materials



From Ionanis Gkiouslekas

Color variation in translucent materials



From Ionanis Gkiouslekas

Question: Does sub-surface scattering affect shape perception?

Opaque (BRDF)



Translucent (BSSRDF)



Rendered by Asher Dunn, Mitsuba Renderer
<http://www.mitsuba-renderer.org/>