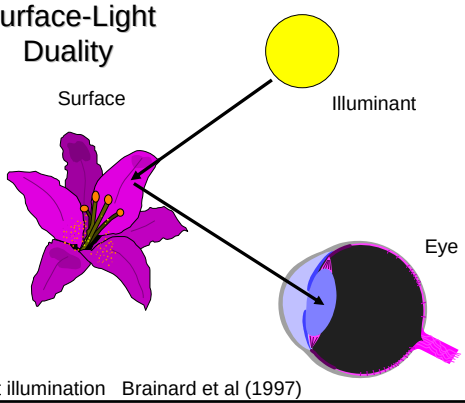
G89.2223 Perception
Maloney

October 14, 2009

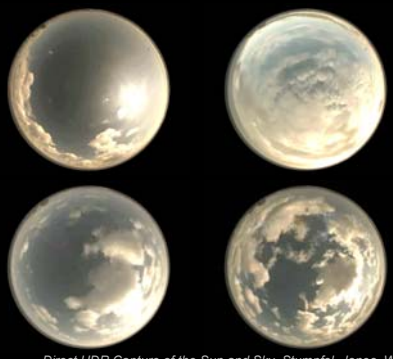
Surface Color Perception 2
Color in 3D

Surface-Light Duality



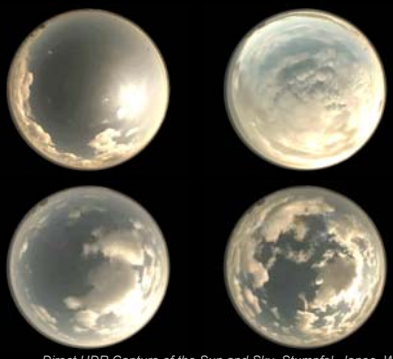
Equivalent illumination Brainard et al (1997)

Terrestrial Light Fields



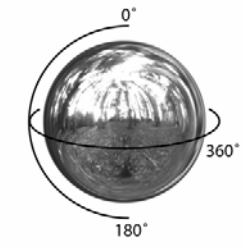
Direct HDR Capture of the Sun and Sky. Stumpfel, Jones, Wenger, Tchou,Hawkins & Debevec. SIGGRAPH 2004.

Terrestrial Light Fields

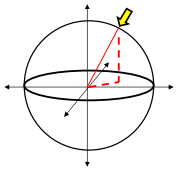


complex
dynamic

Direct HDR Capture of the Sun and Sky. Stumpfel, Jones, Wenger, Tchou,Hawkins & Debevec. SIGGRAPH 2004.



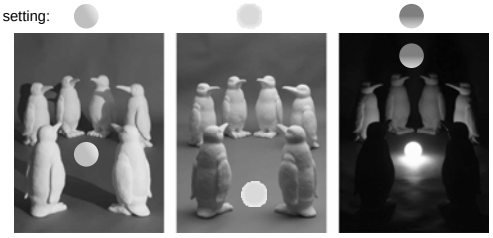
Light Field Inference



- ✓ Pentland (1982)
- ✓ Koenderink et al. (2003, 2004)
- ✓ Khang et al. (2006)

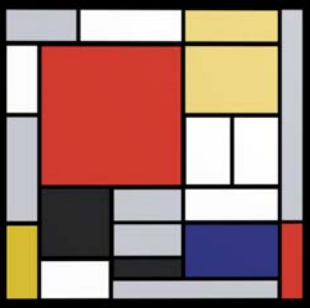
Light Field Inference

final setting:



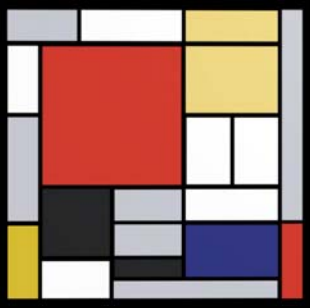
✓*Koenderink, Pont, van Doorn, Kappers, Todd, Perception, 36, 2007*

A Thought Experiment



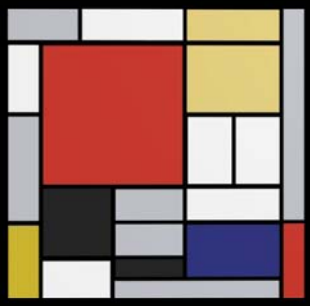
Piet Mondrian, Composition with Red, Yellow, Blue and Black
1921, Gemeentemusuem, The Hague

The Mondrian Singularity



Piet Mondrian, Composition with Red, Yellow, Blue and Black
1921, Gemeentemusuem, The Hague

Edwin Land

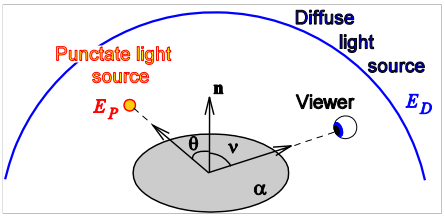


Experiment 1

Perceived Orientation and Perceived Color of Matte Surfaces

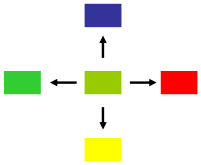
Boyaci, H., Doerschner, K. & Maloney, L. T. (2004), Perceived surface color in binocularly-viewed scenes with two light sources differing in chromaticity. *Journal of Vision*, **4**, 664-679.

Scenes



Scenes

Task: Achromatic Setting



Experiment 2

- 20 repetitions of each condition
- 2 light locations
- 10 rotations (5 azimuth, 5 elevation)
- 4 naïve observers

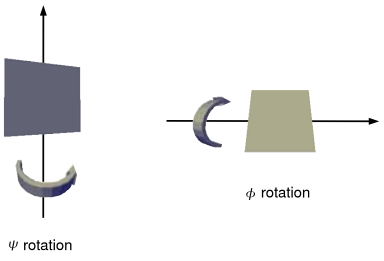
Blue-Yellow Balance Settings

$$\Lambda^{B}$$

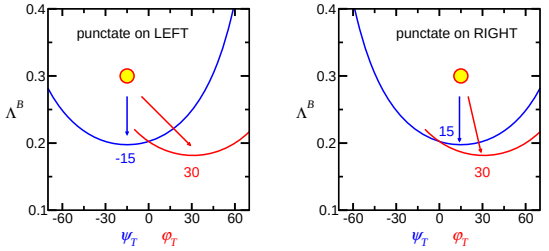
Equivalent illuminant

"How blue the light impinging on the test patch seems to be …"

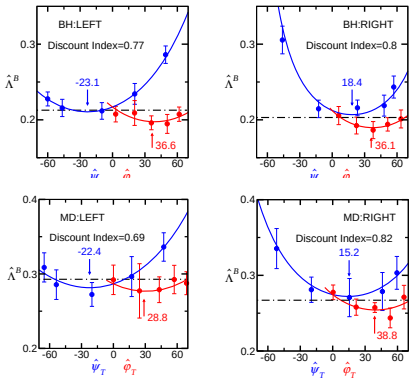
Coordinates

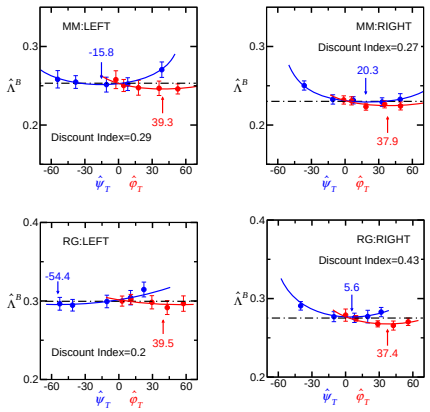


Ideal Observer

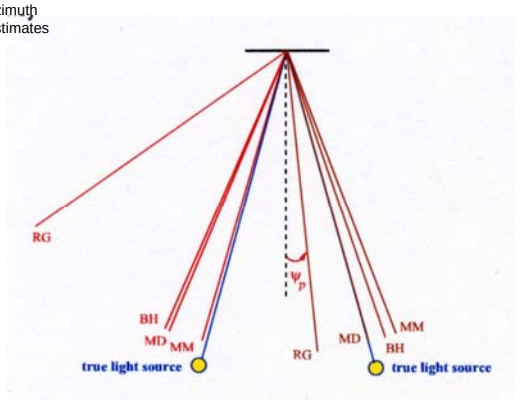


Equivalent illuminant

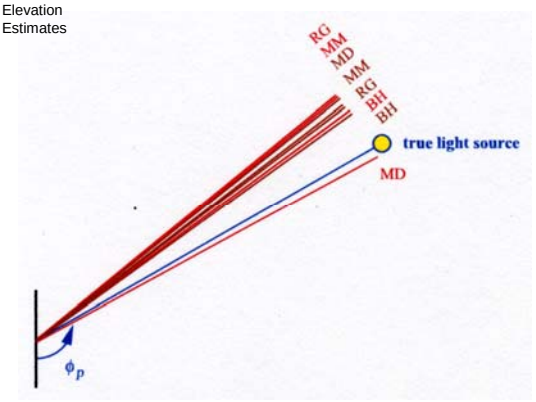




Azimuth Estimates



Elevation Estimates



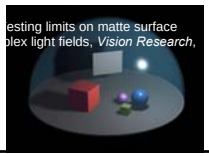
Conclusions: Experiment 1

In scenes with a punctate and diffuse light sources differing in chromaticity,

•Observers partially discount illumination changes with orientation

•Observers effectively estimate information about the spatial and chromatic distribution of illumination in the scene (the light field).

esting limits on matte surface
plex light fields, *Vision Research*,



Experiment 2

A dynamic analogue of lightness constancy

Foster, *Nascimento*

Gerhard, H. E. & Maloney, L. T. (in preparation)

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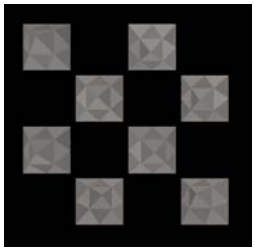
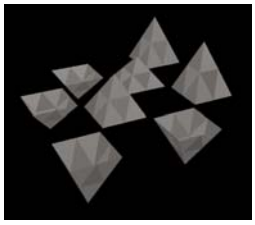
Stimuli: rendered scenes



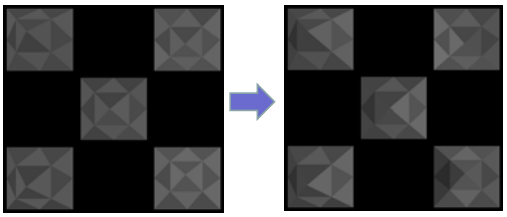
observer's view
(stereo pair, binocular viewing)



rotated view

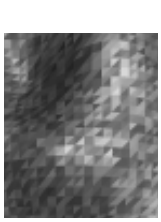
Light source moves

15°

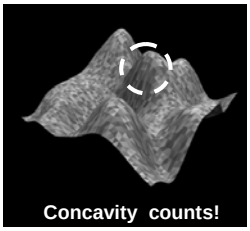


Note ambiguity

There's an ambiguity here…



OR

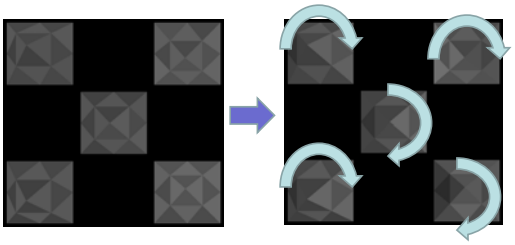


Concavity counts!

FVM 2009 25

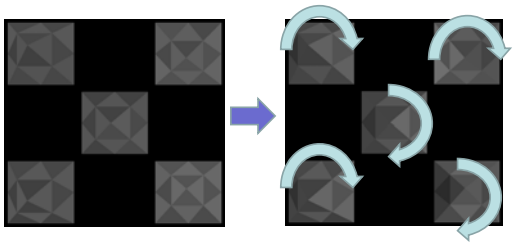
Matched change in albedos "scrambled light"

15°



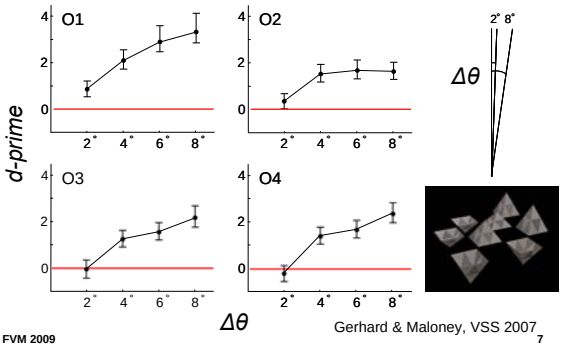
Matched change in albedos
"scrambled light"

15°



How accurately?

Dynamic Light Sensitivity



FVM 2009

Gerhard & Maloney, VSS 2007

7

On every trial

Either the light moves or there is a non-light change

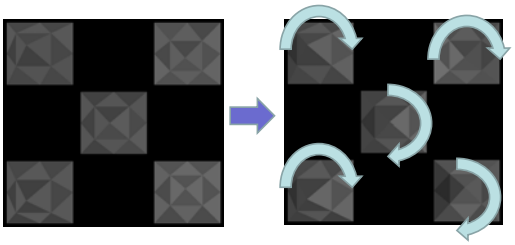
On half the trials a single surface in an unknown location Changes albedo

Your task: detect the surface change

Will your detection performance be better with light changes than non-light changes?

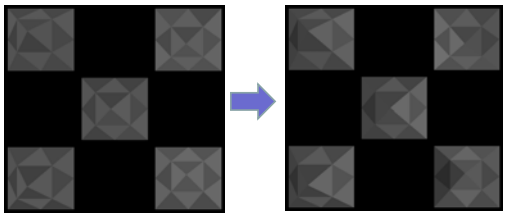
Thought Experiment
Detect single surface change

15°



Thought Experiment
Detect single surface change

15°



Note ambiguity

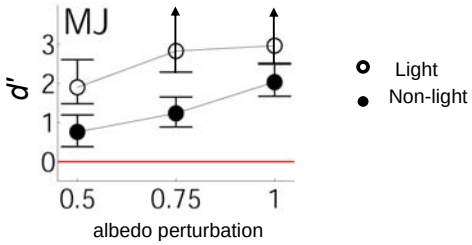
Methods

2 global light change conditions
light, scrambled light

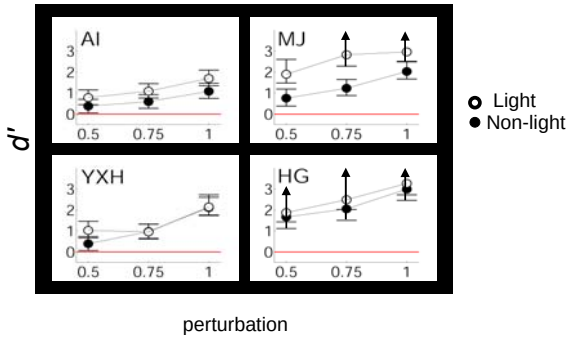
3 albedo perturbation levels
±50, ± 75, or ± 100%

240 trials per level per condition
1440 total

Results: one subject



Results



Results

$$\frac{d'_{light}}{d'_{non-light}} = 1.65$$

$t = 3.27$, $p < 0.001$

Experiment 3: Summary

Observers detect changes in the Light field and can use this information To improve detection of simultaneous Changes in surface albedo.

Gerhard, H. E. & Maloney, L. T. (in preparation)

Summary

The visual system can model the light field in space and time to some extent.

It can use this information to improve estimation of surface color and detection of surface color change.

Gerhard, H. E. & Maloney, L. T. (in preparation)