Module # 2—Seeing Lightness, Darkness, and Color

Visual Perception and the Brain

DUKE INSTITUTE *for* BRAIN SCIENCES

Topic 1. Seeing Lightness and Darkness

Lesson 1. Definitions

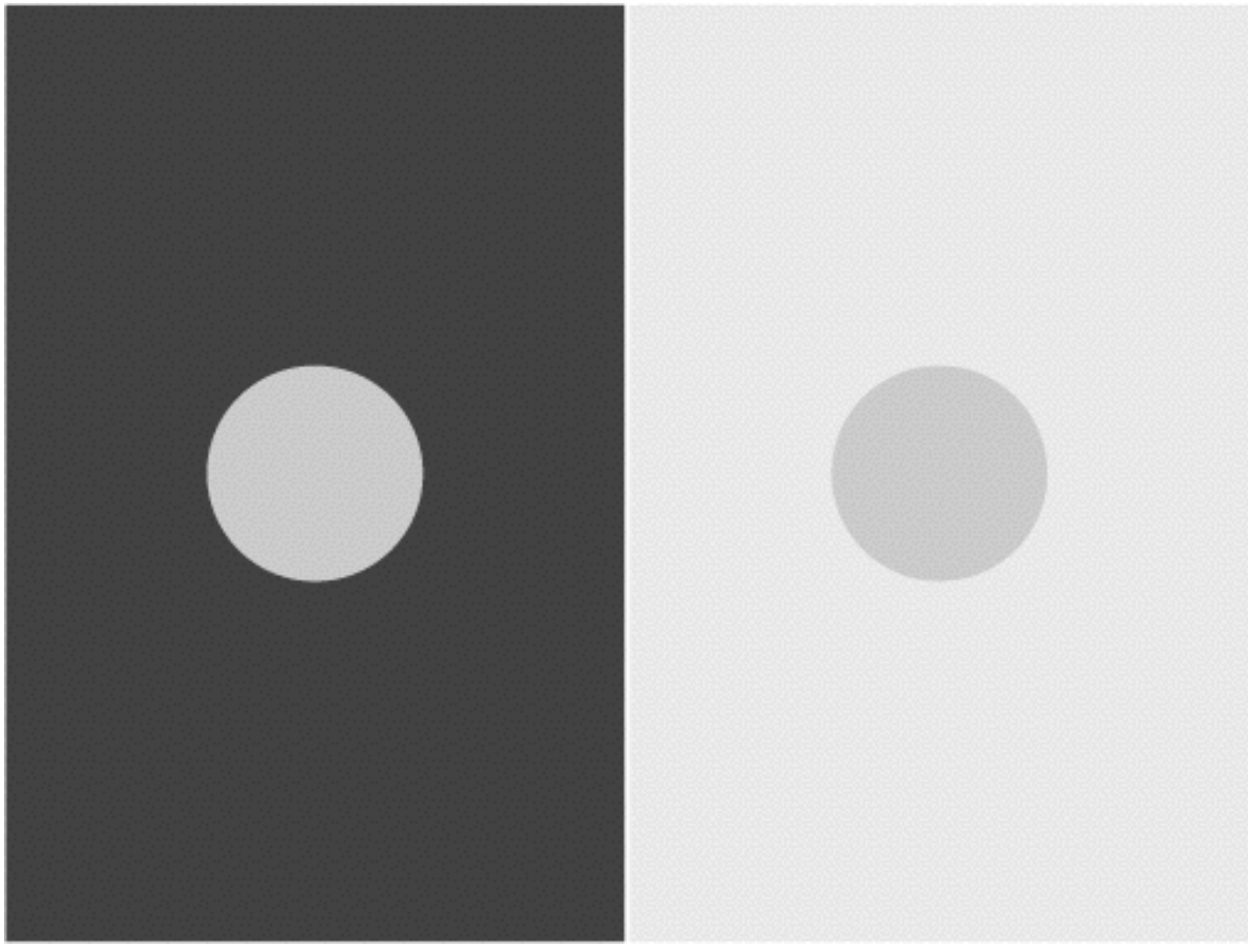
Definitions

- Luminance—an objective measurement of light intensity per unit area (e.g., candelas/square meter; physical)
- Lightness—a subjective impression of the intensity of light reflected from an object surface (no units; psychophysical)

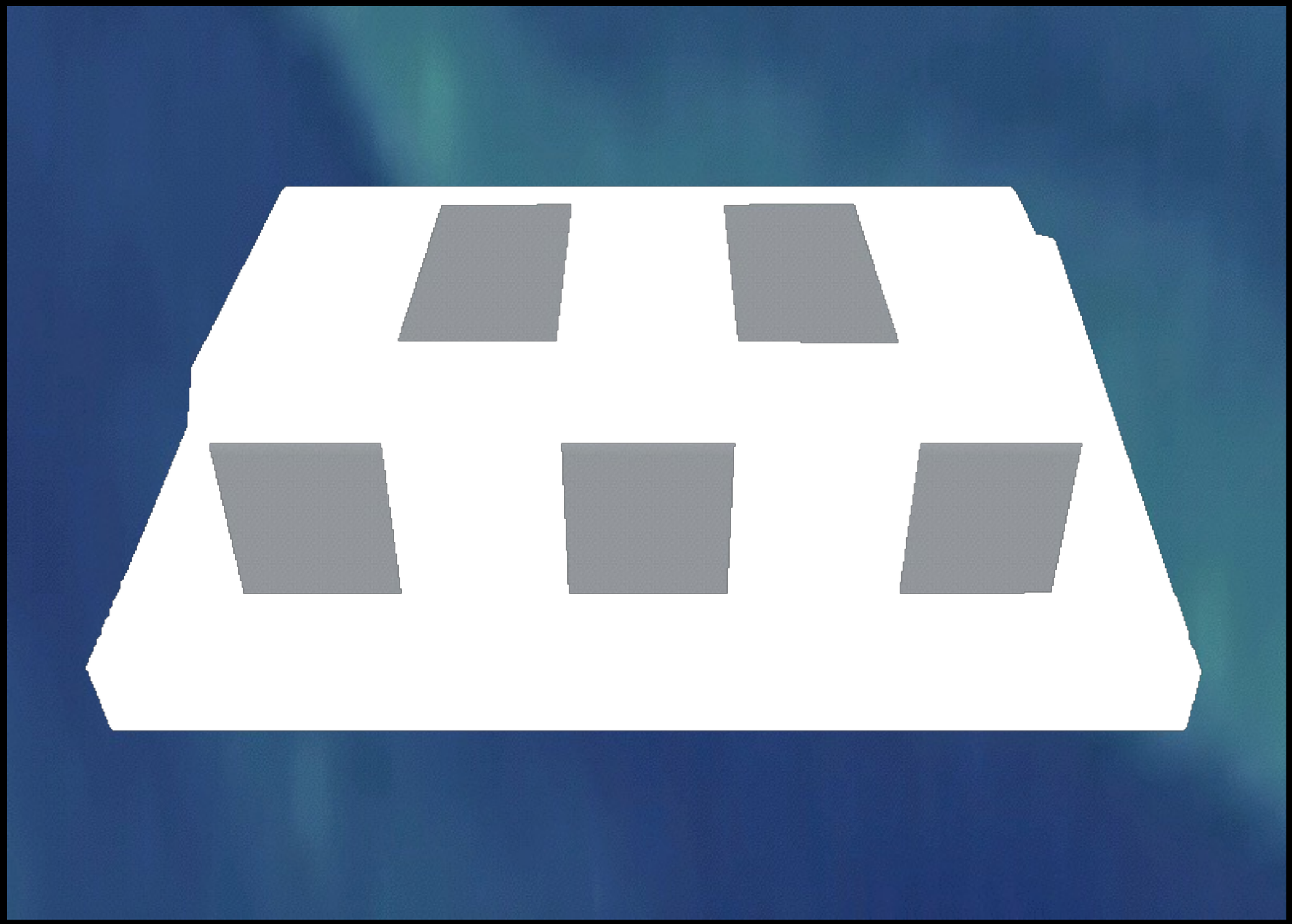
Lesson 2. Discrepancies between Luminance and Lightness

The standard example

The puzzle…



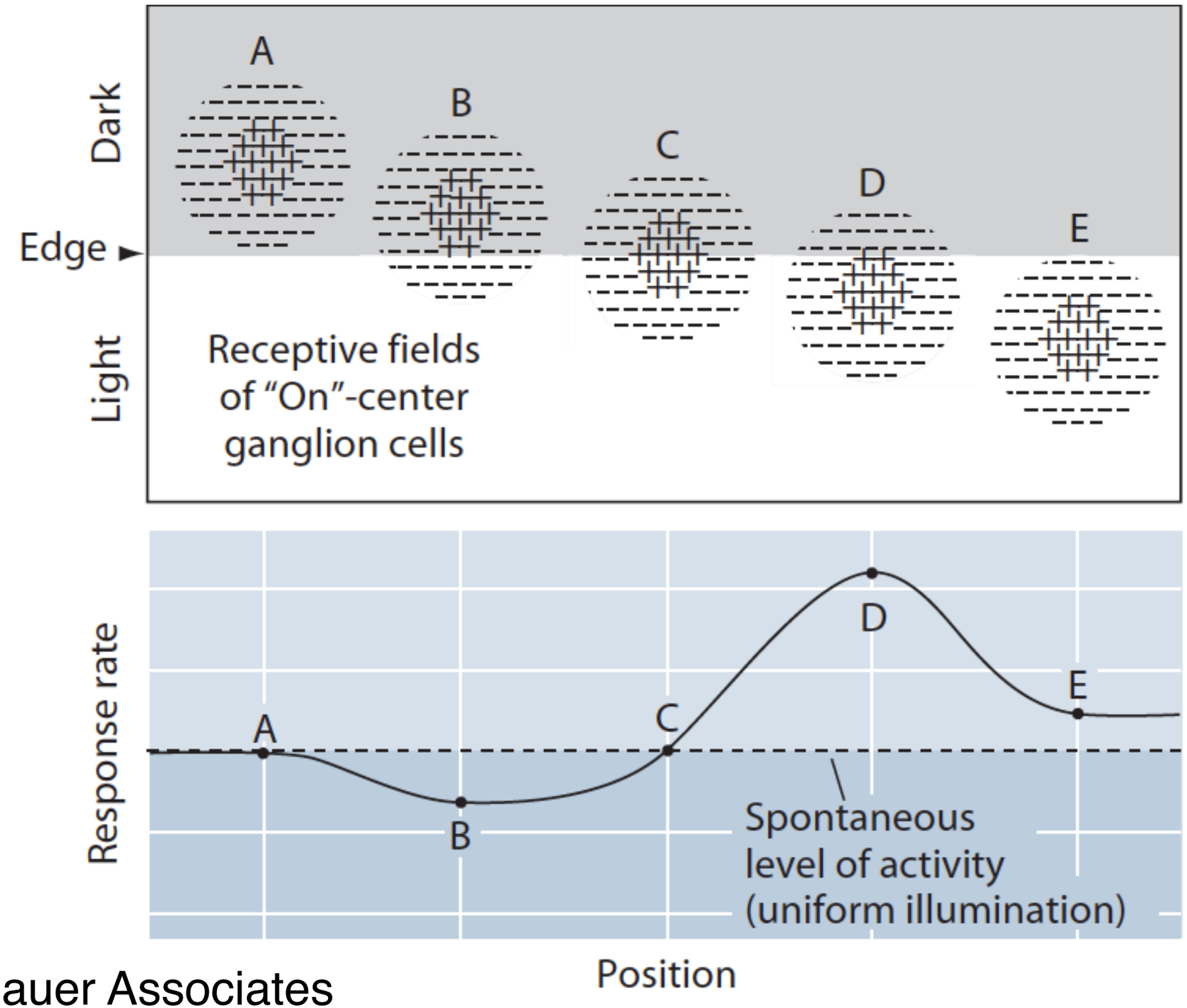
Seeing gray as black or white



A Conventional Explanation

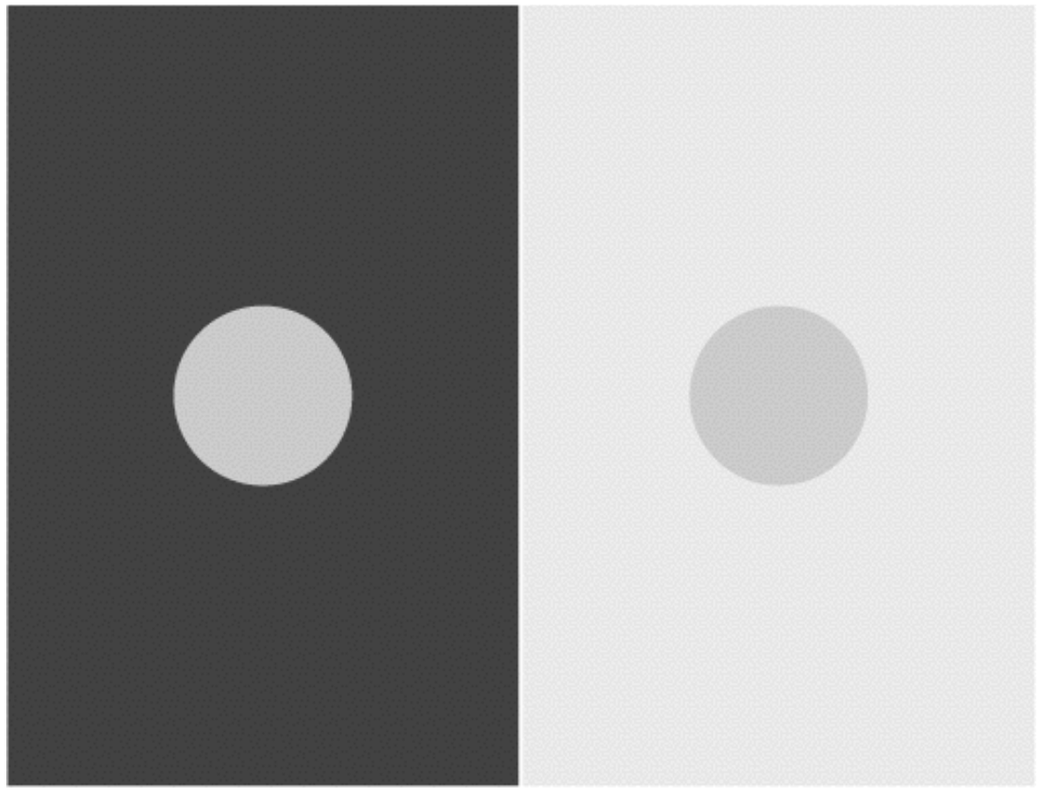
The difference between measured luminance and the lightness we actually see is an incidental consequence of biology; the visual wants to get it right, but does a sloppy job.

How this explanation works



Lesson 3. More Complex Examples as Counter Evidence

But this sort of explanation is foiled by the phenomenology of what we see



White's "illusion"

These effects are opposites….

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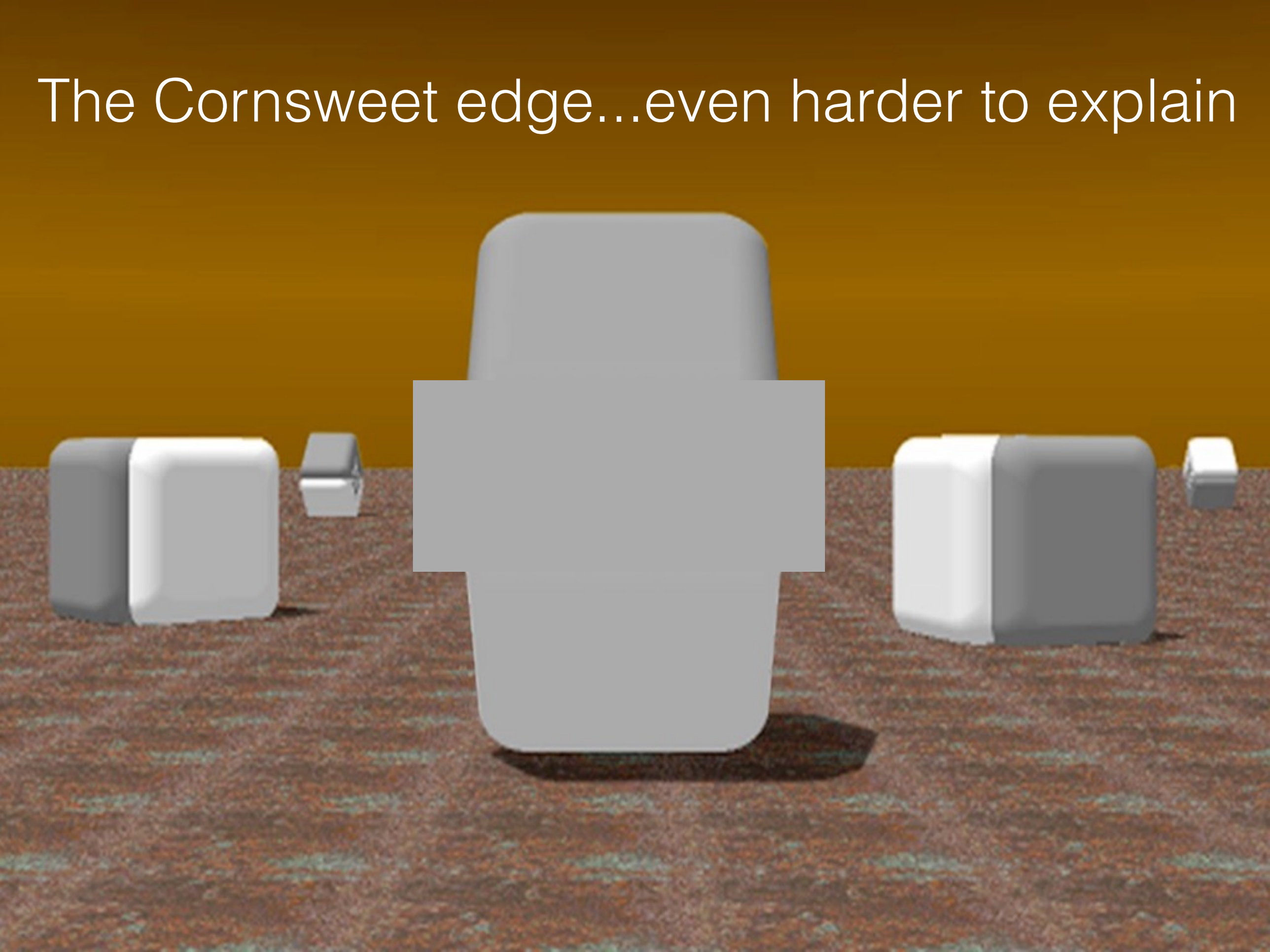
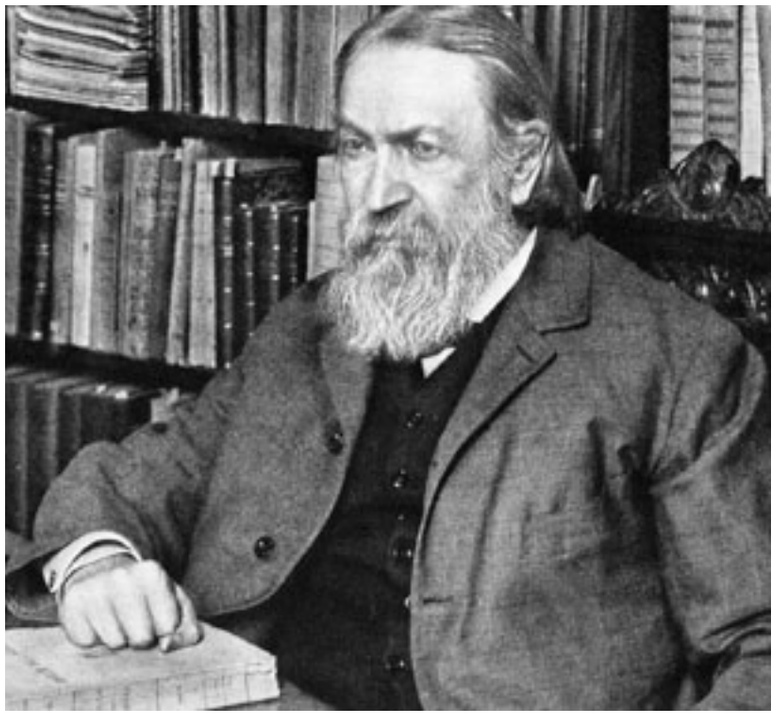
White's "illusion"

These effects are opposites….

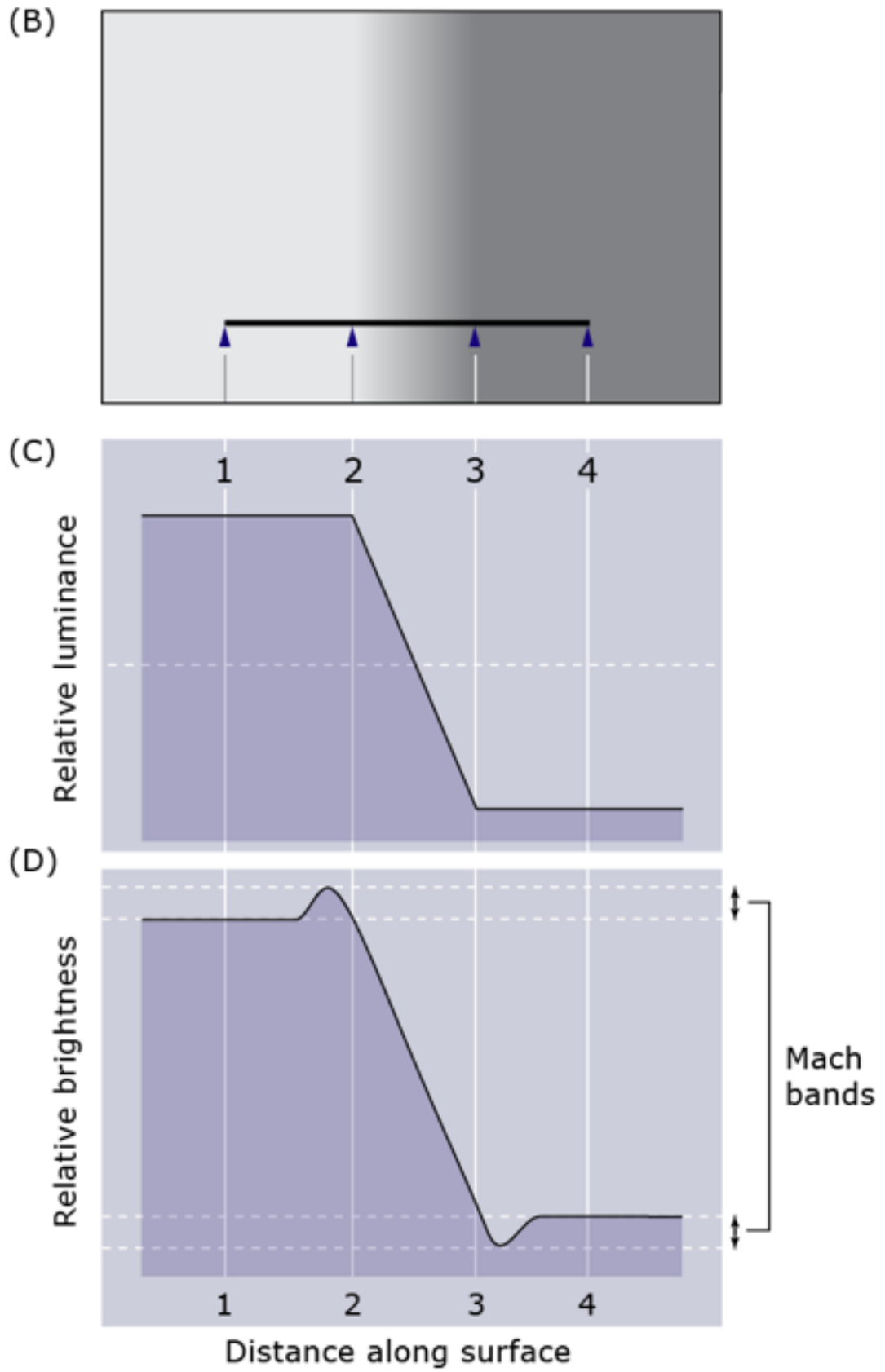
The Cornsweet edge...even harder to explain



Mach “bands” are harder still…



Ernst Mach
(1838–1916)



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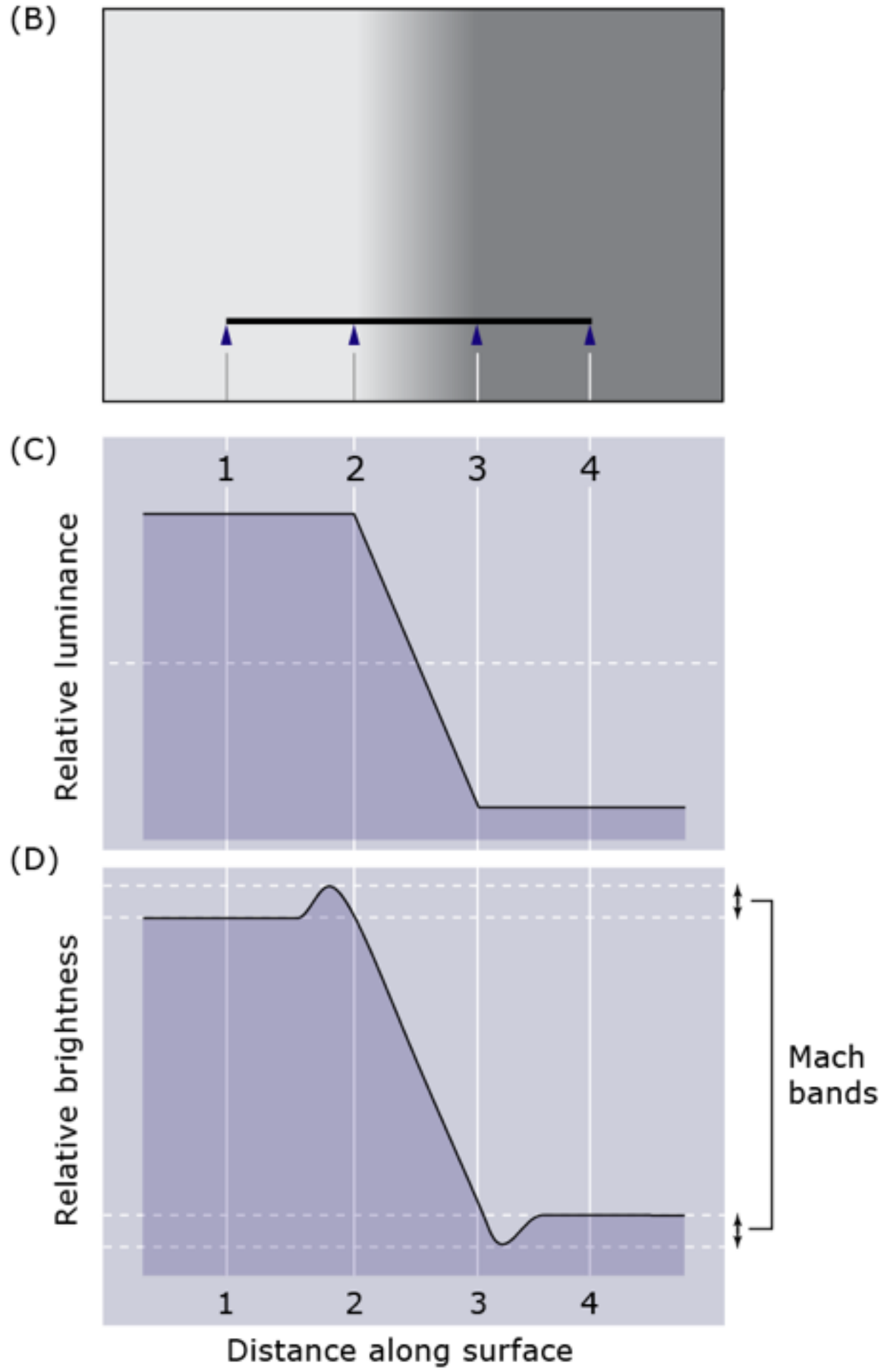
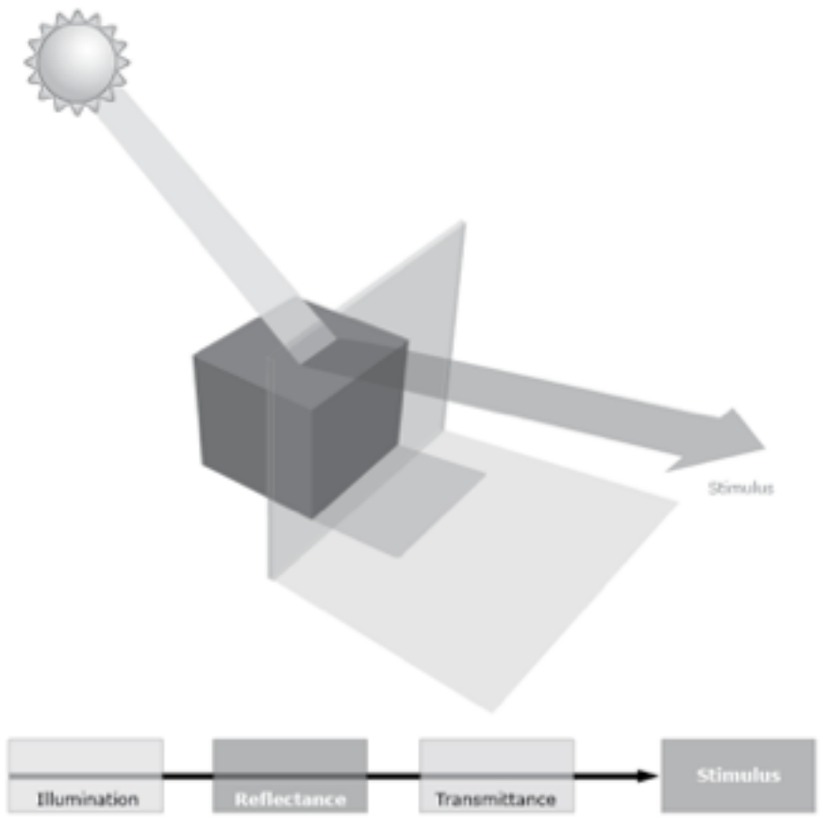
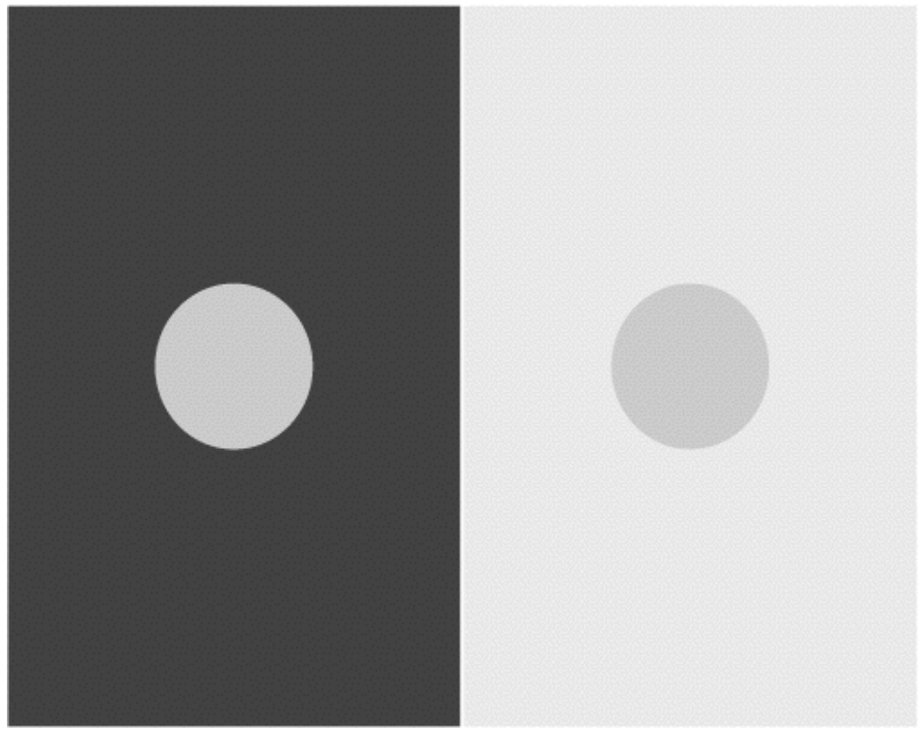


So what is going on?

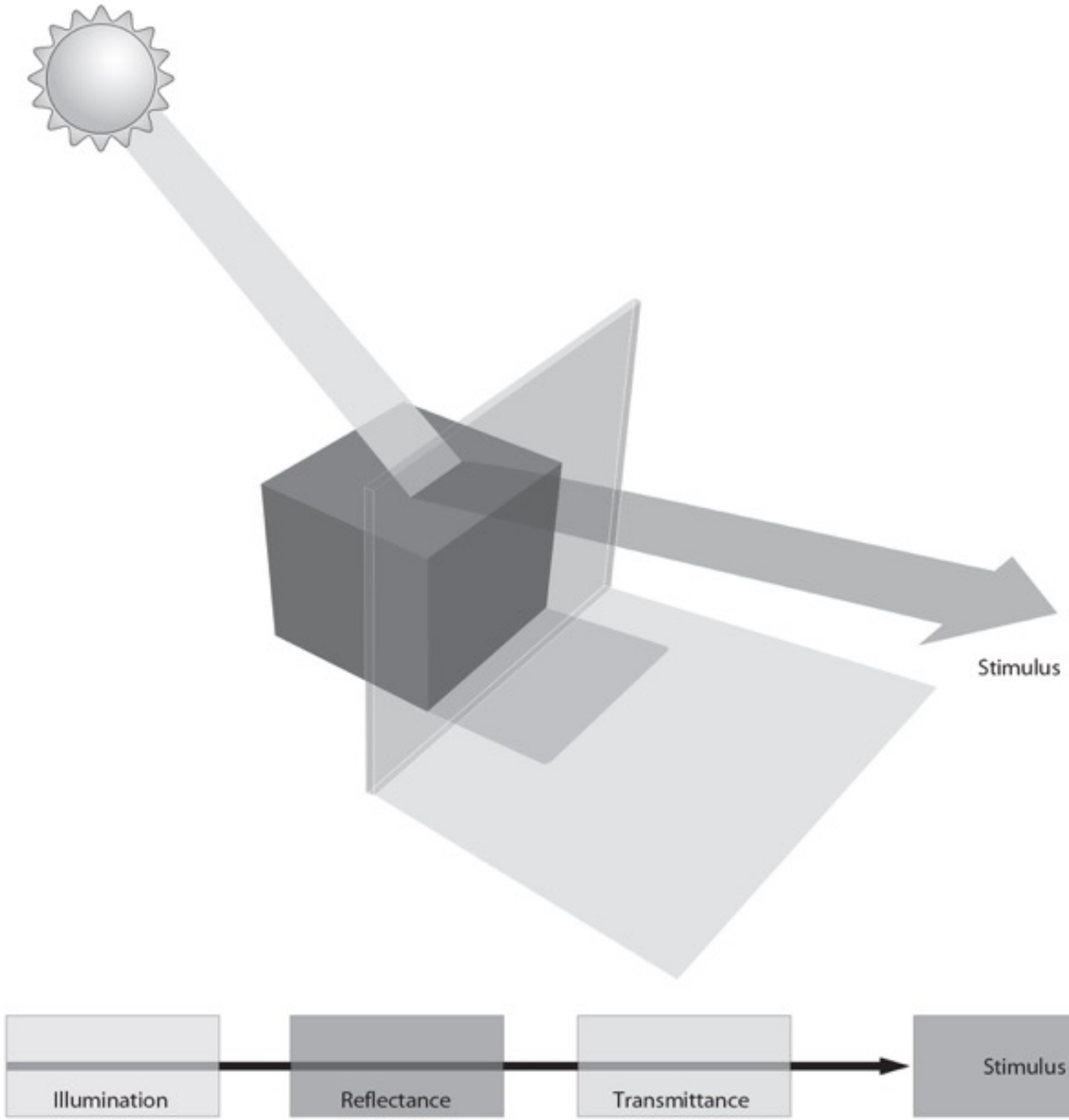
Lesson 4. An Empirical Explanation Based on Accumulated Experience

Getting Around the Inverse Problem

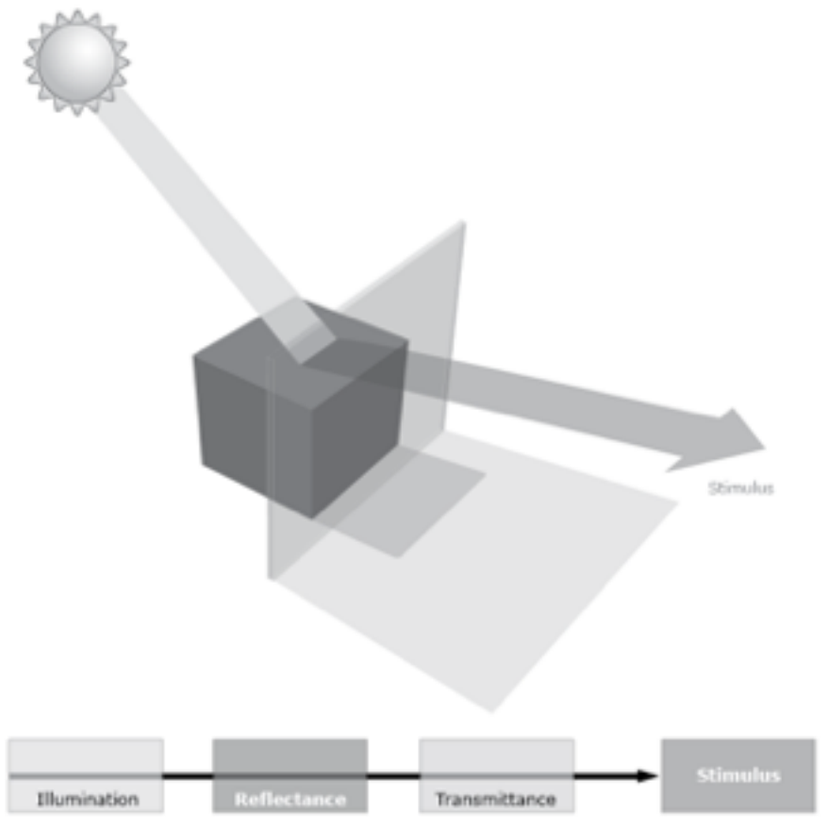


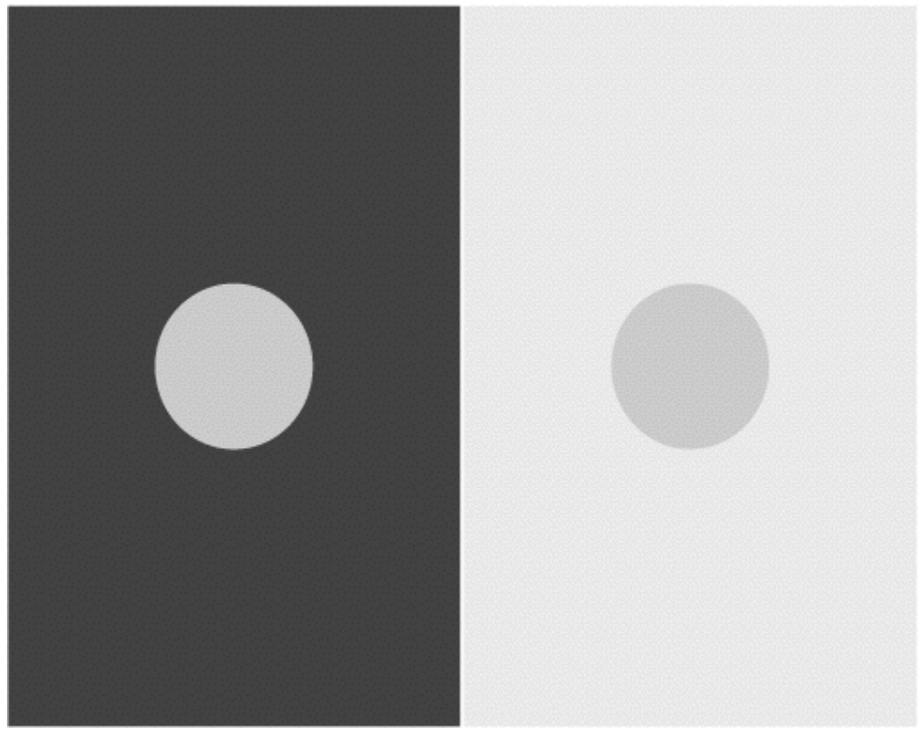


Getting Around the Inverse Problem



Getting Around the Inverse Problem





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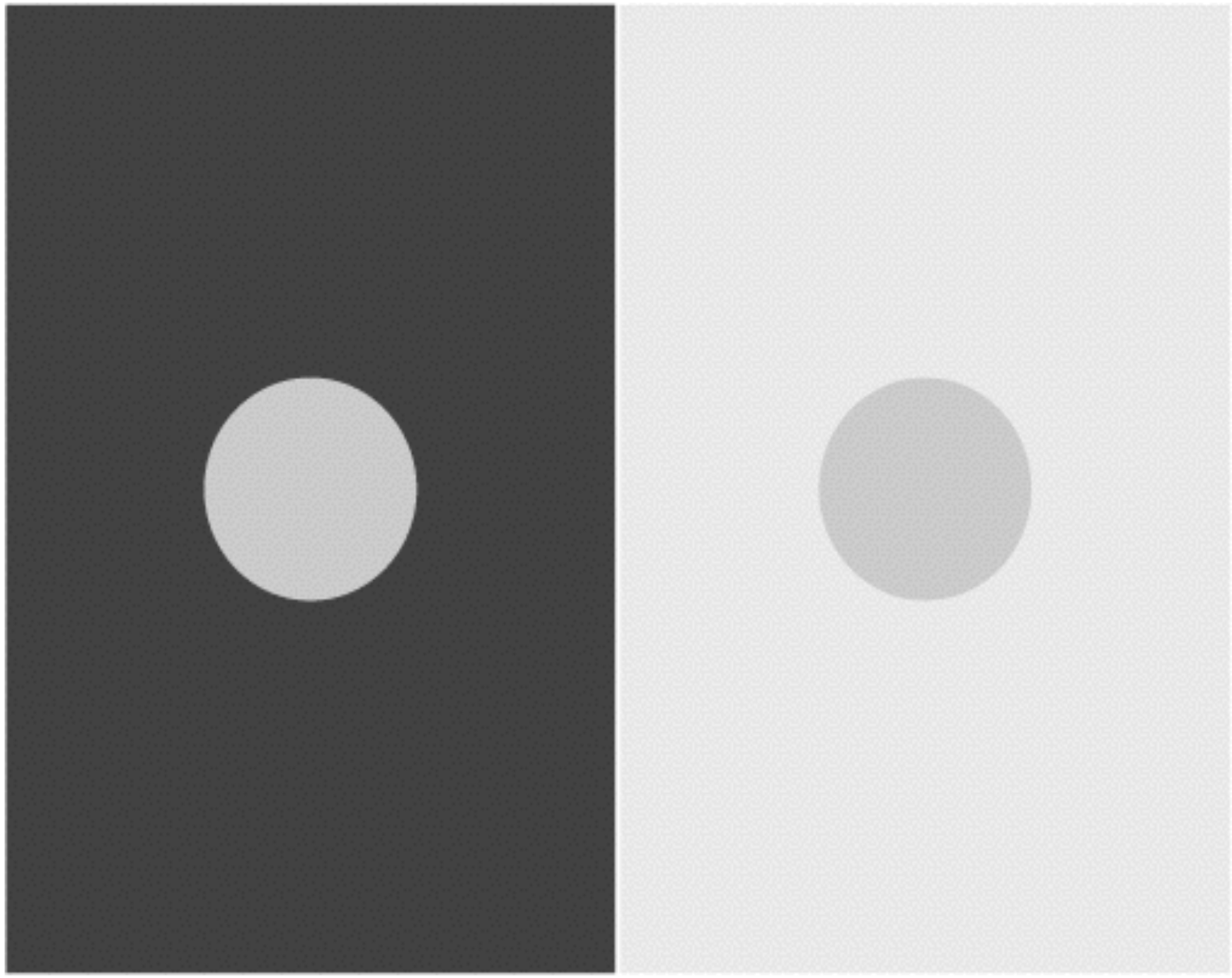
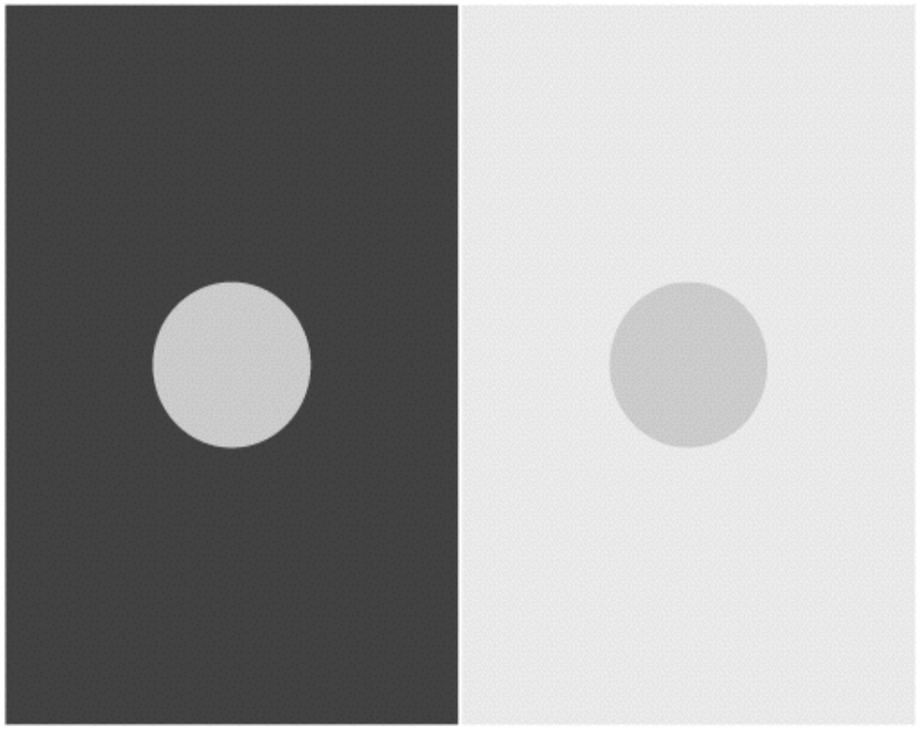
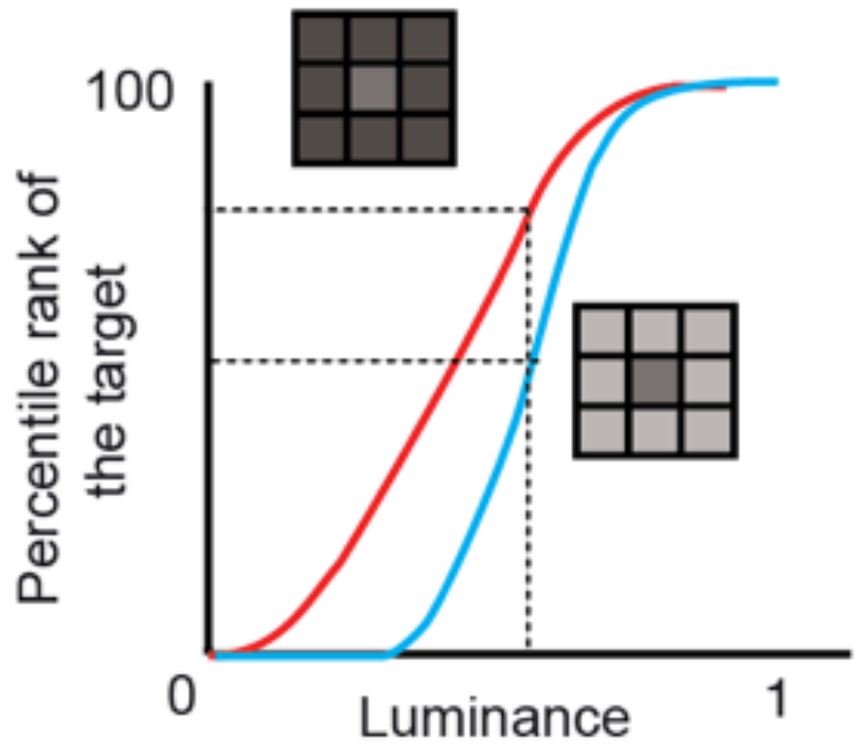
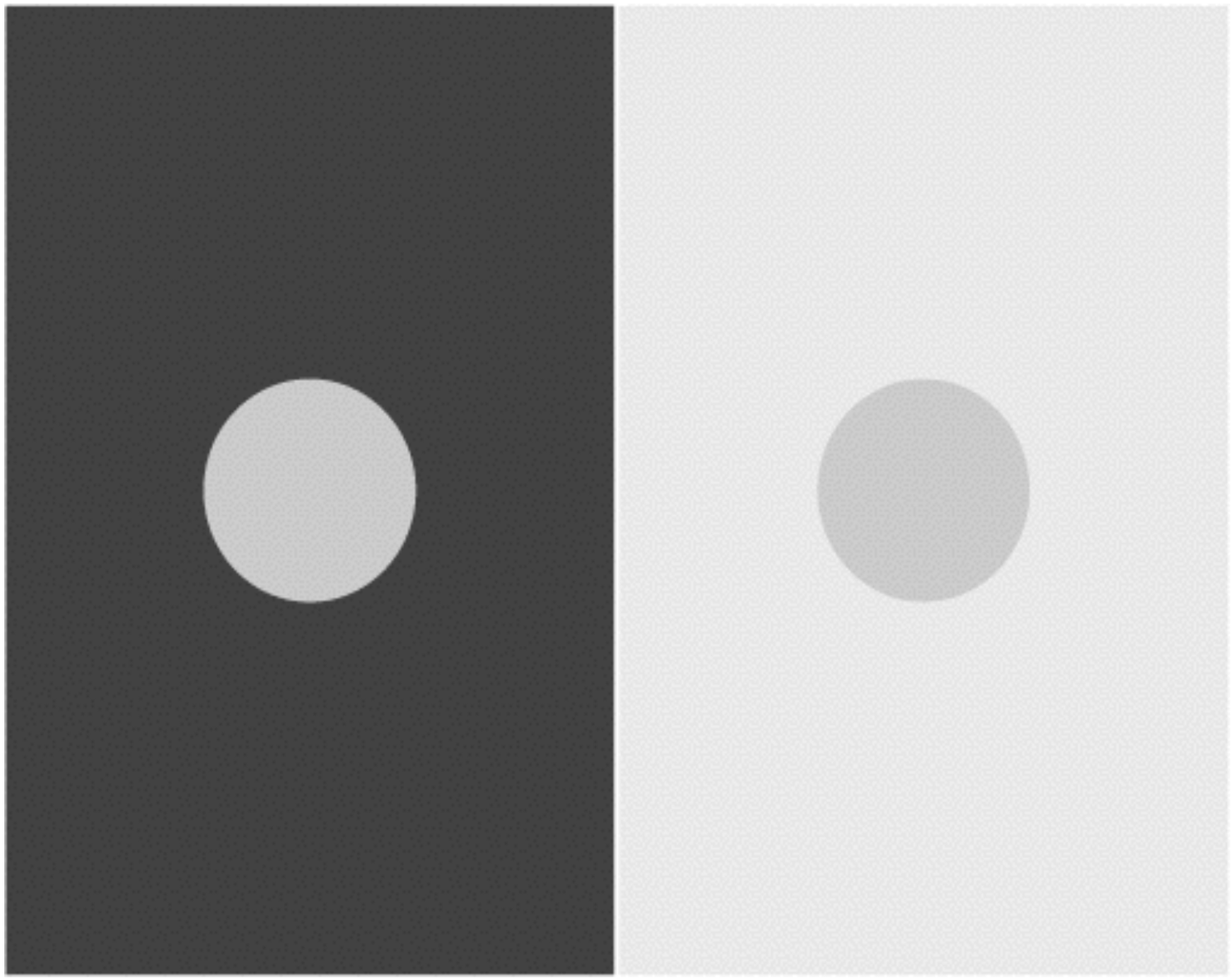


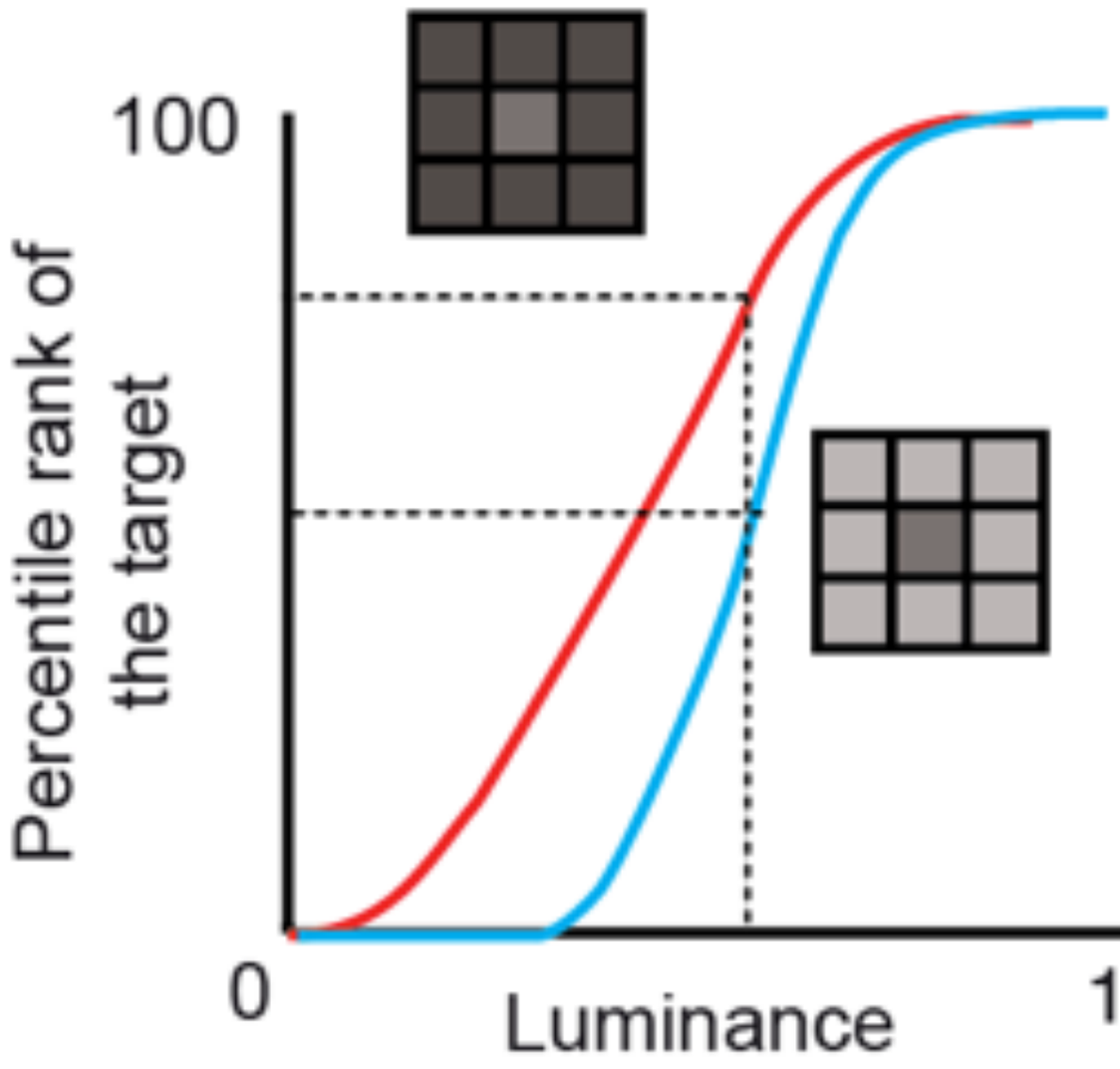
So how can the phenomenology of lightness be explained on this basis?

Images versus Simple Patterns







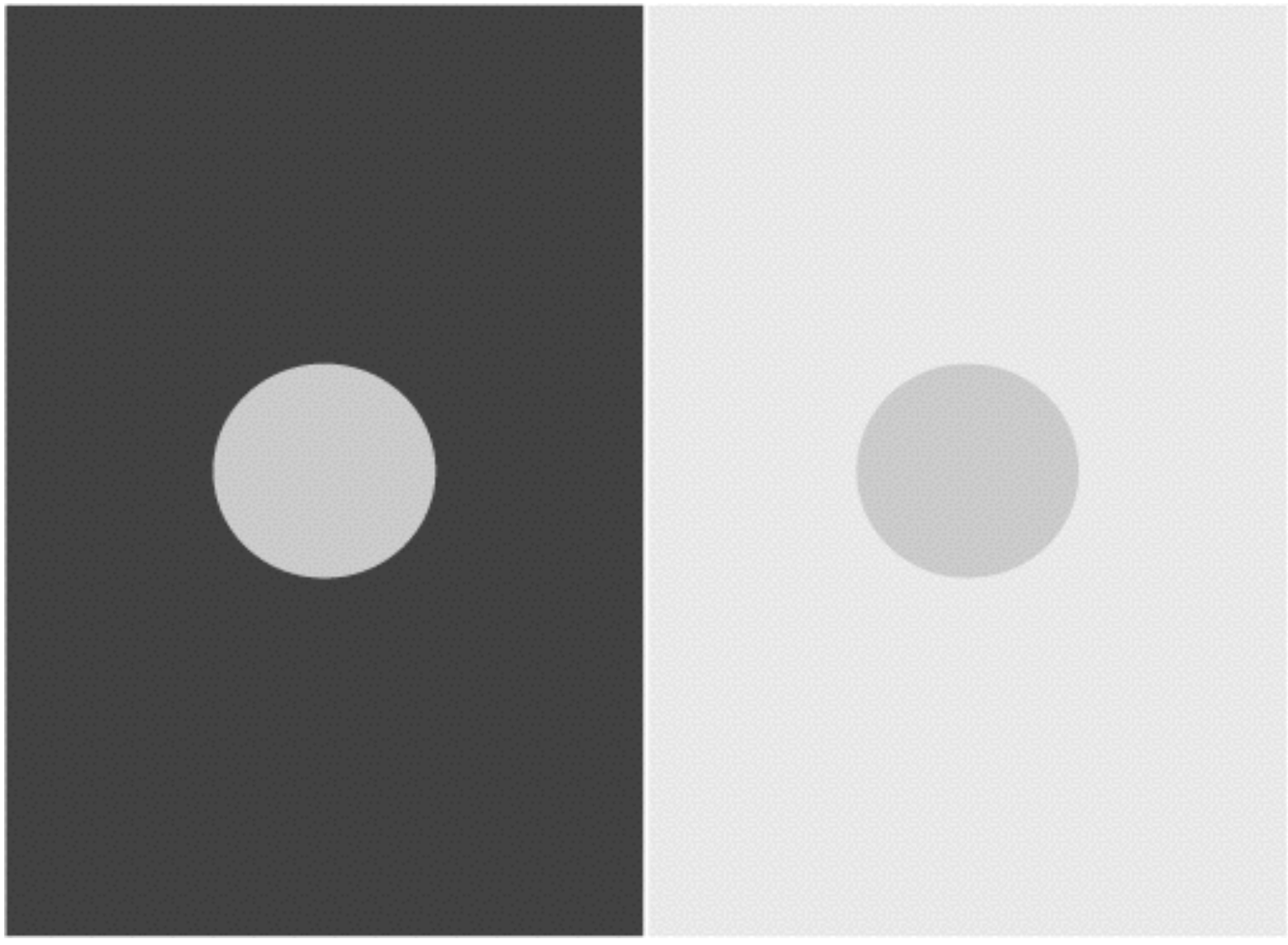


The characteristic of the world that enables this link is that nearby image points tend to arise from objects made of the same stuff.

But this statistical information, per se, is of little or no value.

The role of the physical world is simply an arena that provides feedback via reproductive rates about the relative success of visual perceptions and visually guided behaviors.

Thus the two identical central targets look different because these perceived lightness values track reproductive success, not physical properties in the world.



Summary of the Main Points

- Lightness and darkness values are the most fundamental visual qualities we perceive
- We don’t see these qualities in the same way physical instruments measure them

Summary of the Main Points

- Tracking experience aligns lightness percepts on a subjective scale according to their impact on reproductive success
- This strategy gets around the inverse problem
- The way we see lightness can be

Credits

All images from: Dale Purves, R. Beau Lotto. *Why We See What We Do Redux*, Sinauer Associates Inc., 2011

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