

Brain and Illusions

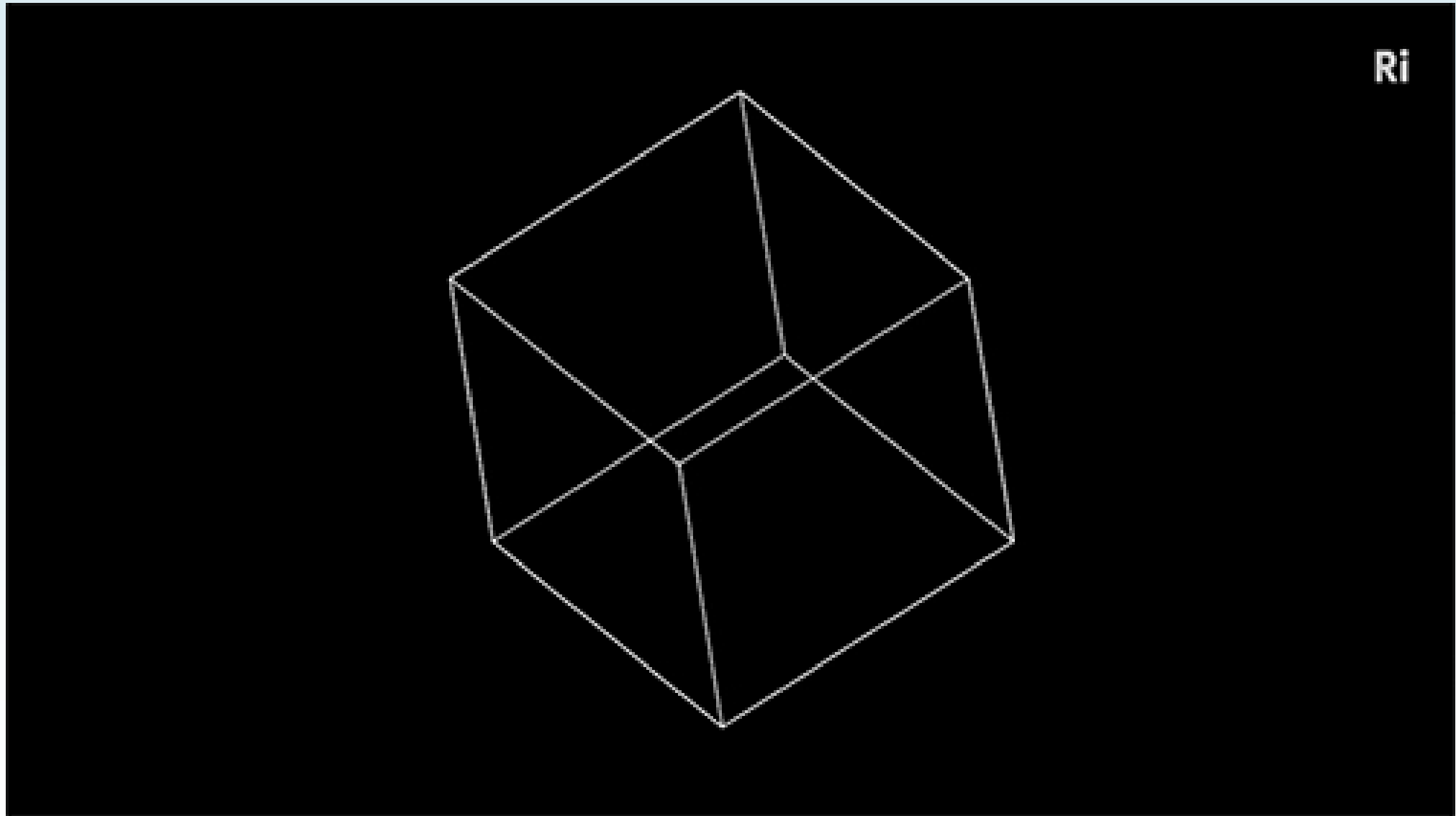
Perception and Interfaces (COMP0160) 2023/24

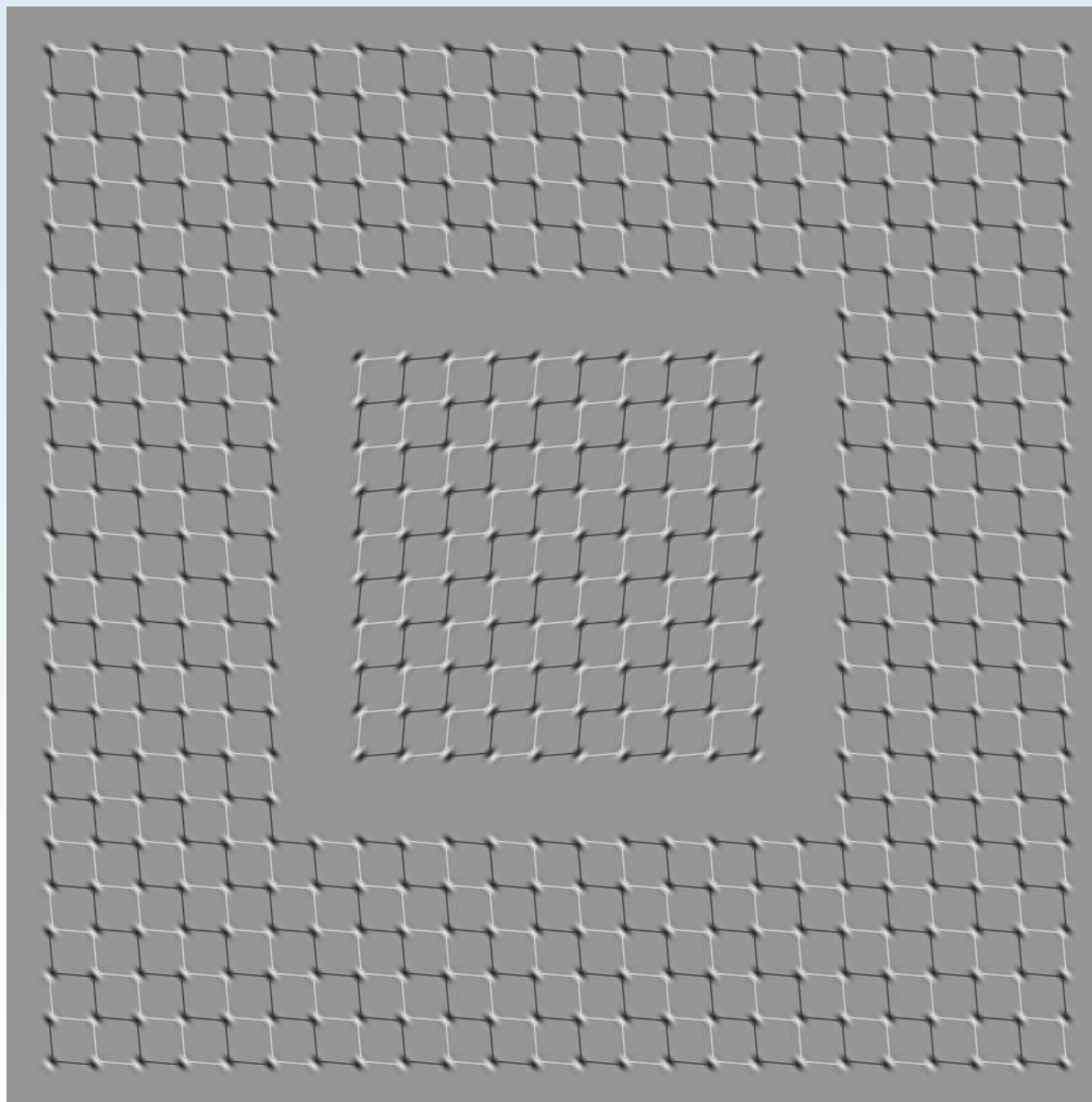
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TO START ... THREE ILLUSIONS OF VERY DIFFERENT TYPES





Physiological Measures of Presence in Virtual Environments

Learning Objectives

- Describe how various types of illusion are perceived by users
- Give an overview of some common types of illusion and what they tell us about the brain
- Provide insight into how user interfaces can exploit illusions

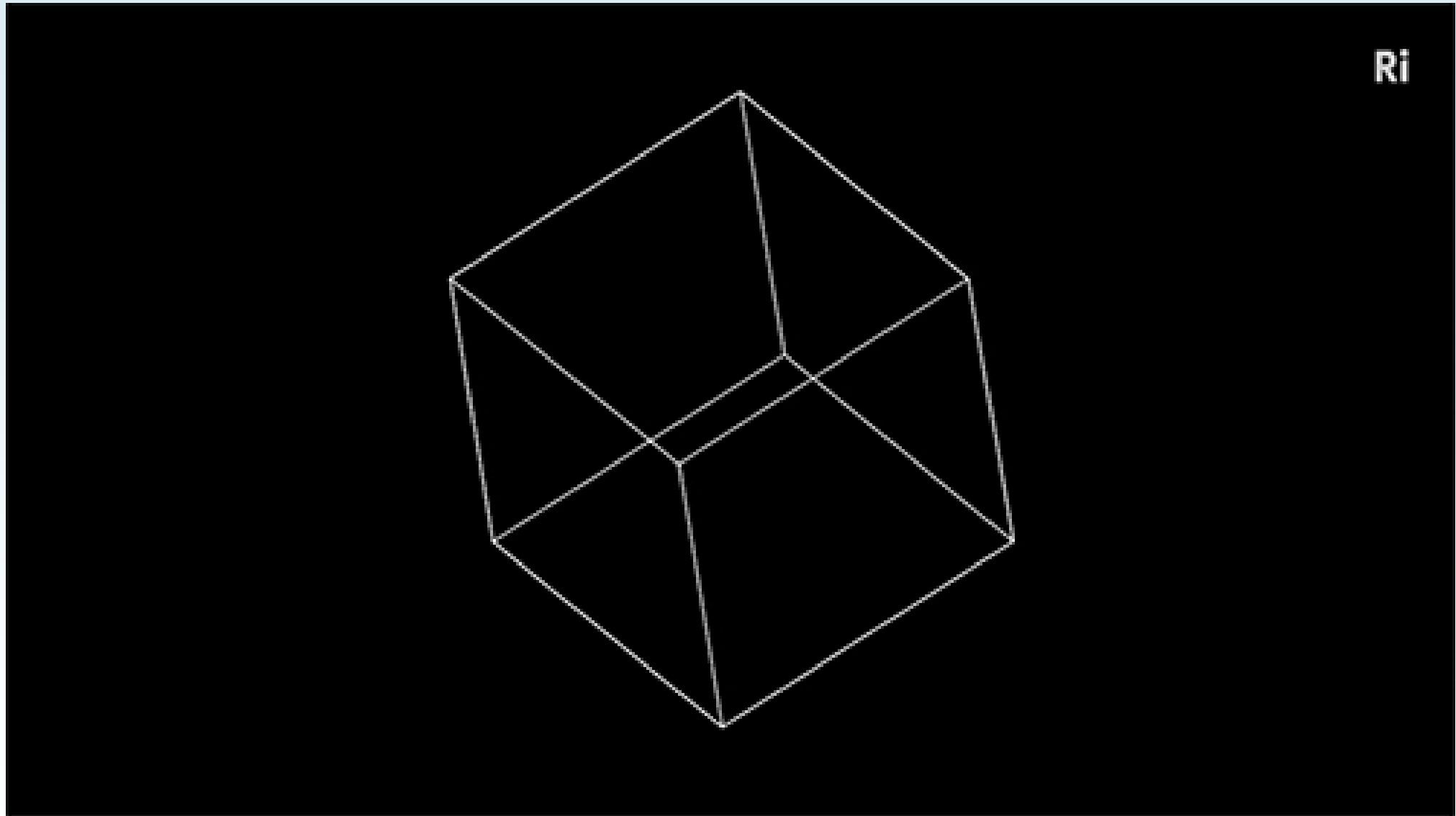
Learning Outcomes

- Know how illusions give us an insight into certain functions of the brain
- Know how certain illusions arise from cross-modal and inter-modal signalling
- Understand how interfaces can use certain illusions to avoid implementing sensory interfaces when this would be difficult or unreliable

Overview

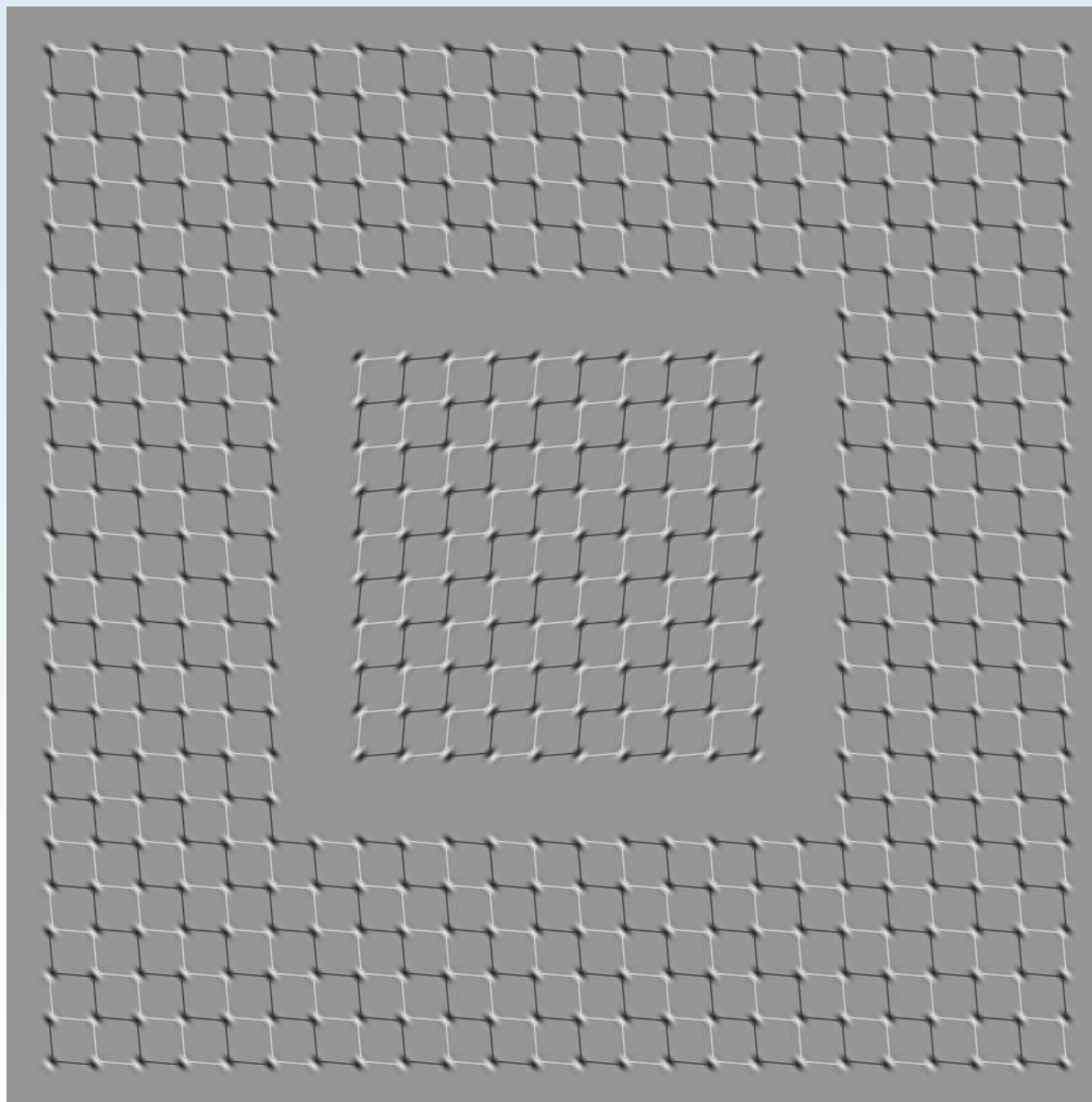
- Illusions and Their Explanations
- Sensory Integration
- Illusions of the Self

ILLUSIONS AND THEIR EXPLANATIONS



Sensory Rivalry

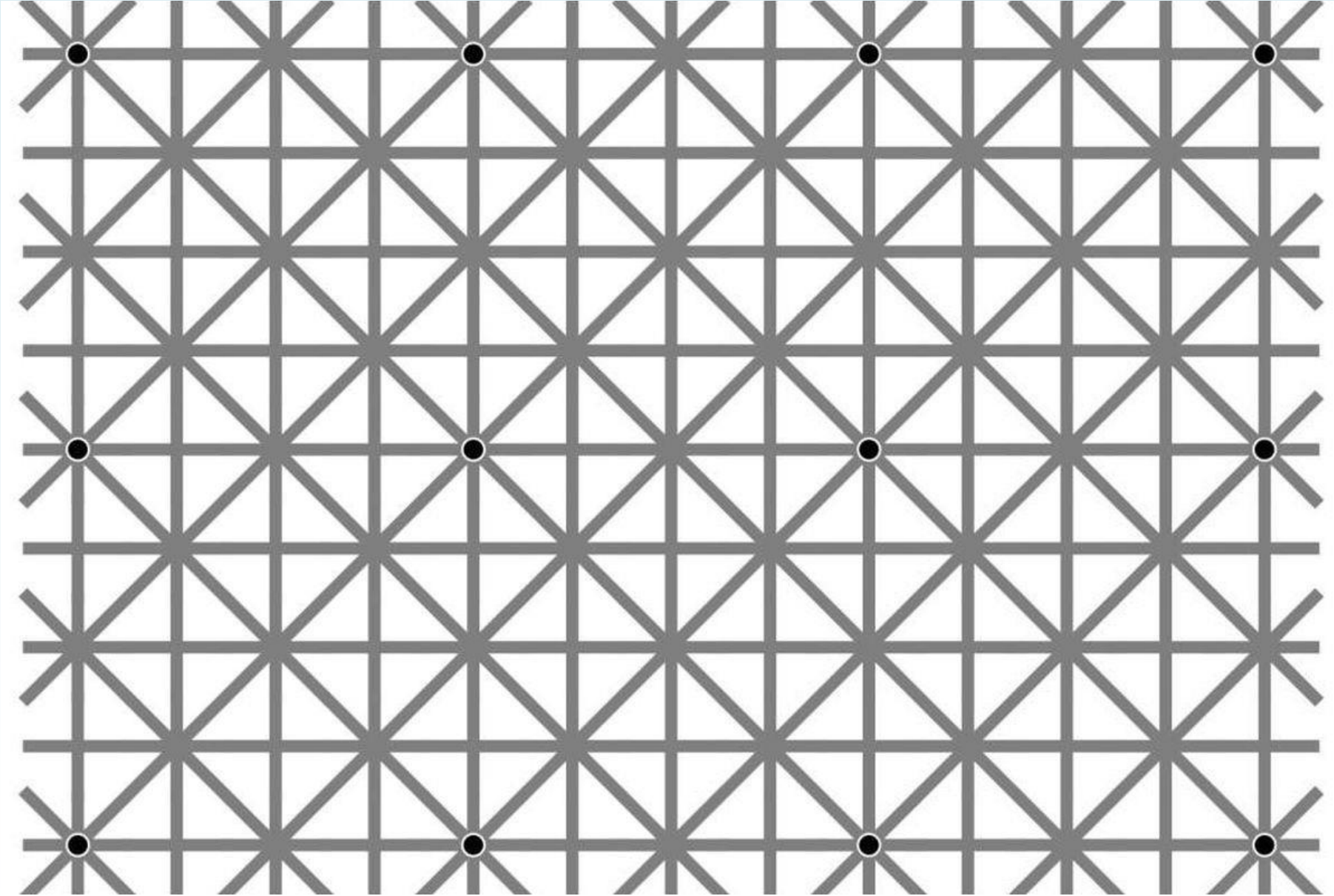
- Bottom-up versus top-down processing theories
- Event related potentials (ERPs) have been associated with the switches
 - Kornmeier, J., & Bach, M. (2005). The Necker cube—an ambiguous figure disambiguated in early visual processing. *Vision research*, 45(8), 955-960.
- Models of switching for a variety of illusions can predict the timing of rivalry switching
 - The Mathematics of Visual Illusions - Ian Stewart
<https://youtu.be/ZmTtMZiR3xQ>



Peripheral Drift Illusion

- Repeated asymmetric patterns (RAPs)
- Activated by eye movement
- Appears (not conclusive) to be caused by difference in rate of neuronal changes for processing contrast

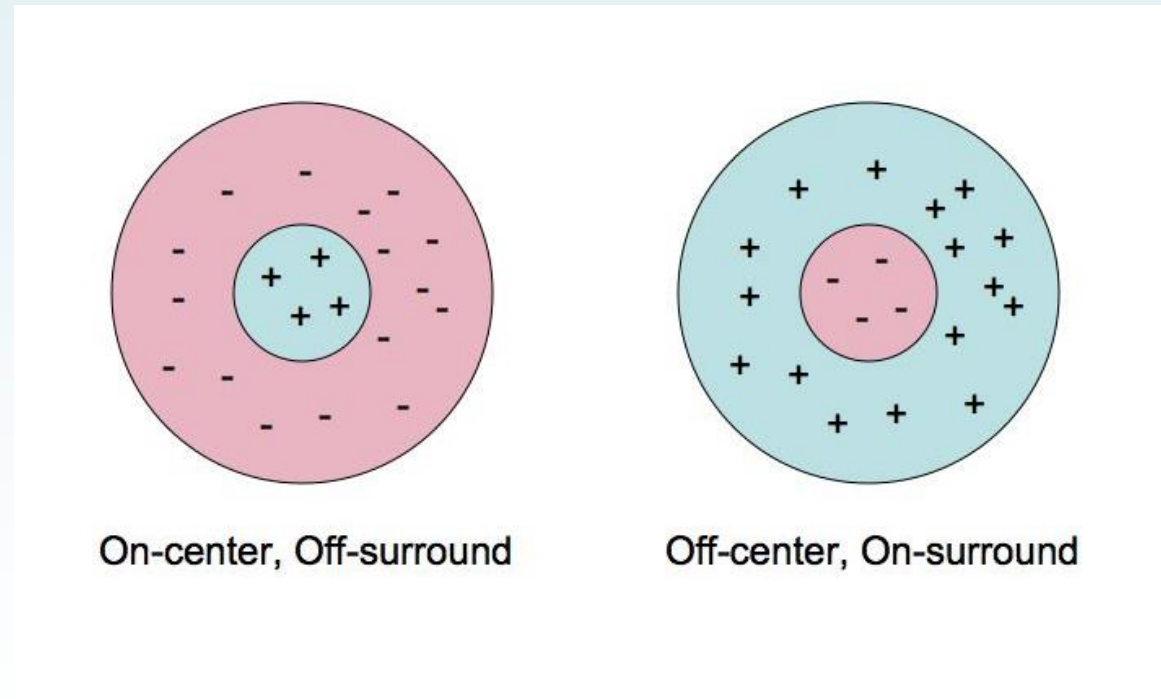
Backus, B. T., & Oruç, I. (2005). Illusory motion from change over time in the response to contrast and luminance. *Journal of vision*, 5(11), 10-10.



Ninio J, Stevens KA. Variations on the Hermann grid: an extinction illusion. Perception (2000)

Hermann Grid

- Neurons have a circularly symmetric receptive field that detect contrast

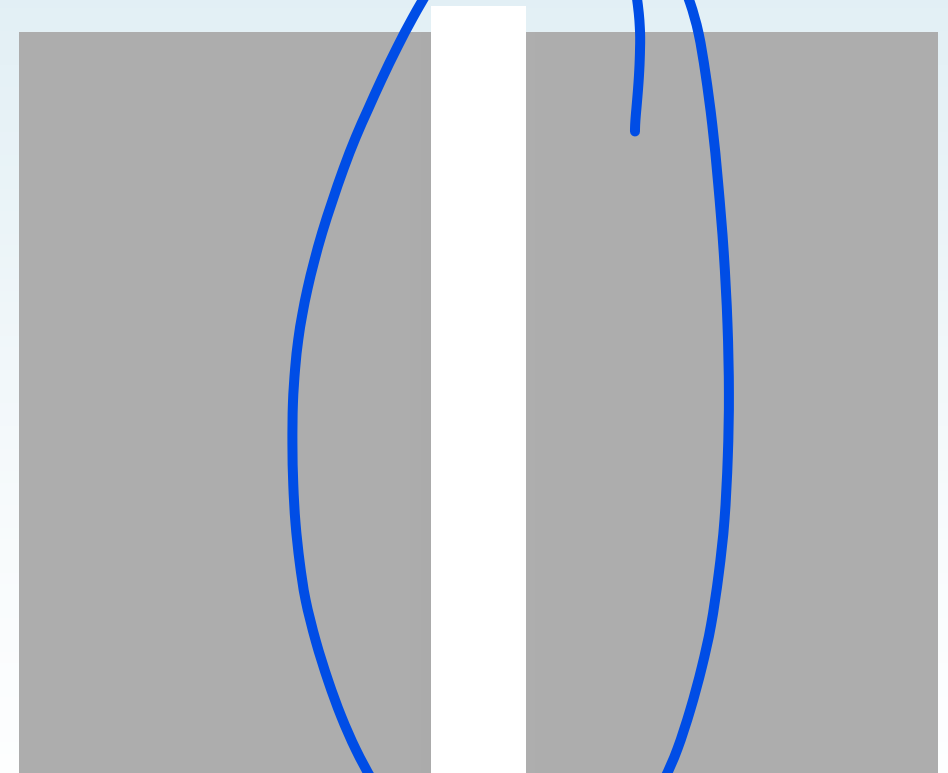
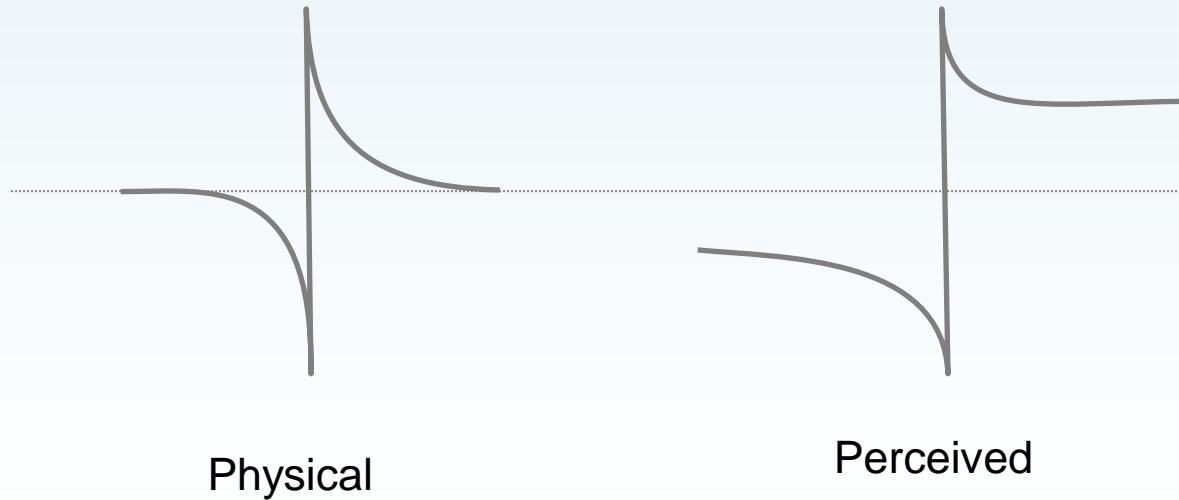


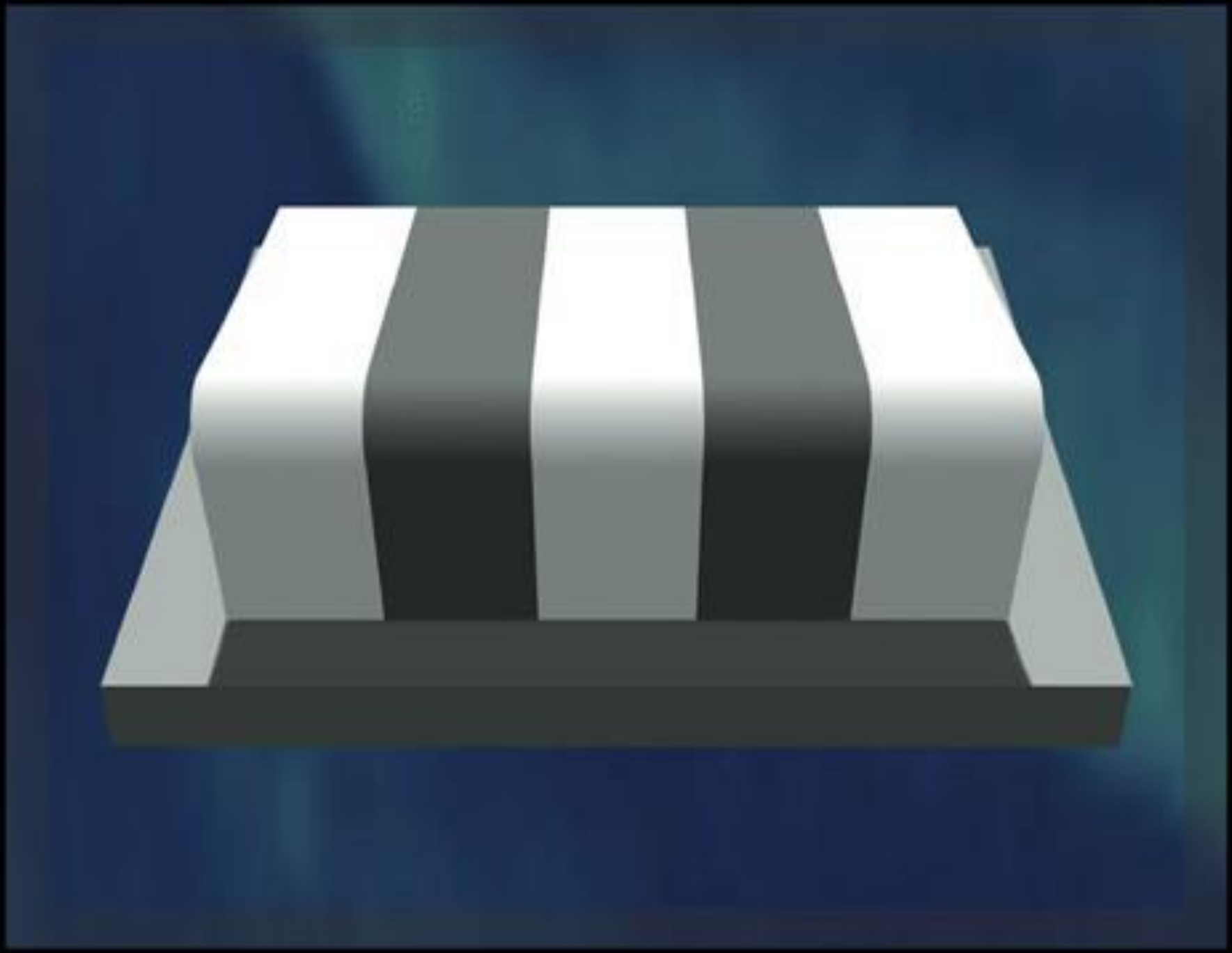
But Top-Down?

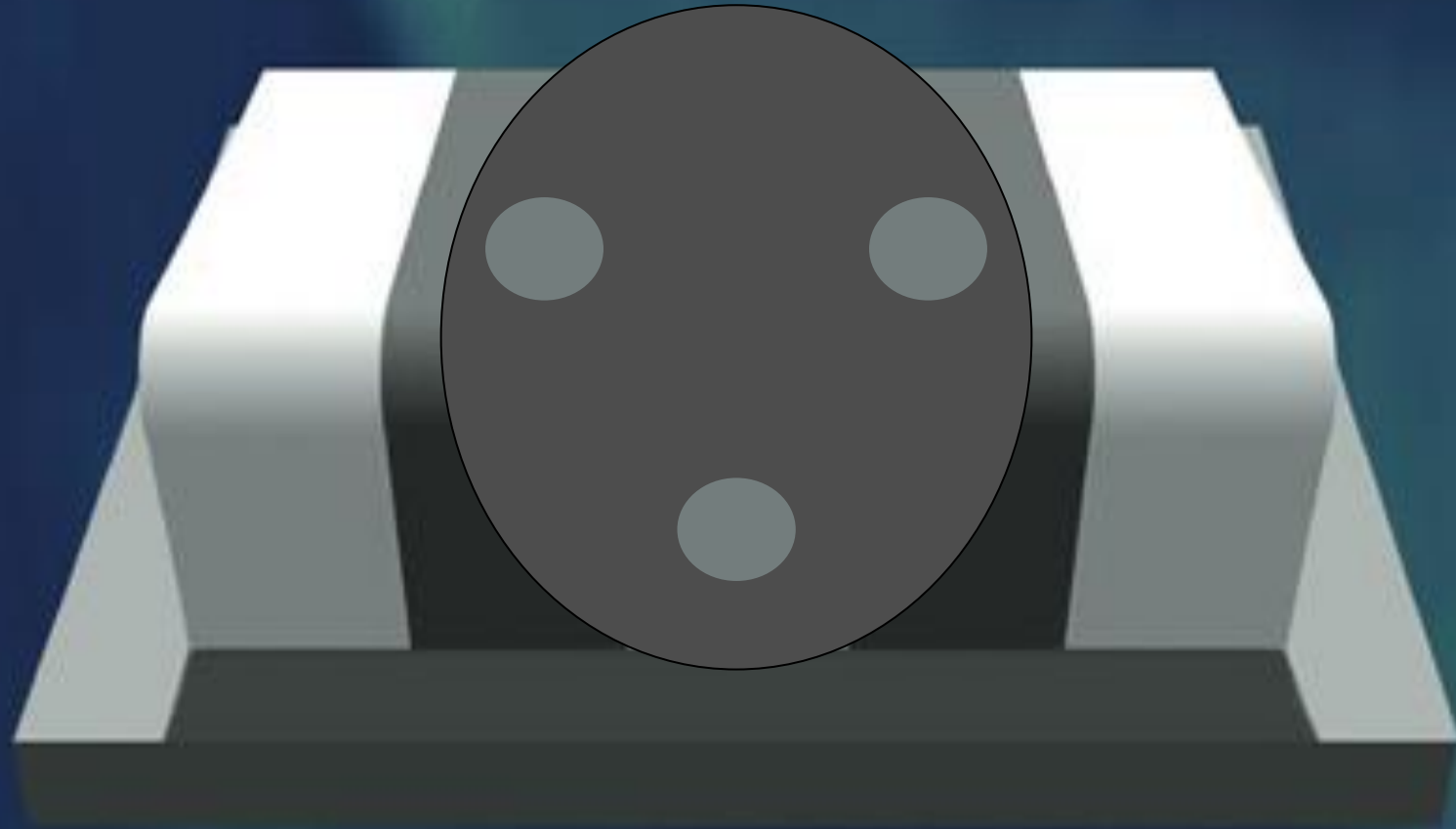
- We can infer a lot from the scene geometry
- The following illusions indicate that our brain interprets space in particular ways

Cornsweet illusion (recap)

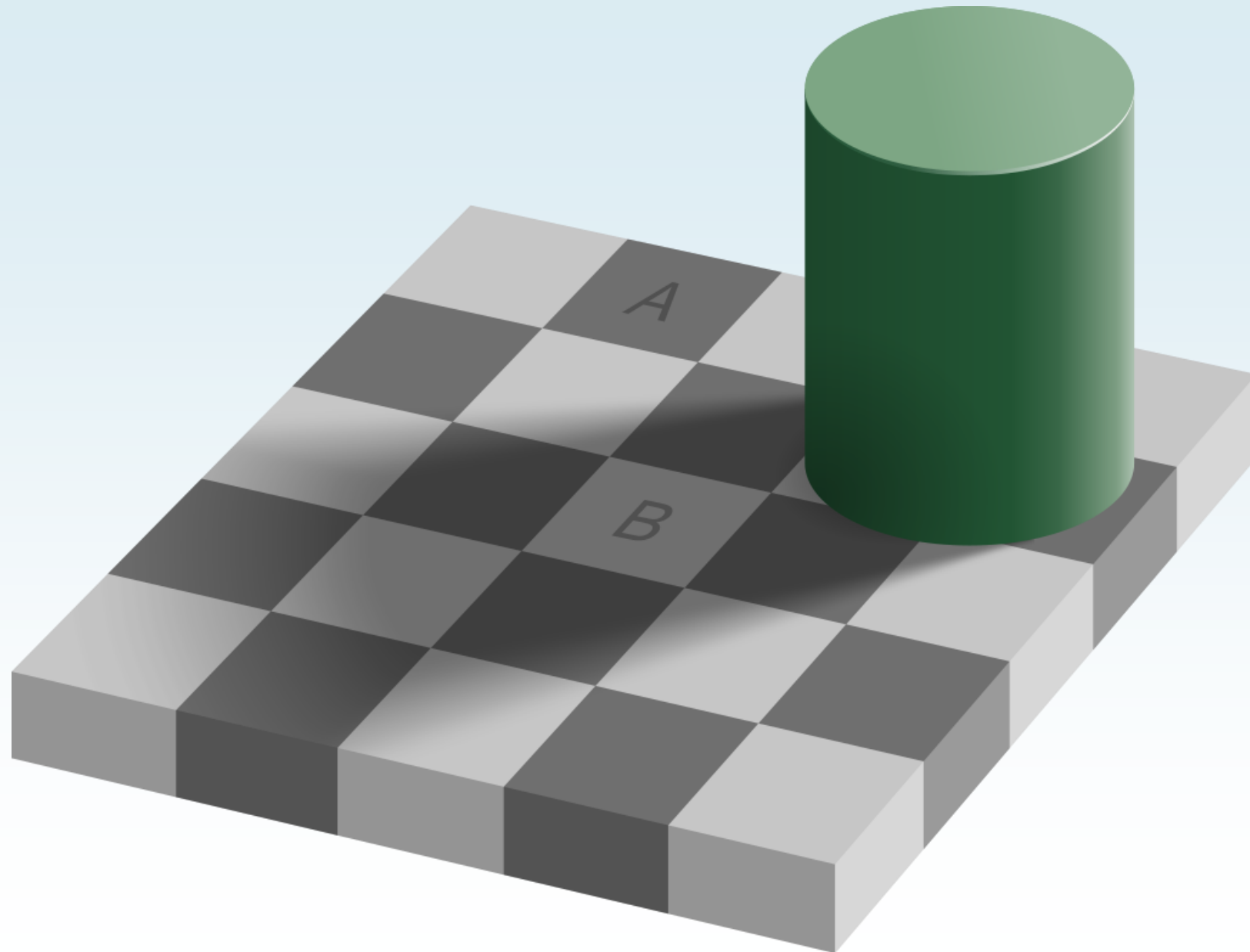
- Two constant colors with wedge at the junction
- Perceived as different brightness

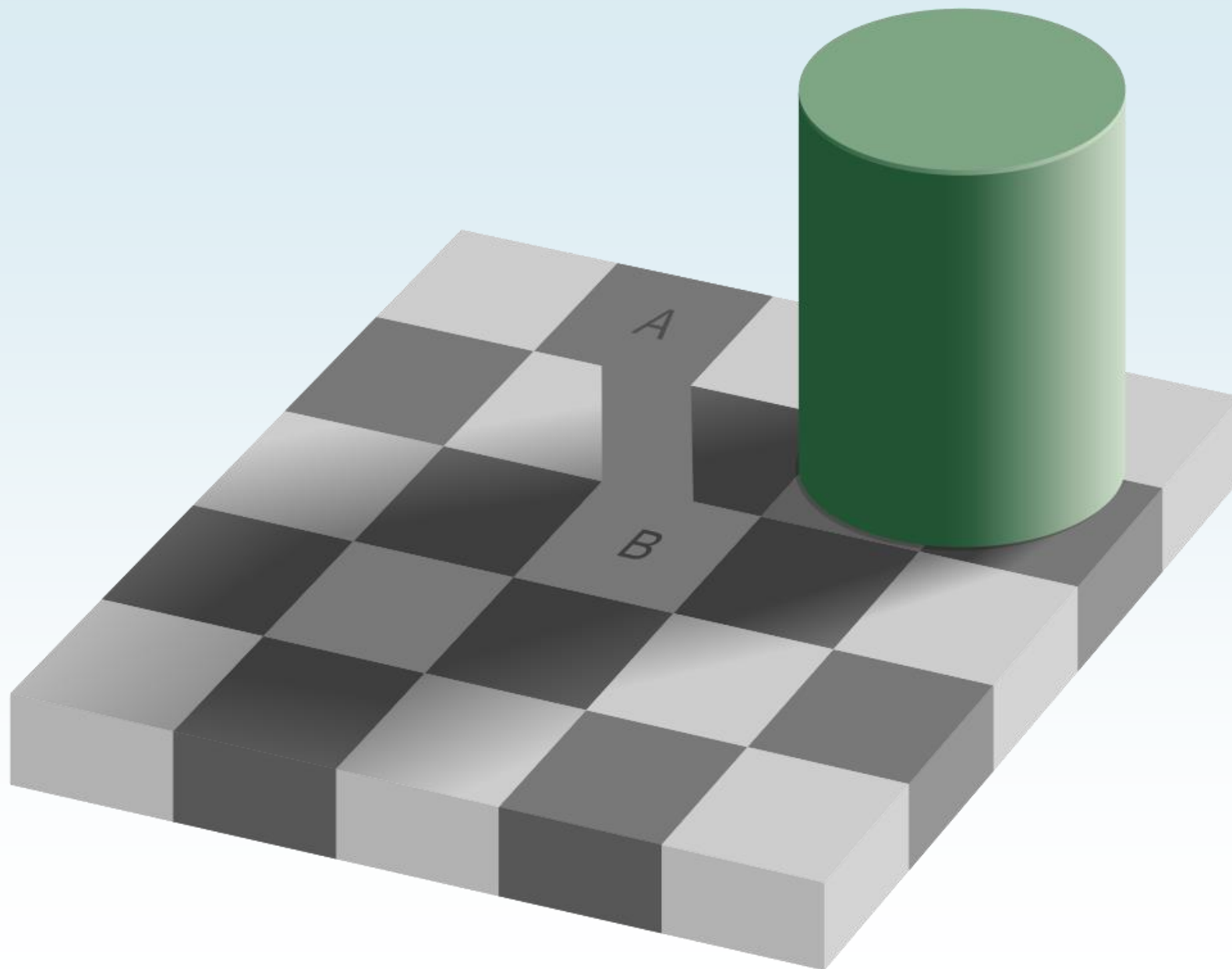


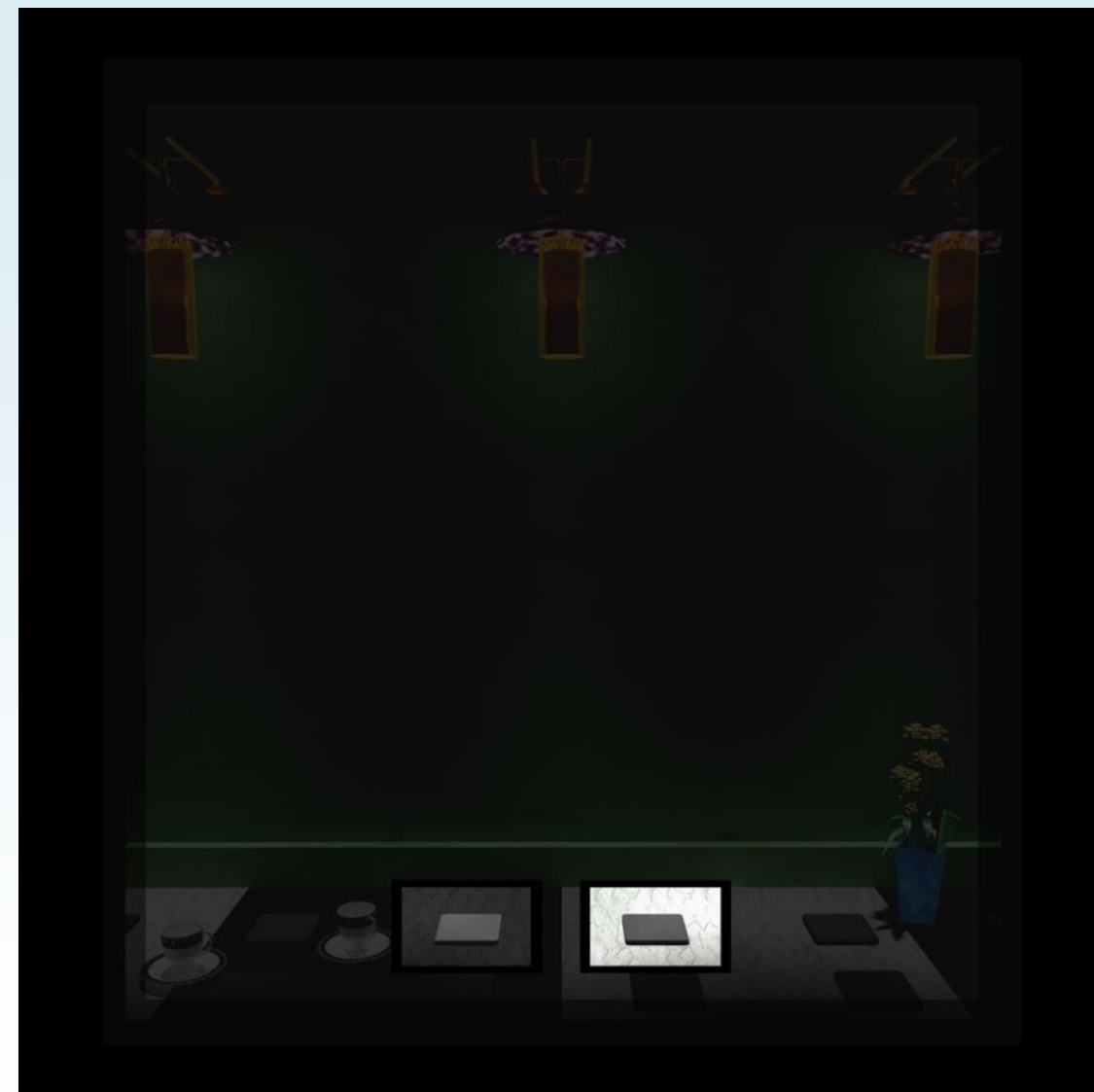
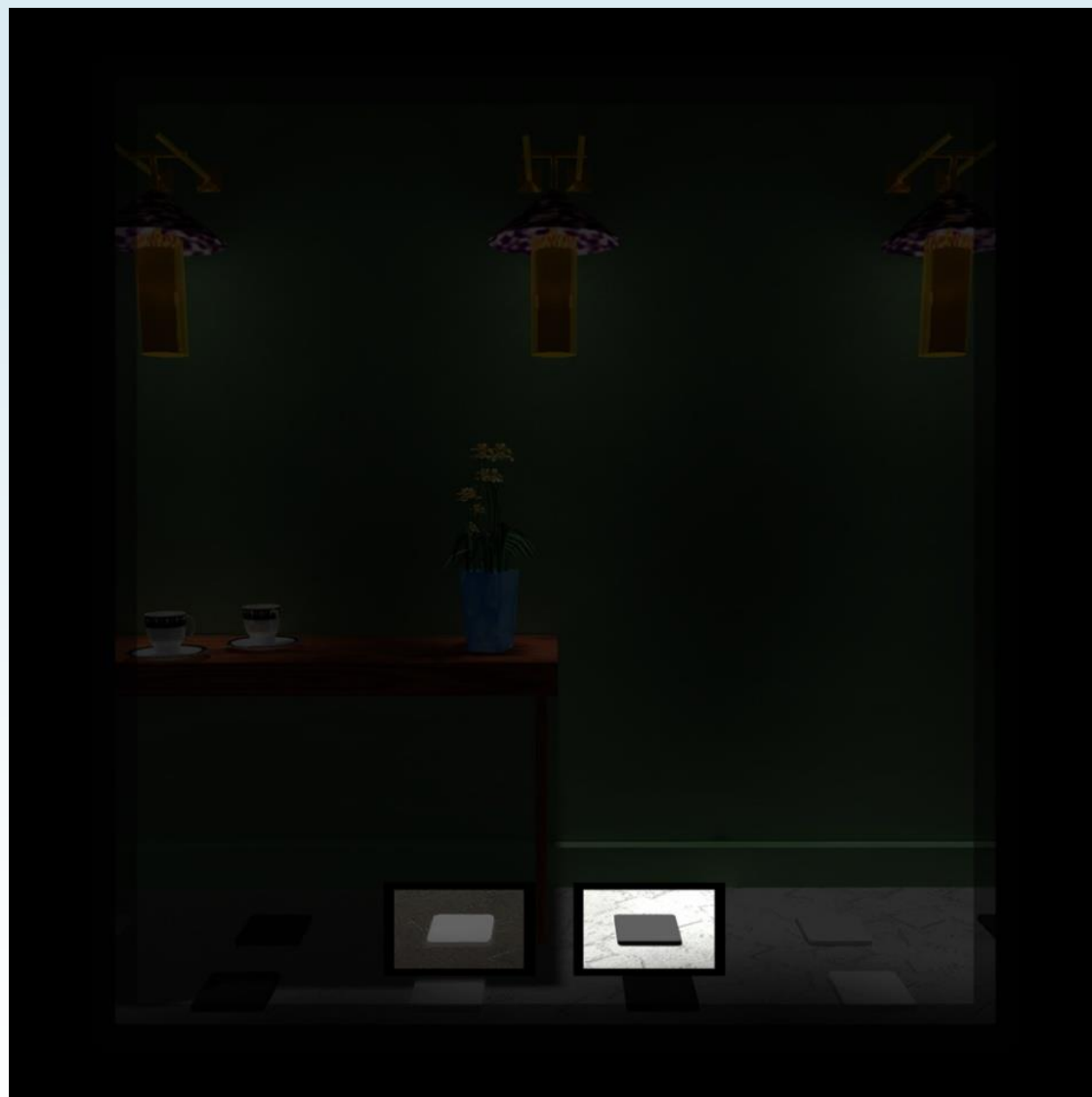


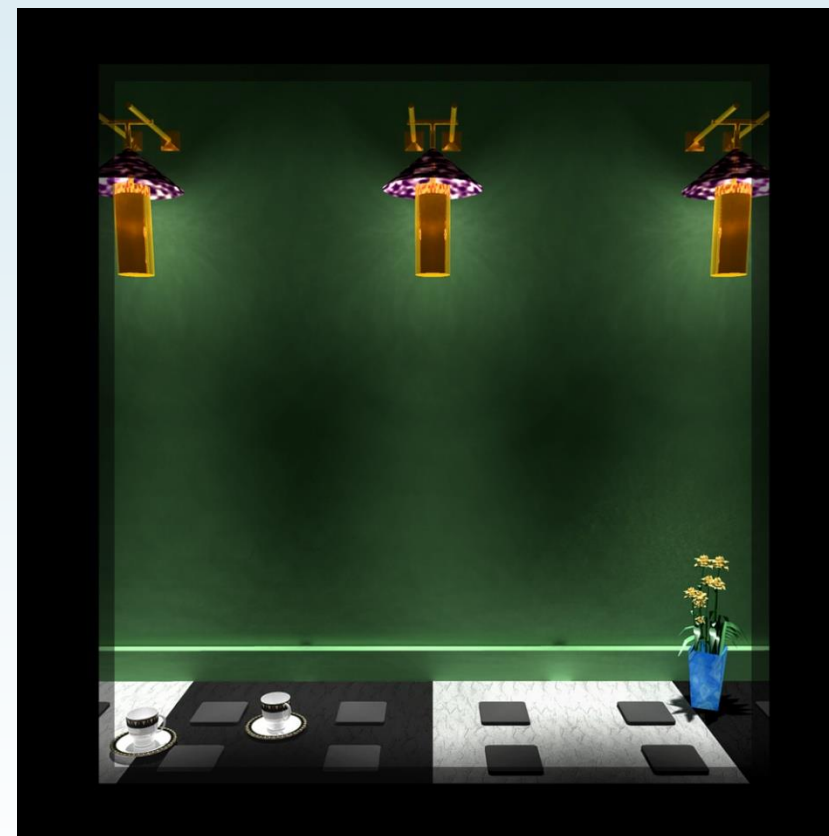


Visual system encodes the “empirical significance” of the stimulus

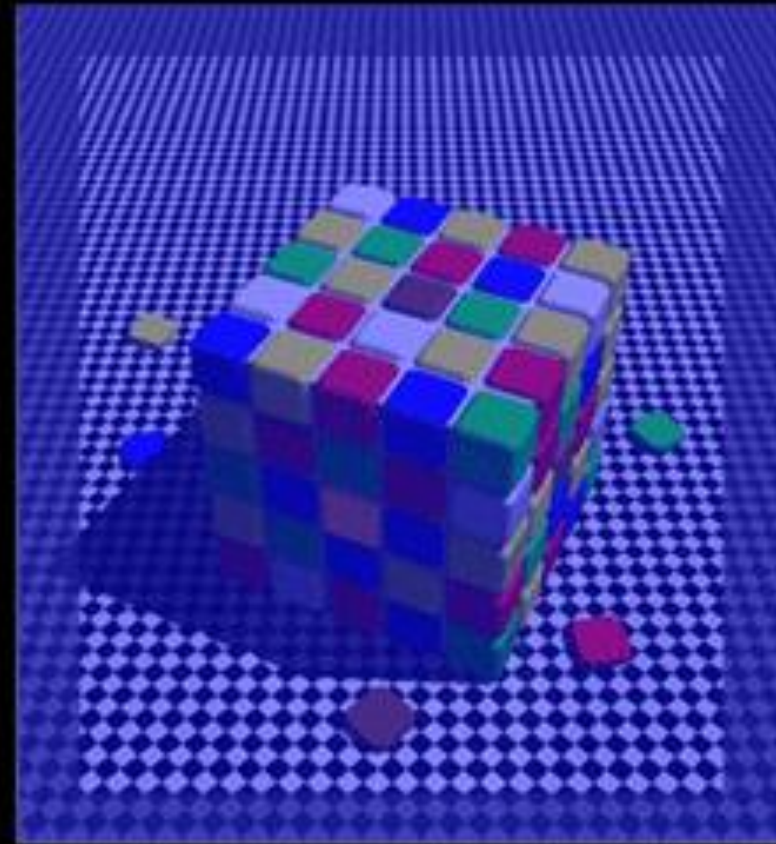
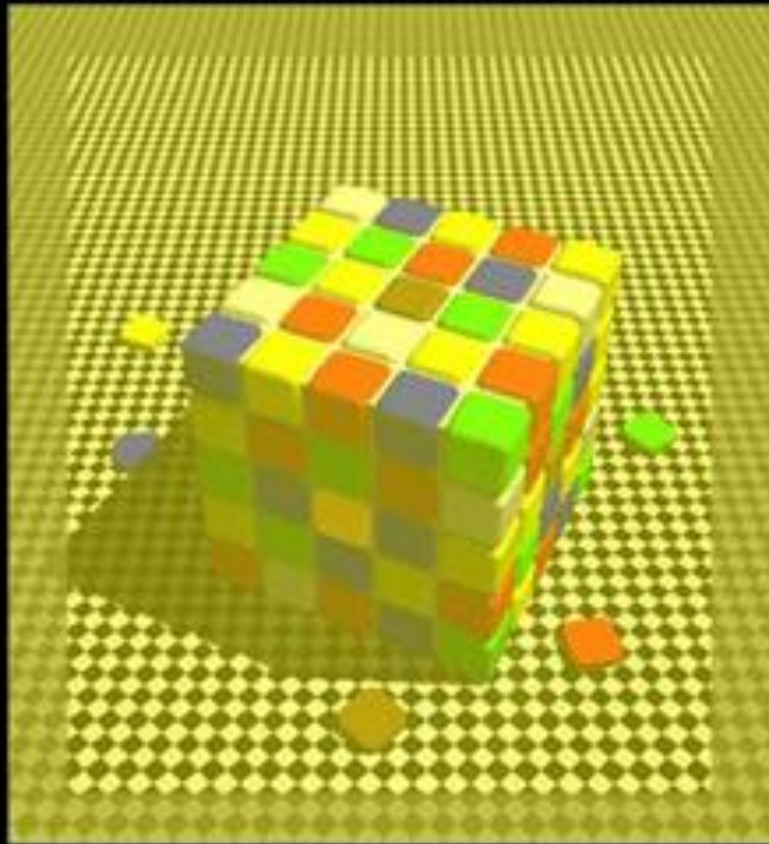


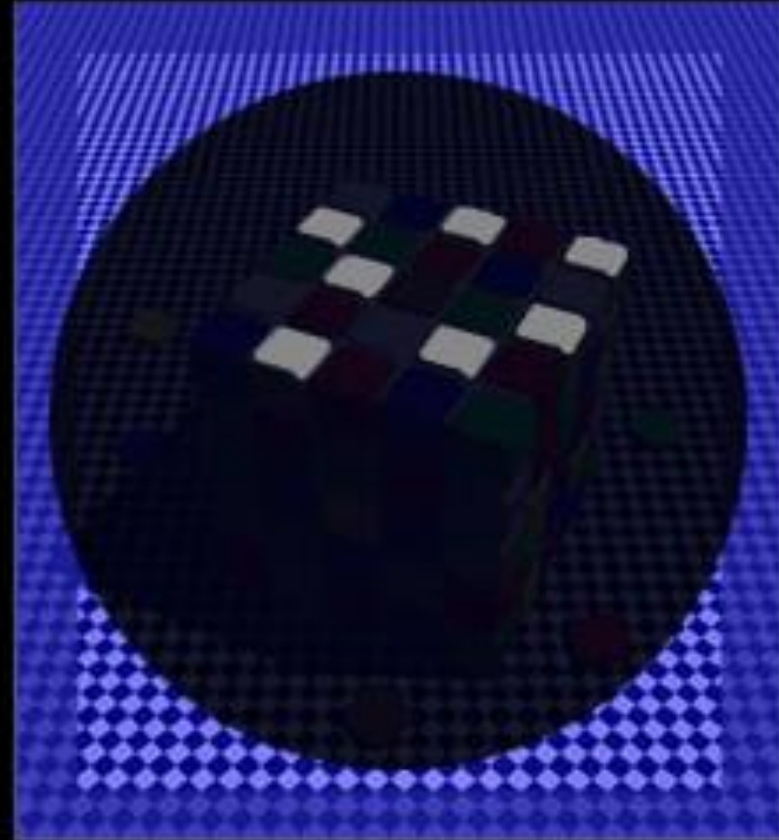
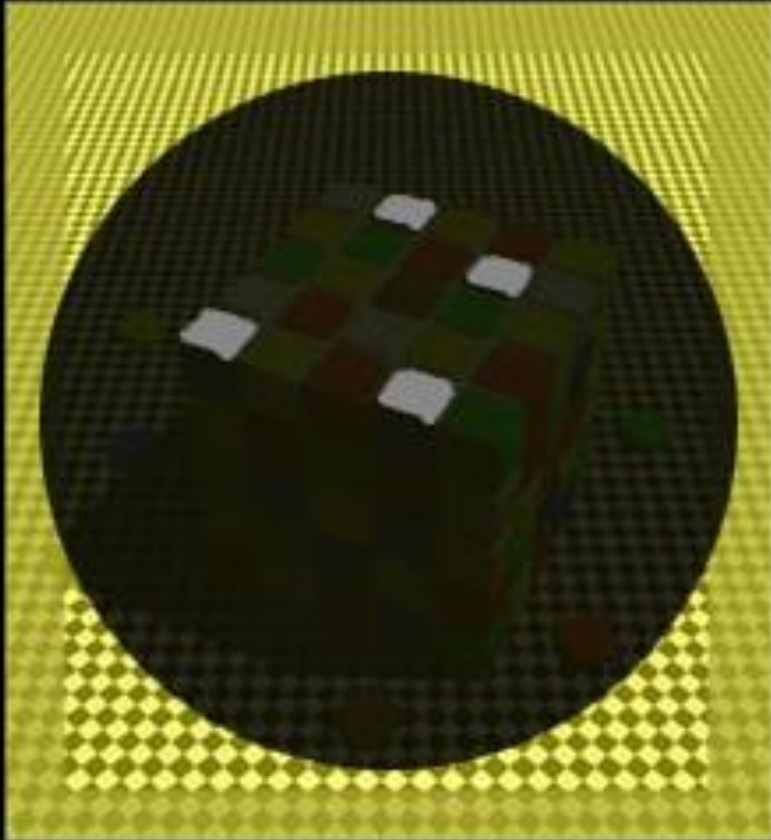






Same local statistics...





Summary So Far

- Top-down and bottom-up processing can both explain different types of illusion
- Importantly the brain doesn't consider absolute values, but values in context (e.g. colours)
- We seem to unconsciously infer a surprising amount about the outside world (gravity, shadows, etc.)
- These are very active areas of research in psychology and neuroscience and there is an enormous amount for HCI to utilise

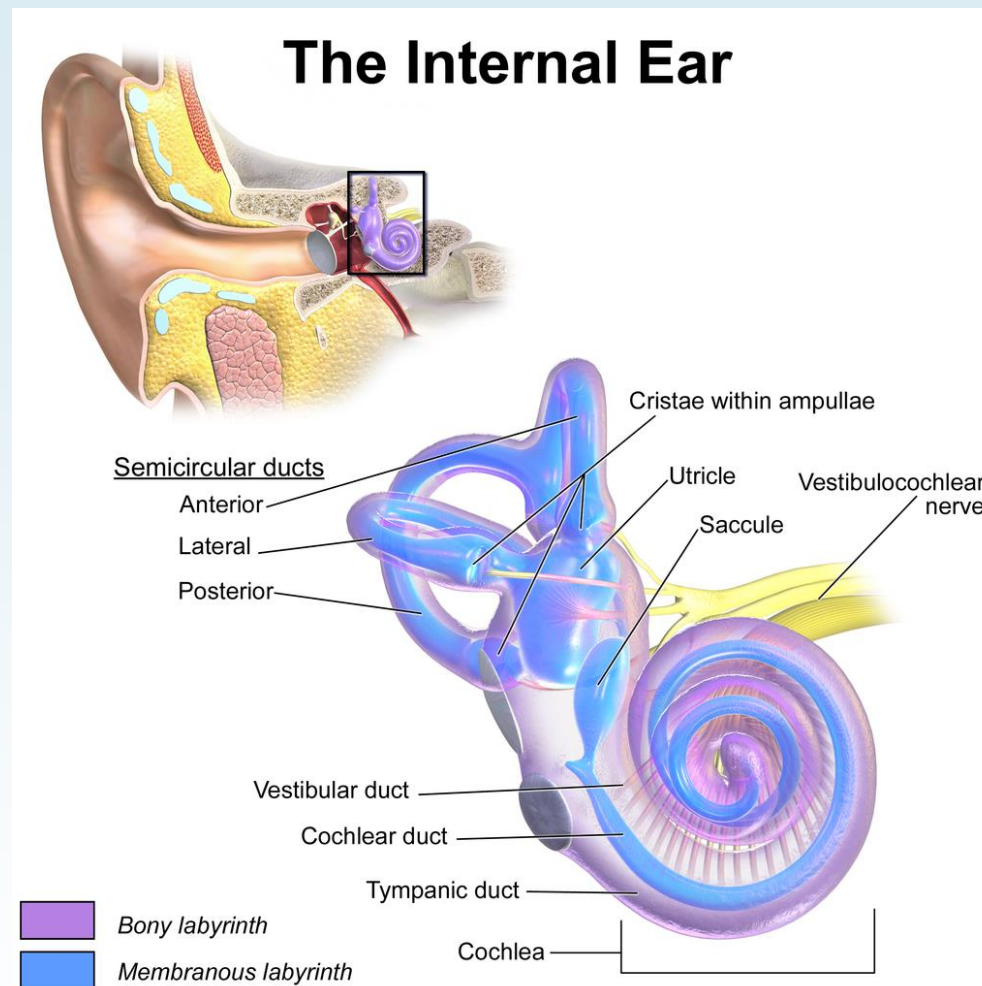
SENSORY INTEGRATION

Can You Trust Your Ears? (Audio Illusions), AsapSCIENCE

<https://youtu.be/kzo45hWXRWU>

Sensory Integration

- Visual and vestibular systems both sense motion, but have different references, sensitivities



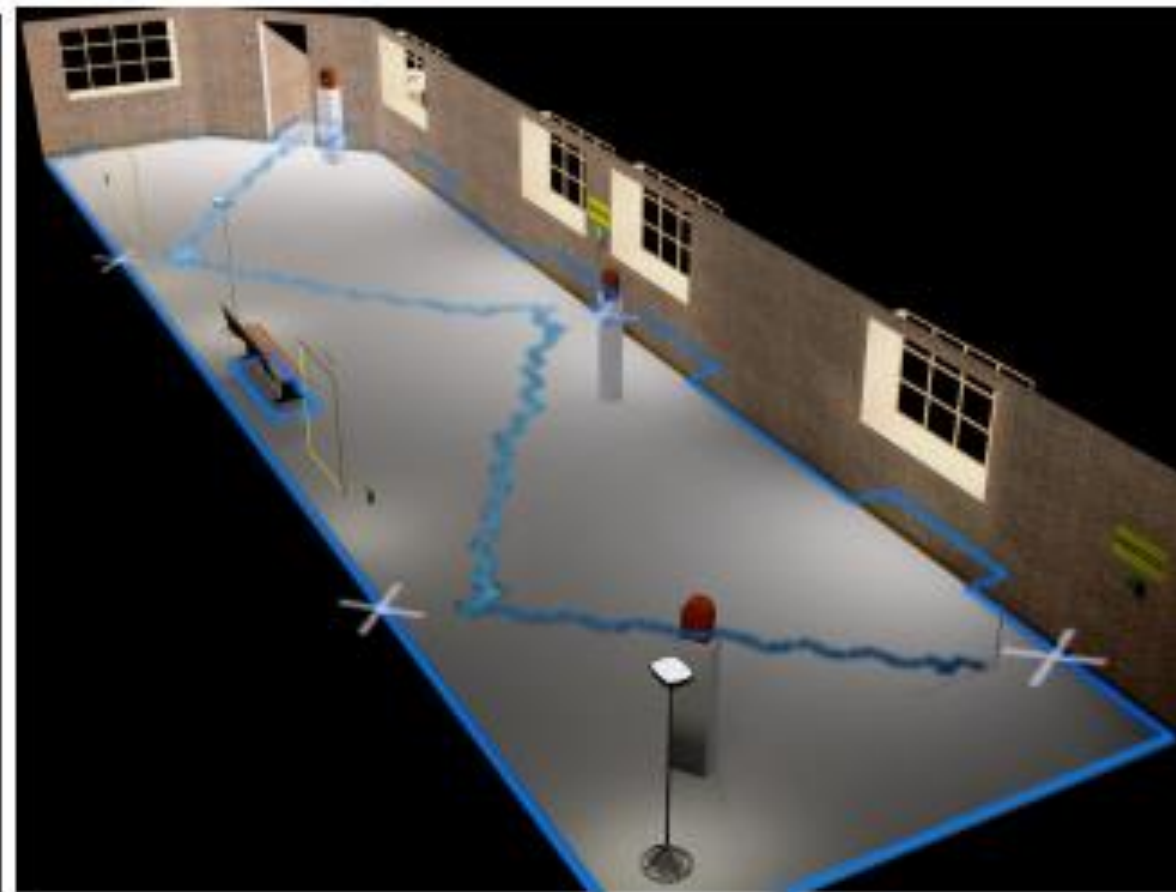
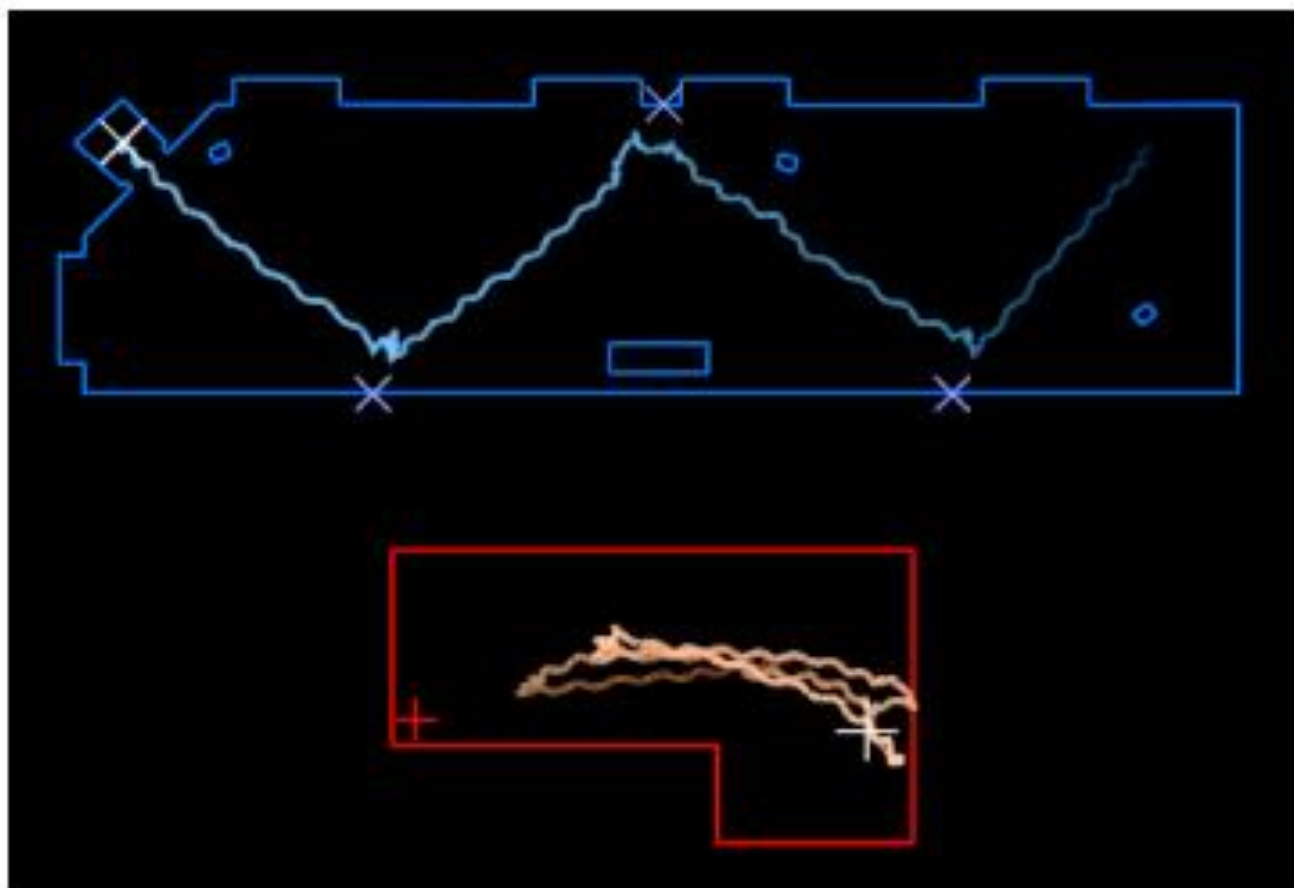
Redirected Walking

Sharif Razzaque. 2005. Redirected walking. Ph.D. Dissertation.
University of North Carolina at Chapel Hill, USA. Advisor(s) Fredrick P.
Brooks

An aerial, slightly tilted view of a city street grid. A prominent church steeple is visible in the upper right quadrant. The streets are light-colored, and the buildings are dark, creating a high-contrast pattern. The overall tone is muted and historical.

Redirected Walking

papers_0263



Redirected Haptics

- Mahdi Azmandian, Mark Hancock, Hrvoje Benko, Eyal Ofek, and Andrew D. Wilson. Haptic Retargeting: Dynamic Repurposing of Passive Haptics for Enhanced Virtual Reality Experiences, CHI 2016

Haptic Retargeting

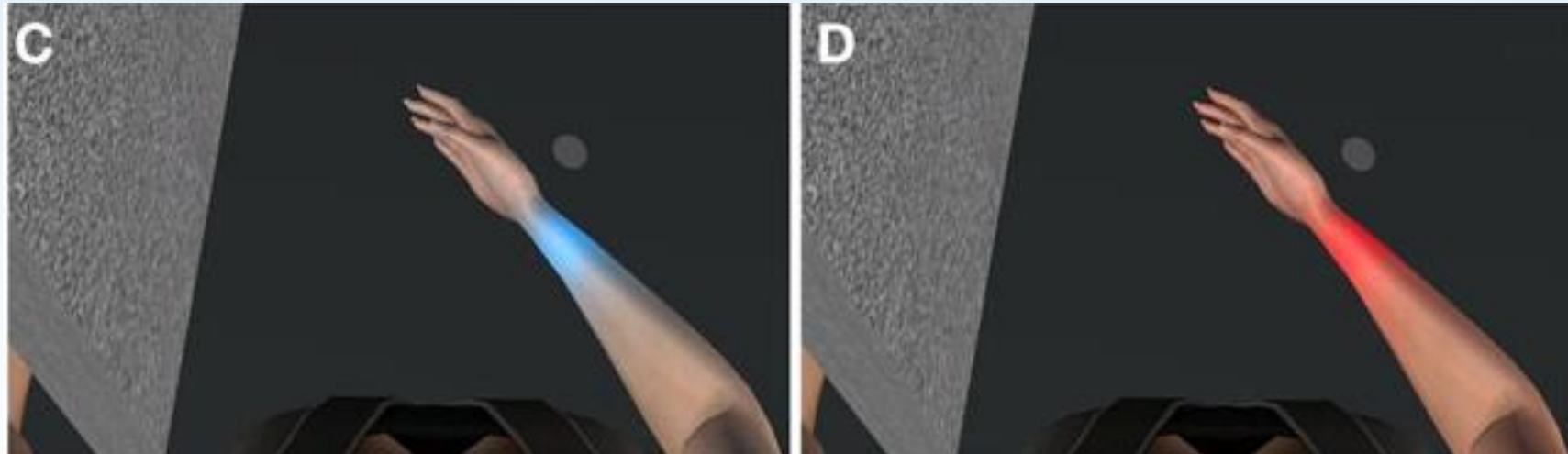
Dynamic Repurposing of Passive Haptics for Enhanced Virtual Reality Experiences

Mahdi Azmandian, Mark Hancock
Hrvoje Benko, Eyal Ofek, Andy Wilson
Microsoft Research

SIGCHI 2016

Common Theme

- Visual dominance over audio, proprioceptive, vestibular ...



Martini, M., Pérez Marcos, D., & Sanchez-Vives, M. V. (2013). What color is my arm? Changes in skin color of an embodied virtual arm modulates pain threshold. *Frontiers in human neuroscience*, 7, 438.

Summary So Far

- We are imagining quite a lot of what we understand the outside world to be
- We appear to be good at inferring structure but perceptions can be fooled by careful control of the stimuli
- To some extent this works because it isn't "reasonable" to suppose that perceptual cues could vary in these ways
- Haven't talked about but need to be wary of side-effects such as eye-strain, simulator sickness, etc.

ILLUSIONS OF SELF

The Rubber Hand Illusion

- Botvinick and Cohen, 1998
- The illusion that a fake rubber hand is part of your own body schema
- That is
 - If this rubber hand is threatened, **you** feel threatened
 - When asked to point at your hand, you point at the rubber hand
 - Verbal questioning about ownership of hand

Is That My Real Hand? | Breakthrough, National Geographic

<https://youtu.be/DphlhmtGRqI>

Body Ownership in Virtual Reality

- Nowadays, virtual reality allows us to immerse people in a virtual world that includes a representation of their body
 - But what does this body do?
-
- Yuan, Y, Steed, A. (2010) Is the Rubber Hand Illusion Induced by Immersive Virtual Reality? IEEE Virtual Reality 2010, 95-102.

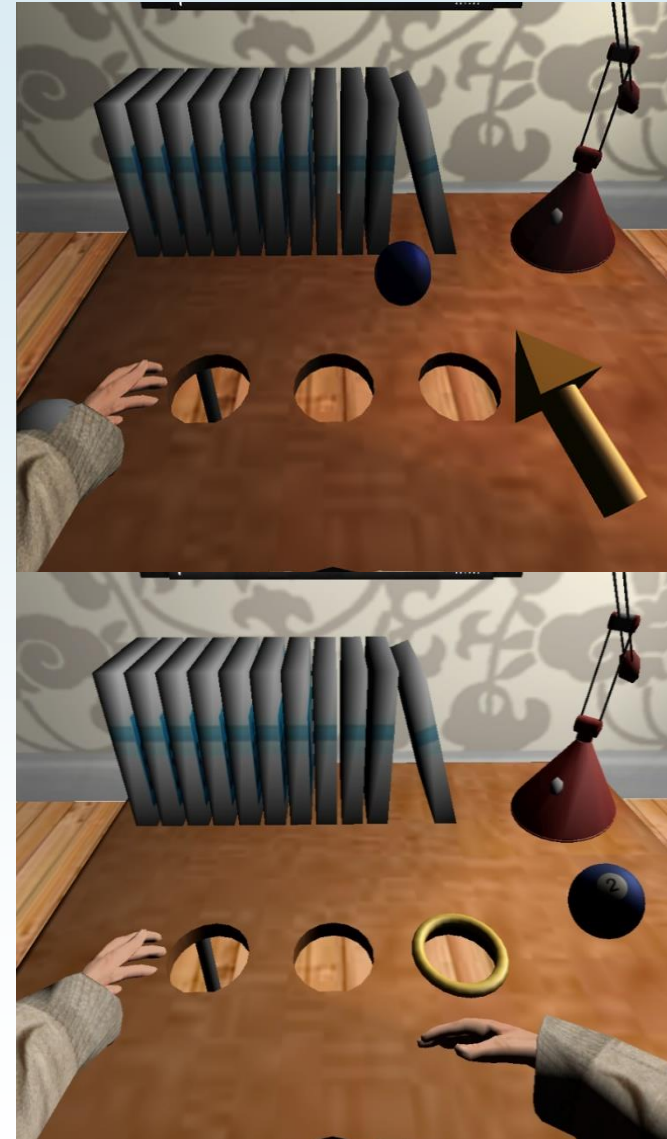






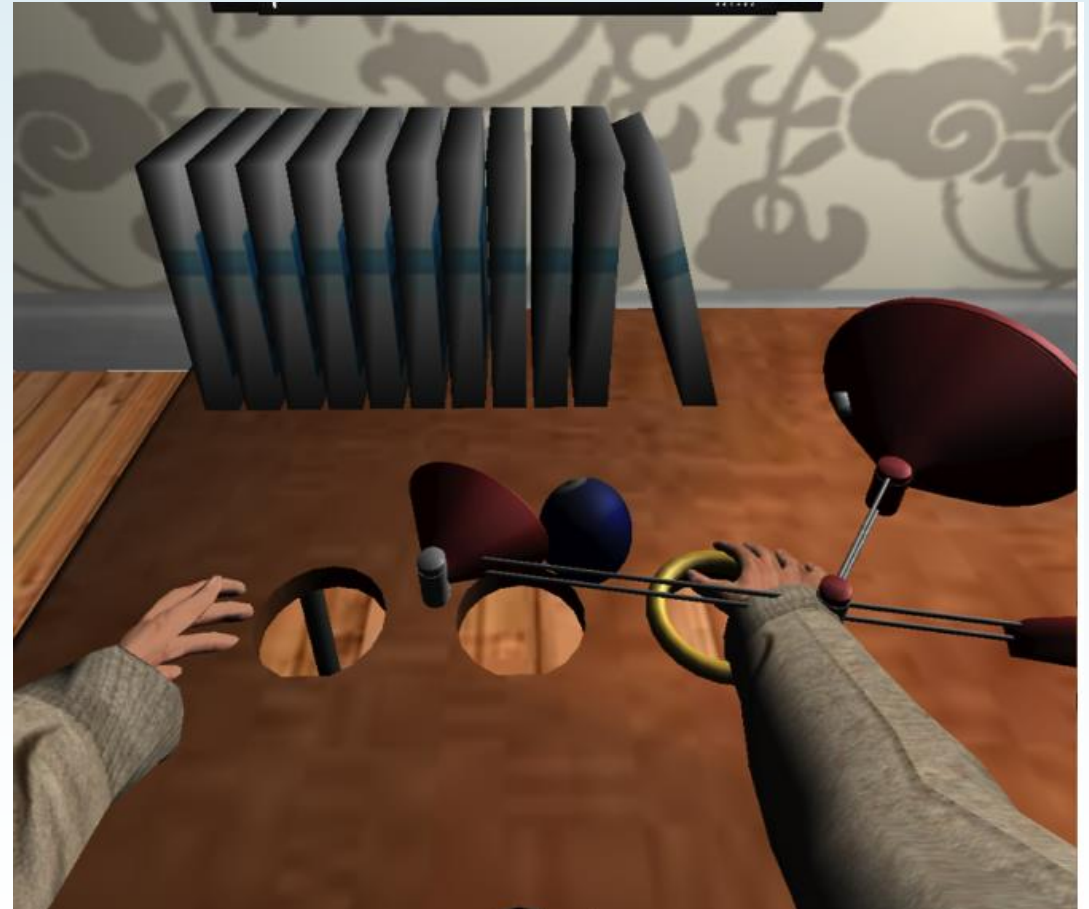
Four Conditions

- Drift or no drift
 - In drift condition, whilst playing Simon game, the hand-tracker offset is slowly increased from 0m to 0.1m (0.56 mm/s)
- Virtual body or arrow



Response to Threat

- At a specific time, the lamp falls over
- The ball and hole have been pre-cued so that the hand is in the region where the lamp falls
- Looking for a stress response



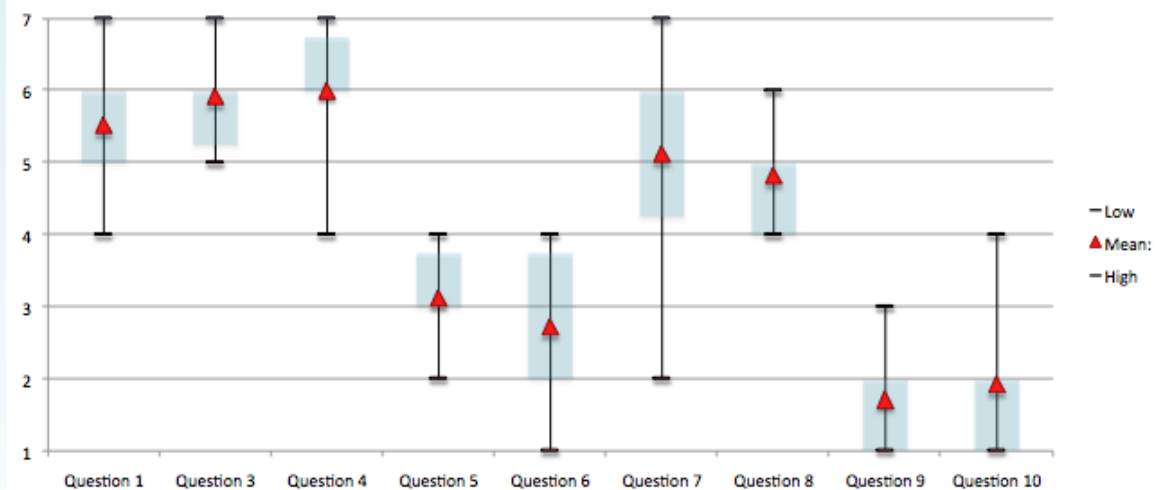
Measuring Response: Questionnaire

- Based on Botvinick and Cohen, 1998 and Slater et al., 2008
- Modified wording to suit situation, the fact that the participant is active and there being no induction
- 9 statements rated on 7-point Likert scale 1 (=strongly disagree) to 7 (=strongly agree)
- *1. During the experiment, how immersed did you feel being in the virtual reality*

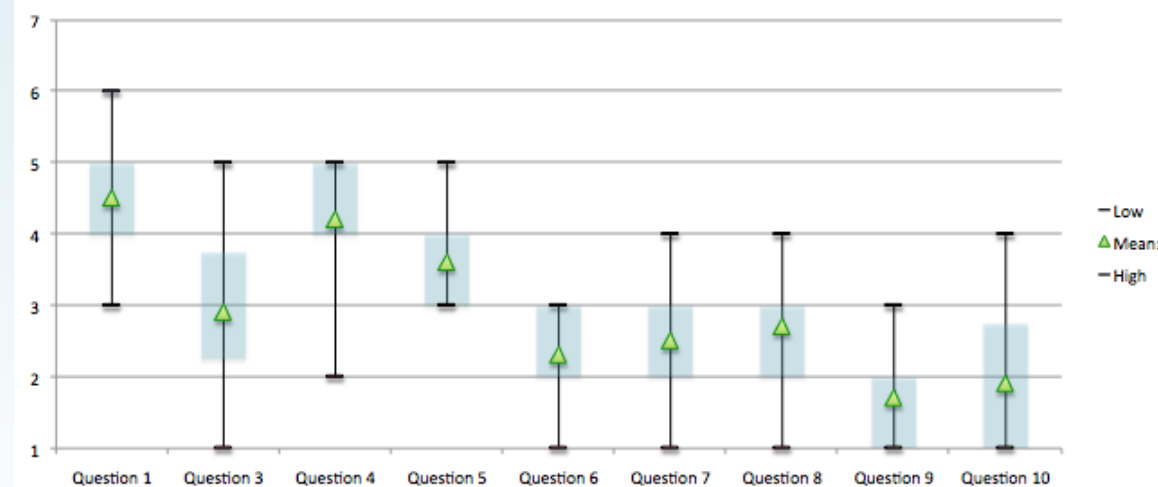
Illusion Response Questions

- 3. *During the experiment there were moments in which I felt as if the virtual arm/arrow was my own arm.*
- 4. *Sometimes I had the feeling that I was holding the virtual object (Balls or TV control) in the location of the real arm.*
- 7. *During the experiment there were moments in which it seemed that my own arm was being hit by the falling lamp.*

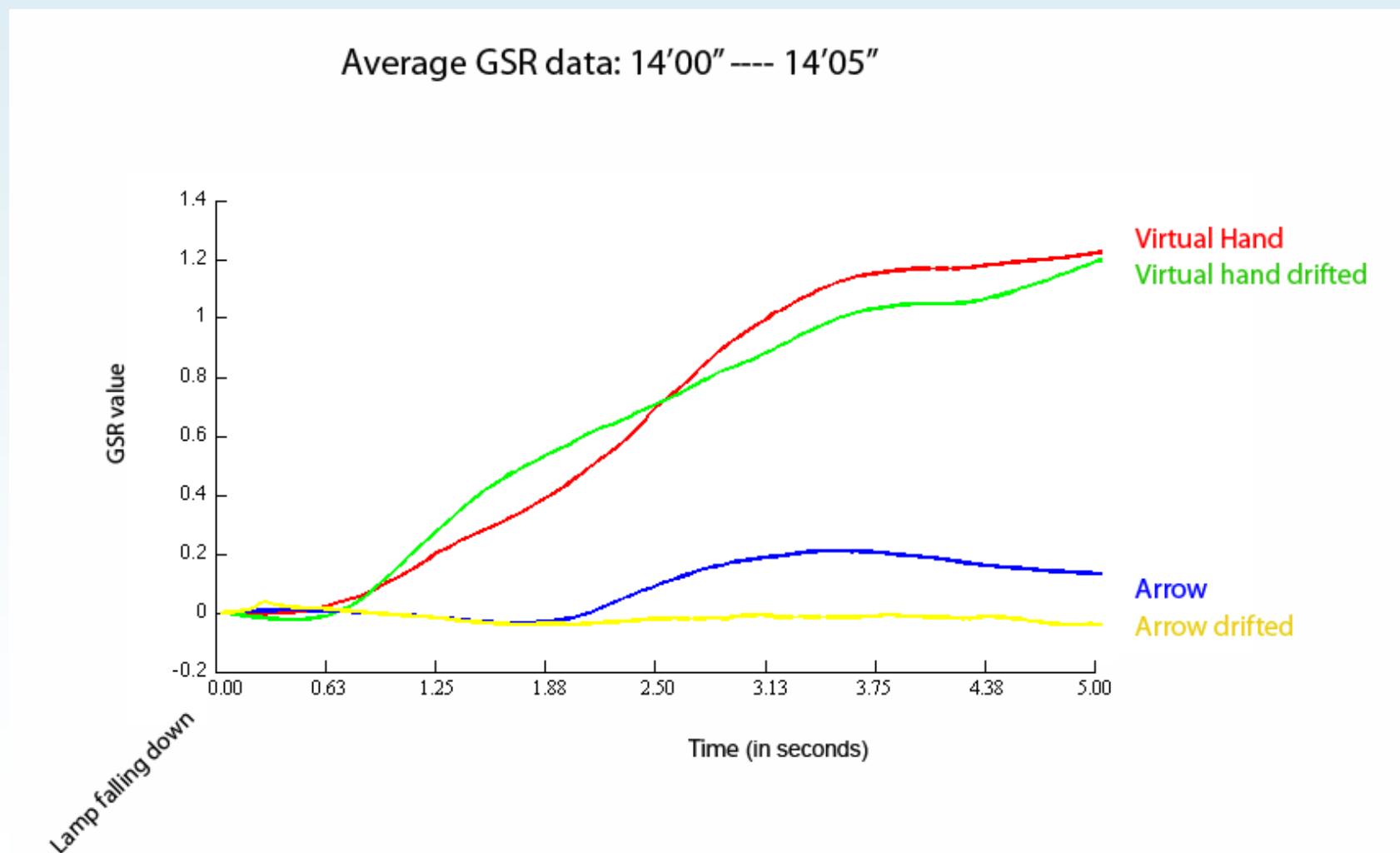
Virtual Hand



Arrow



Galvanic Skin Resistance



Body Ownership

- This has now been reproduced dozens of times and seems reliable
- Many variants with different avatars

For more see:

Kilteni, K., Groten, R., & Slater, M. (2012). The sense of embodiment in virtual reality. *Presence: Teleoperators and Virtual Environments*, 21(4), 373-387.

Enfacement Illusion

- That a different face is your face
- Can be induced in the same way as the rubber hand illusion – e.g. looking at a video of a face being tapped at the same time as your own face
- Interesting way of testing whether the illusion exists

<https://youtu.be/FB2FCD3uNBE>



Using Facial Animation to Increase the Enfacement Illusion and Avatar Self-Identification

Mar Gonzalez-Franco, Anthony Steed†, Steve Hoogendyk, and Eyal Ofek*

* margon@microsoft.com

Microsoft Research, Redmond, USA

† University College London





Summary So Far

- While we focused on immersive systems, this is because they can be considered as illusions because the virtual is somehow “not real”
- However, they have strong implications for other types of HCI such as video, AR, IOT, body-sensor networks

CONCLUSION

Illusions

- Illusions give us insight into how the brain works
- Various illusions show us the limitations of perception in that it needs to infer from noisy data that has expected patterns
- The body illusions tell us that there is a class of illusions that are active, where we model our body
- The brain appears to be quite plastic when it comes to understanding how perception and action are linked