Illusion and Reality: The Science of Perception

Lew Harvey
Psychology and Neuroscience

CU Wizards

With the Support of:

- Philip DiStefano, Chancellor, CU Boulder
- James White, Dean, College of Arts & Sciences
- George Gamow Memorial Lecture Fund
- David Paddock EndowmentCU Outreach Council
- CU Outreach Council
- CU Science Discovery Program
- And Many Local Wizards Fans

Basic Ideas

- We see with our brain, not with our eyes
- **What** is out there and **where** is it?
- The brain creates our perception of reality from multiple streams of information
- Sometimes perceptions are “wrong” (Illusions)

René Descartes (1595-1650)

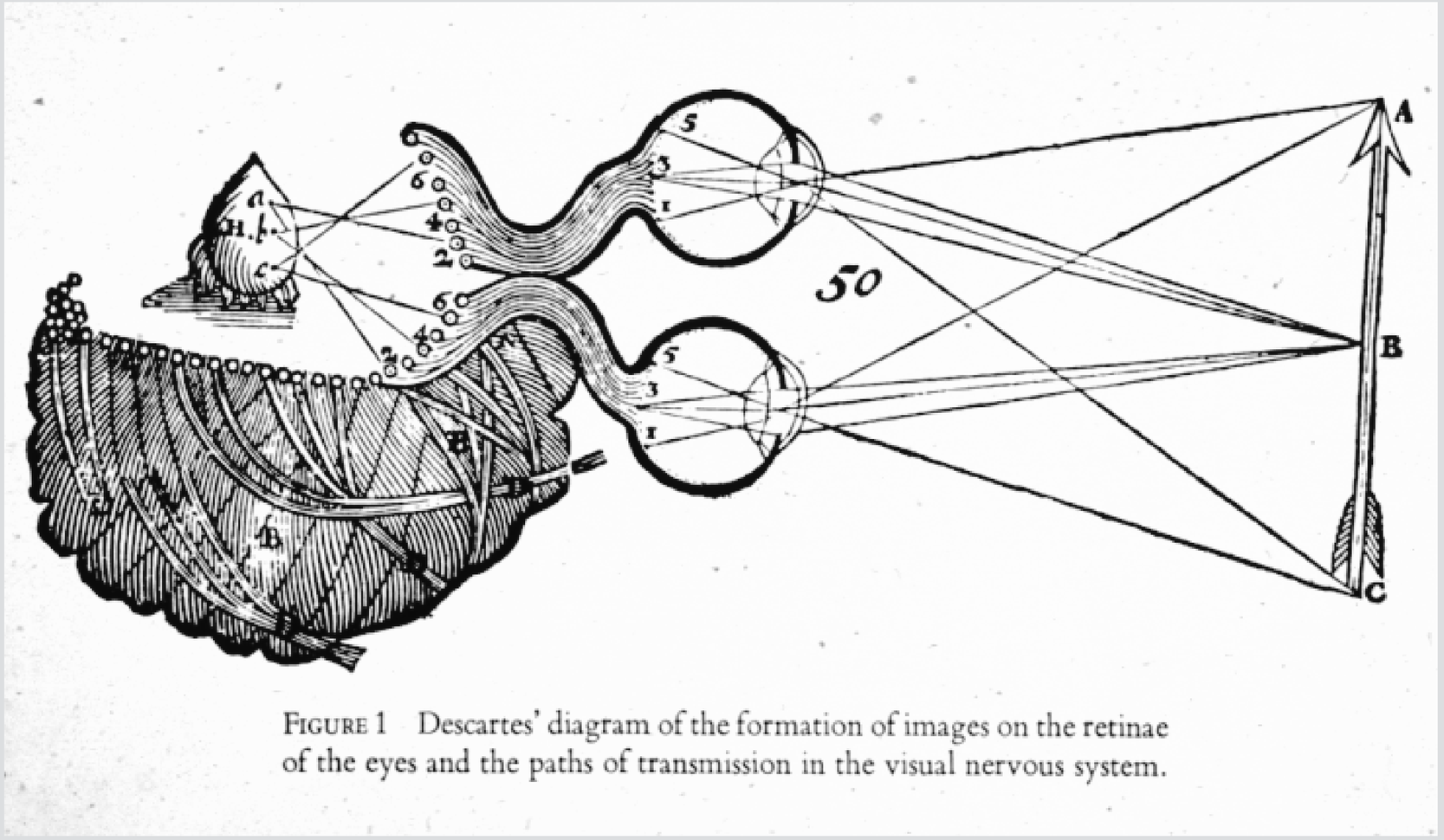
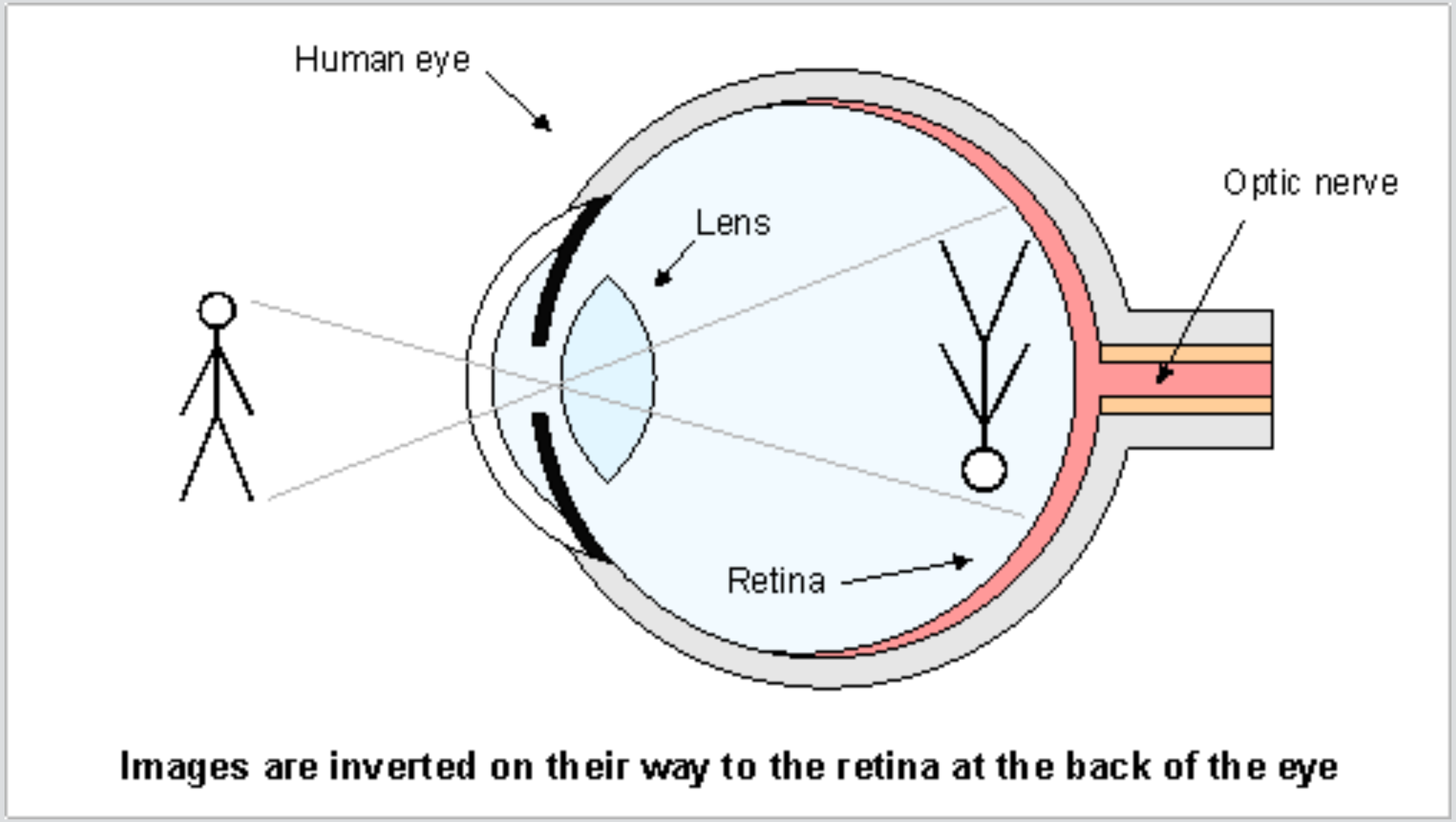


FIGURE 1 Descartes' diagram of the formation of images on the retinae of the eyes and the paths of transmission in the visual nervous system.

Descartes, R. (1648). *Traité de l'Homme.*



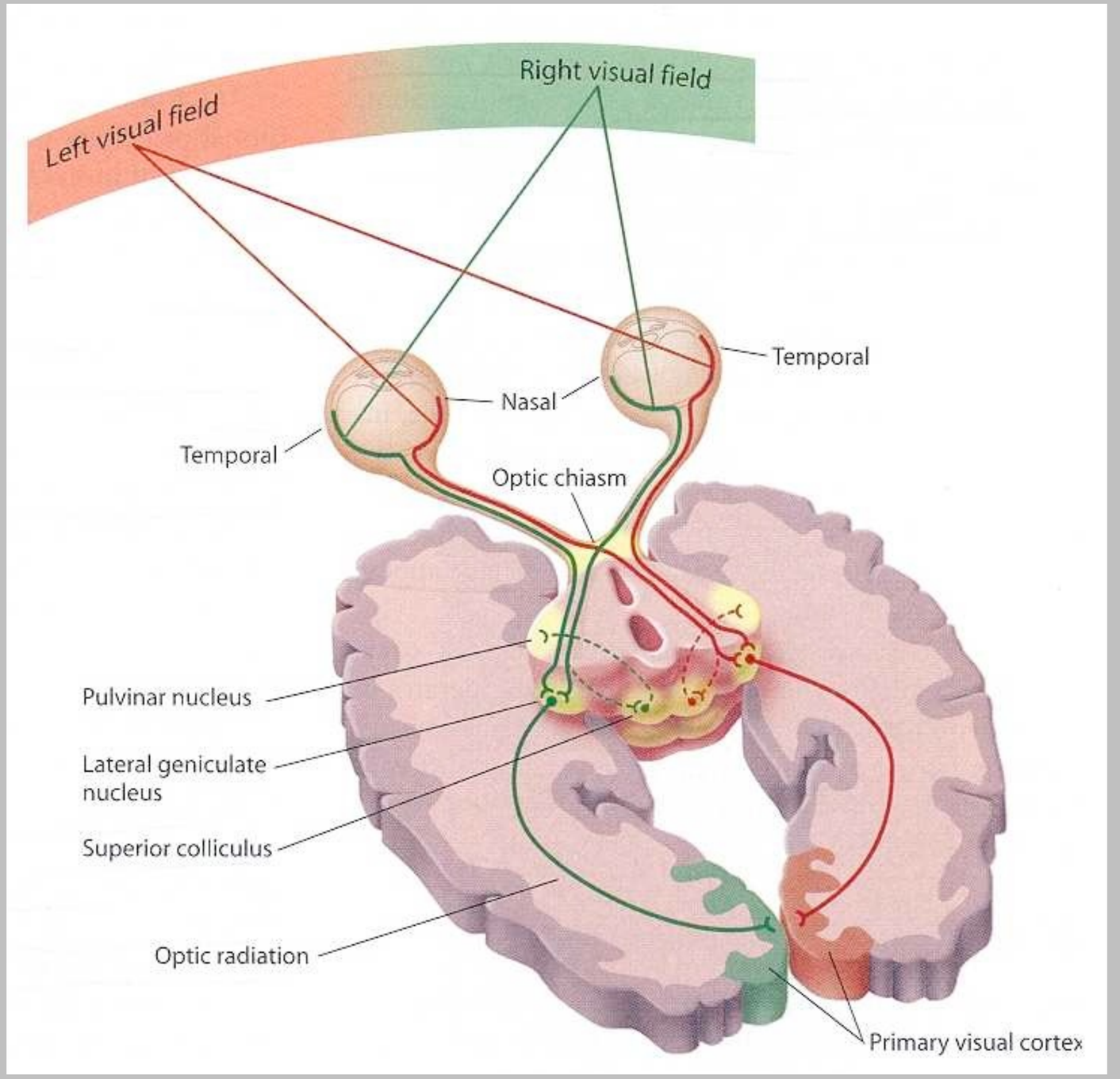
Images are inverted on their way to the retina at the back of the eye

Two volunteers

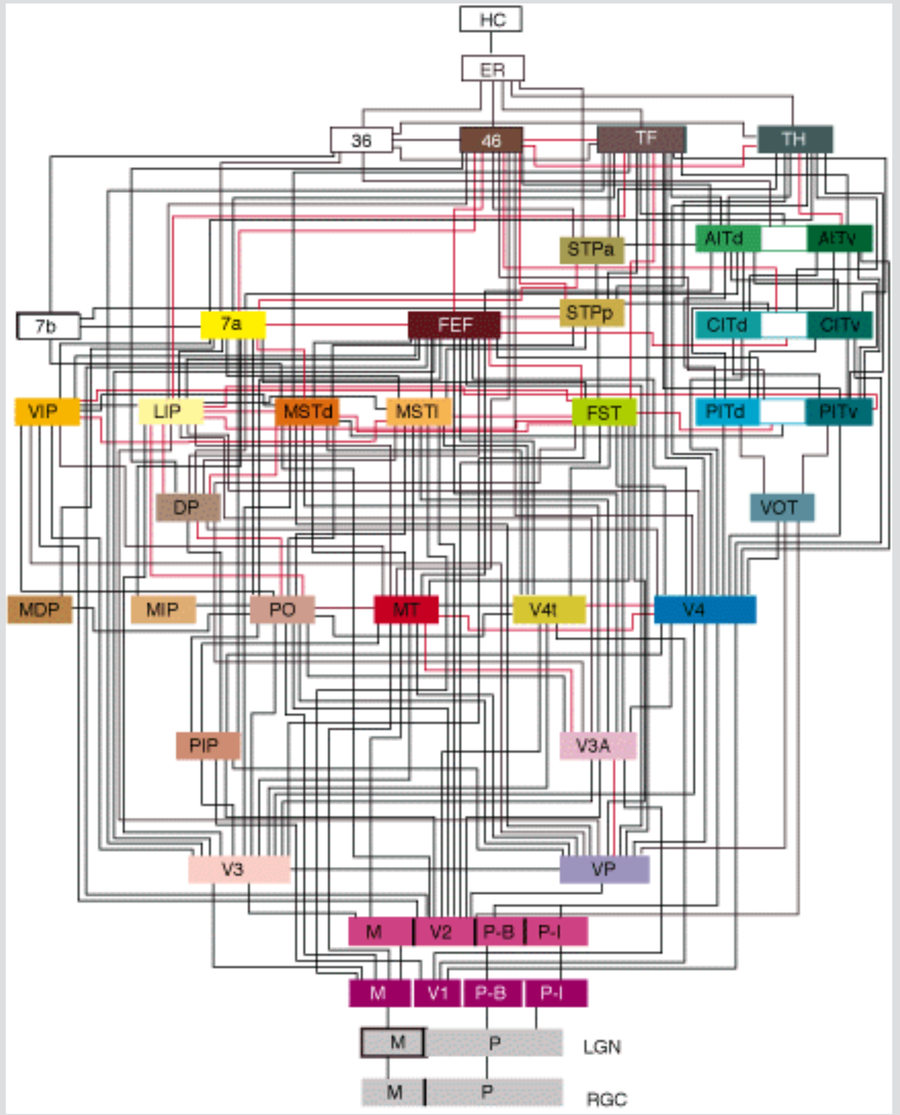
Use Prisms to Distort Retinal Image

Effect of Optical Distortion

Our Brain can rather quickly adapt to optical distortion!

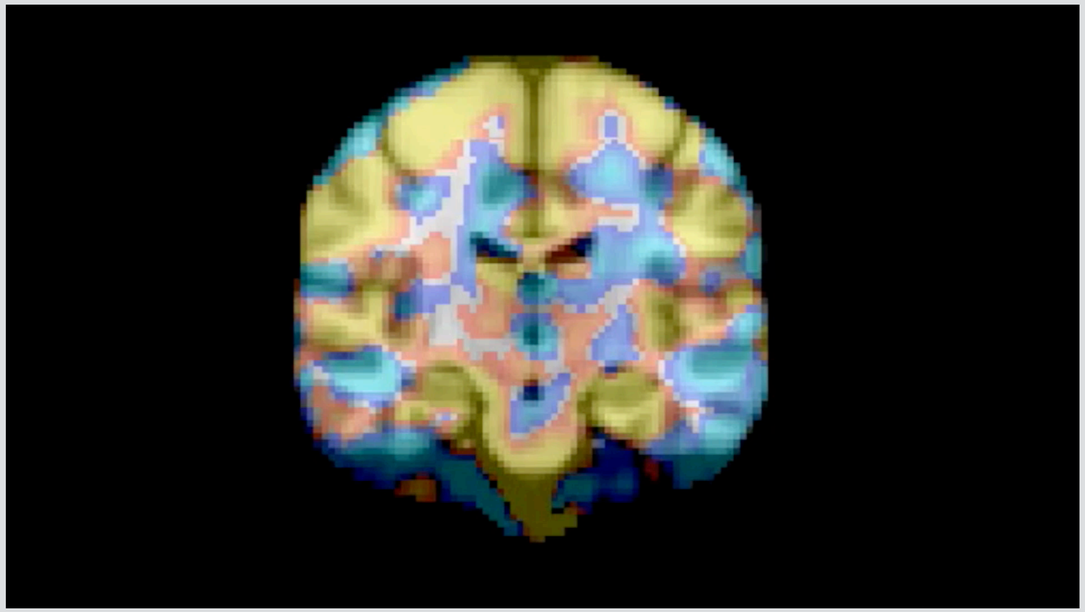

Left visual field
Right visual field
Temporal
Nasal
Temporal
Optic chiasm
Pulvinar nucleus
Lateral geniculate nucleus
Superior colliculus
Optic radiation
Primary visual cortex

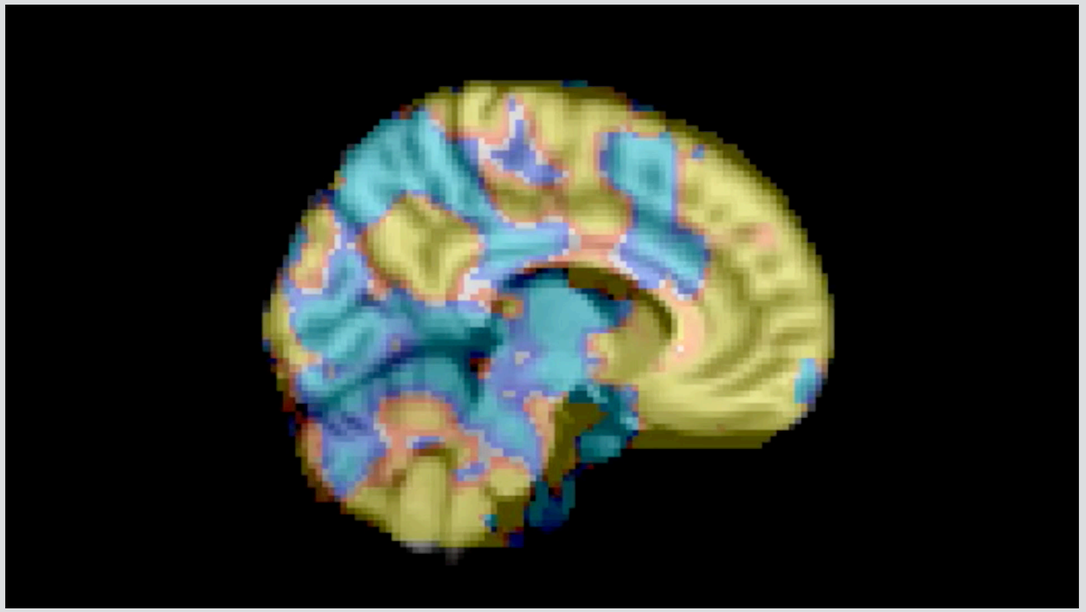
Visual Pathways, circa 1991



Felleman, D. J., & Van Essen, D. C. (1991). Distributed Hierarchical Processing in the Primate Cerebral Cortex. *Cerebral Cortex, 1*(1), 1-47. doi: 10.1093/cercor/1.1.1

Brain Networks, circa 2016
Default Mode Network (DMN)
Activity “At Rest”

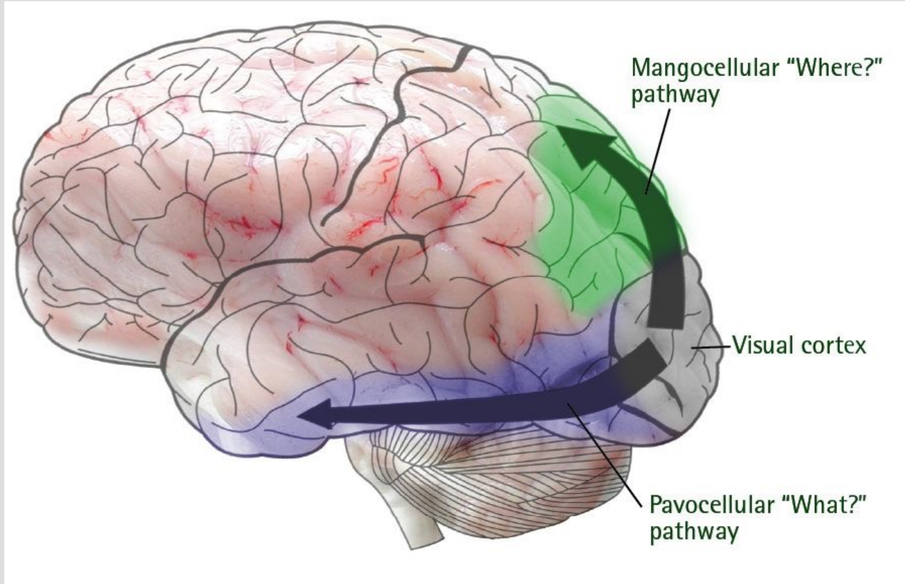




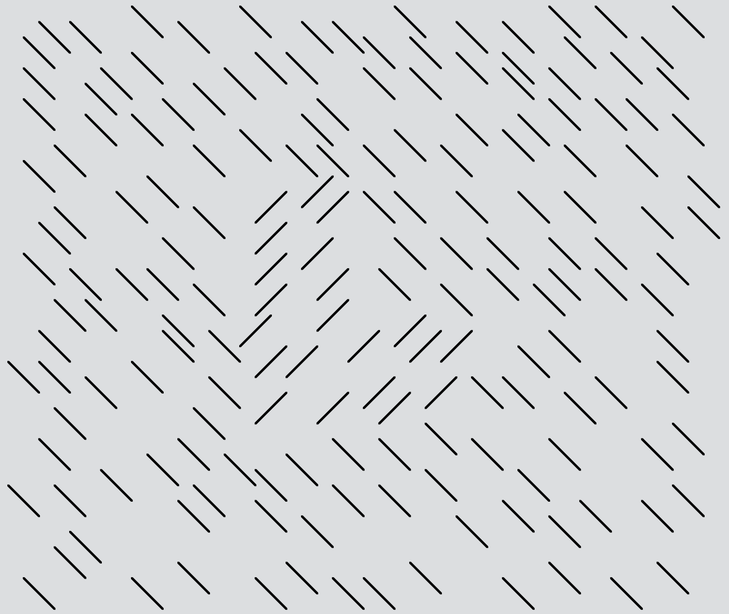
Videos created by Andrew E. Reineberg
Department of Psychology and Neuroscience
University of Colorado Boulder

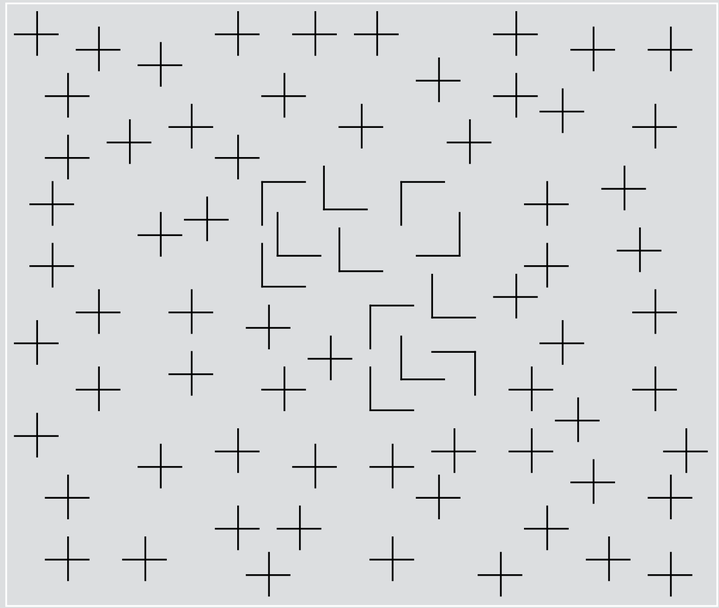
Analysis & Dynamic Interaction

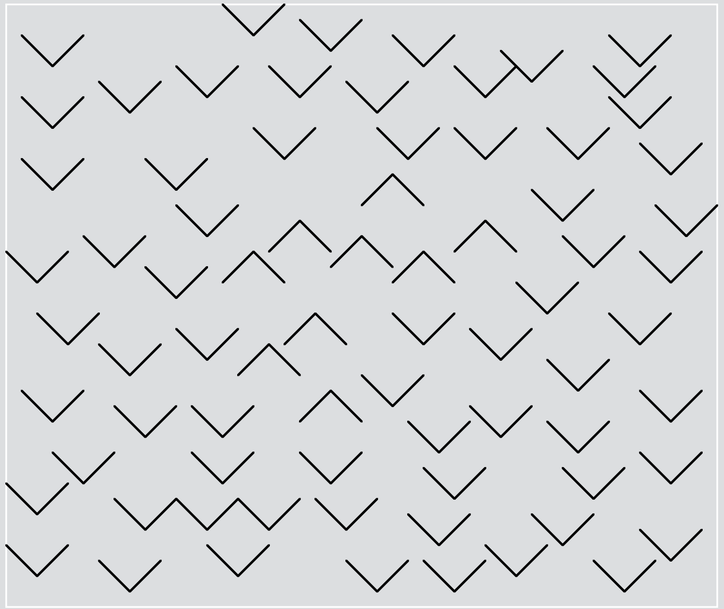
- Sensory input is broken into separate streams of information
  - Lines & edges
  - movement
  - angles & orientation,
  - size & scale
  - color
- Over 50% of cortex has visual responses
- Reality is constructed from these component parts using goals, expectations, biases, rewards.

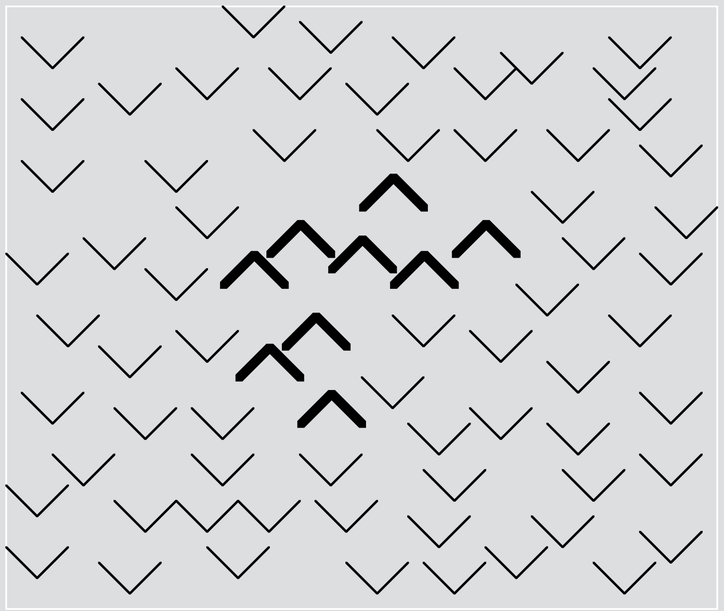


Lines and Edges
Angles and Orientations

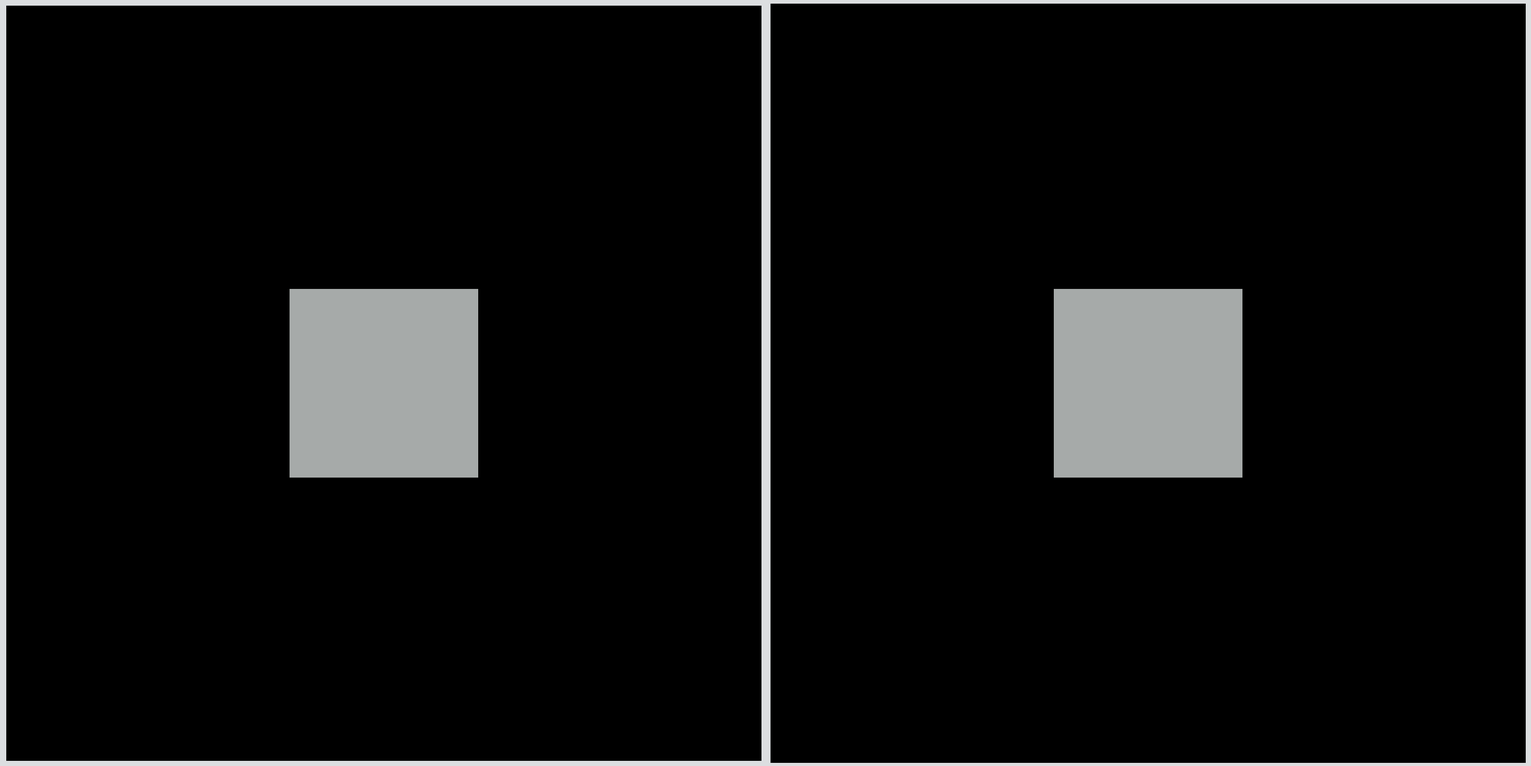


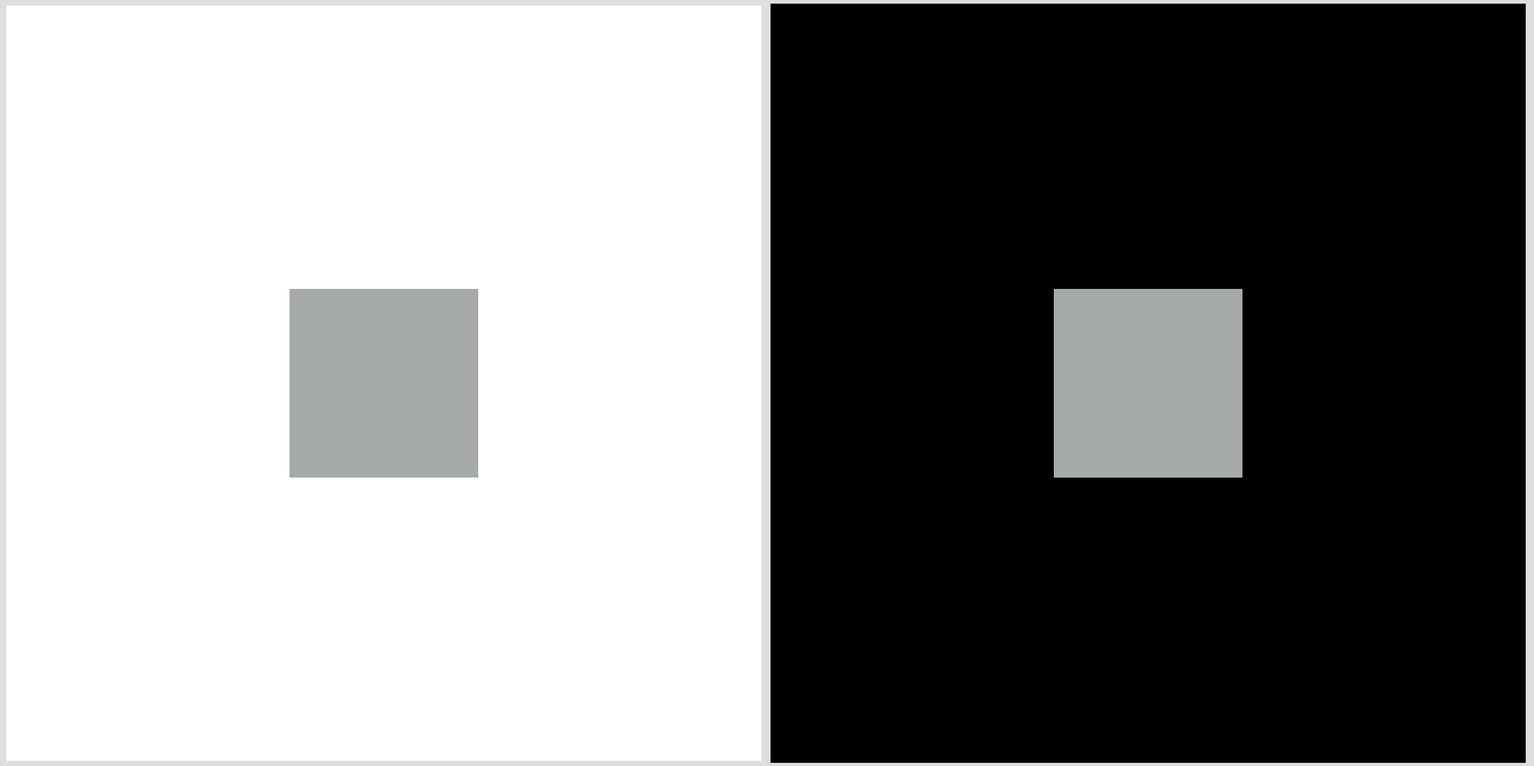


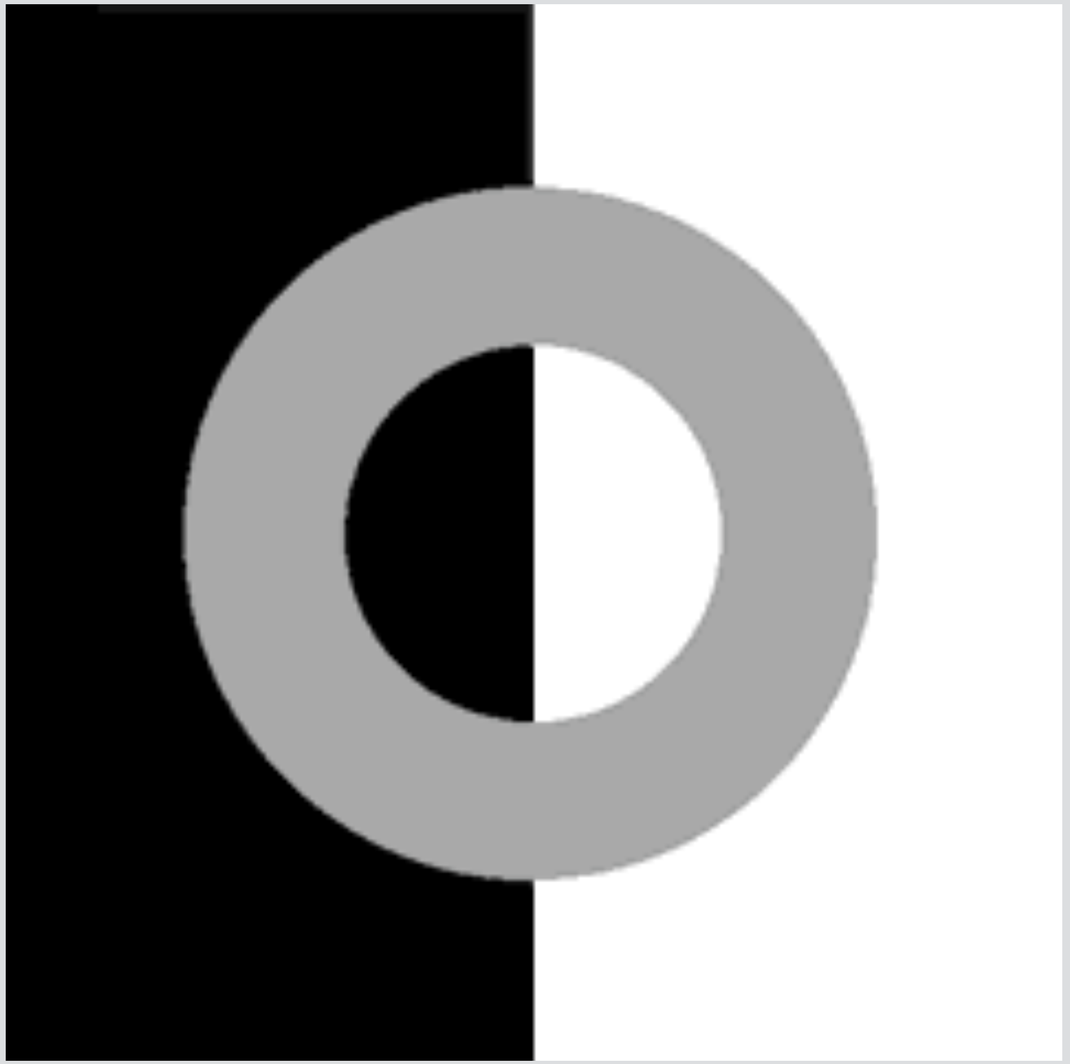


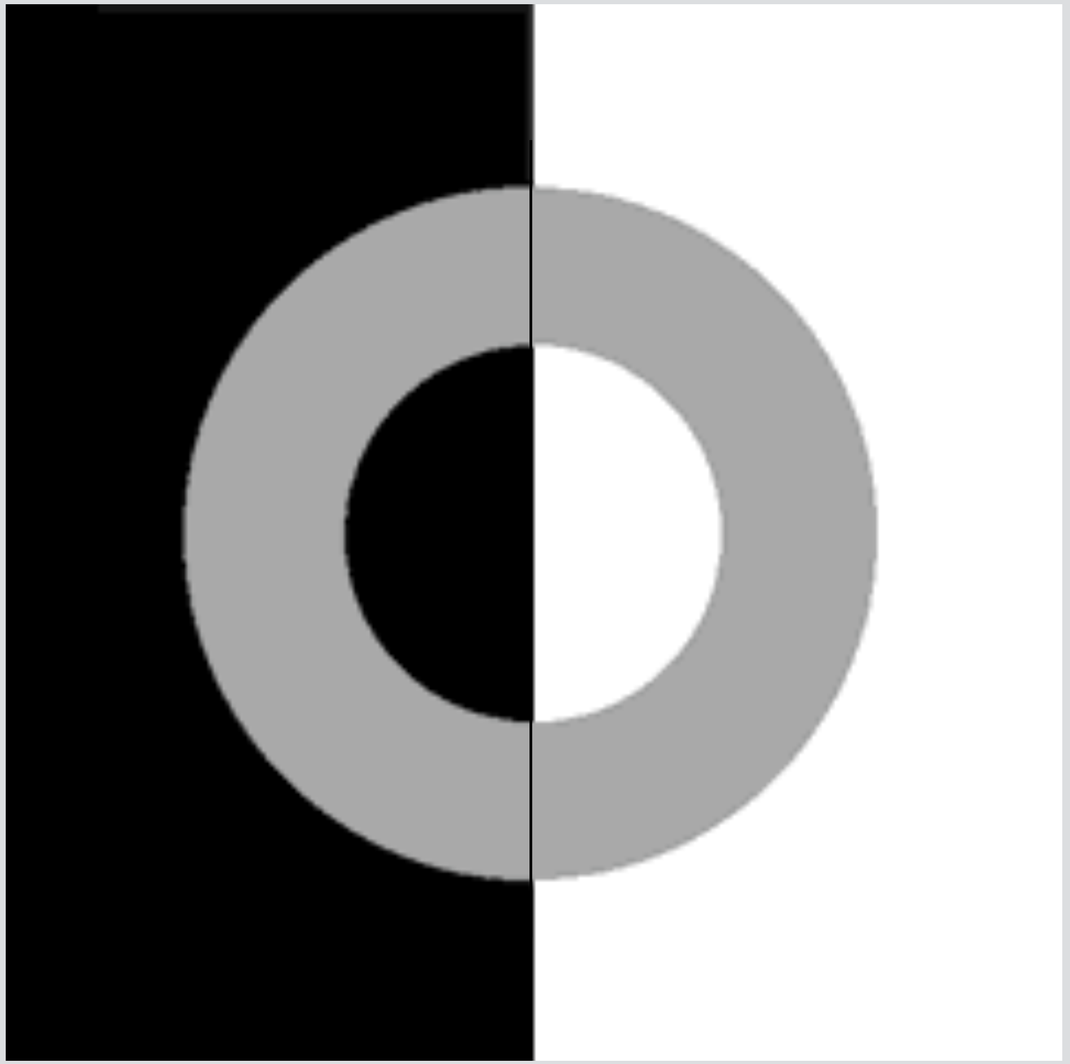


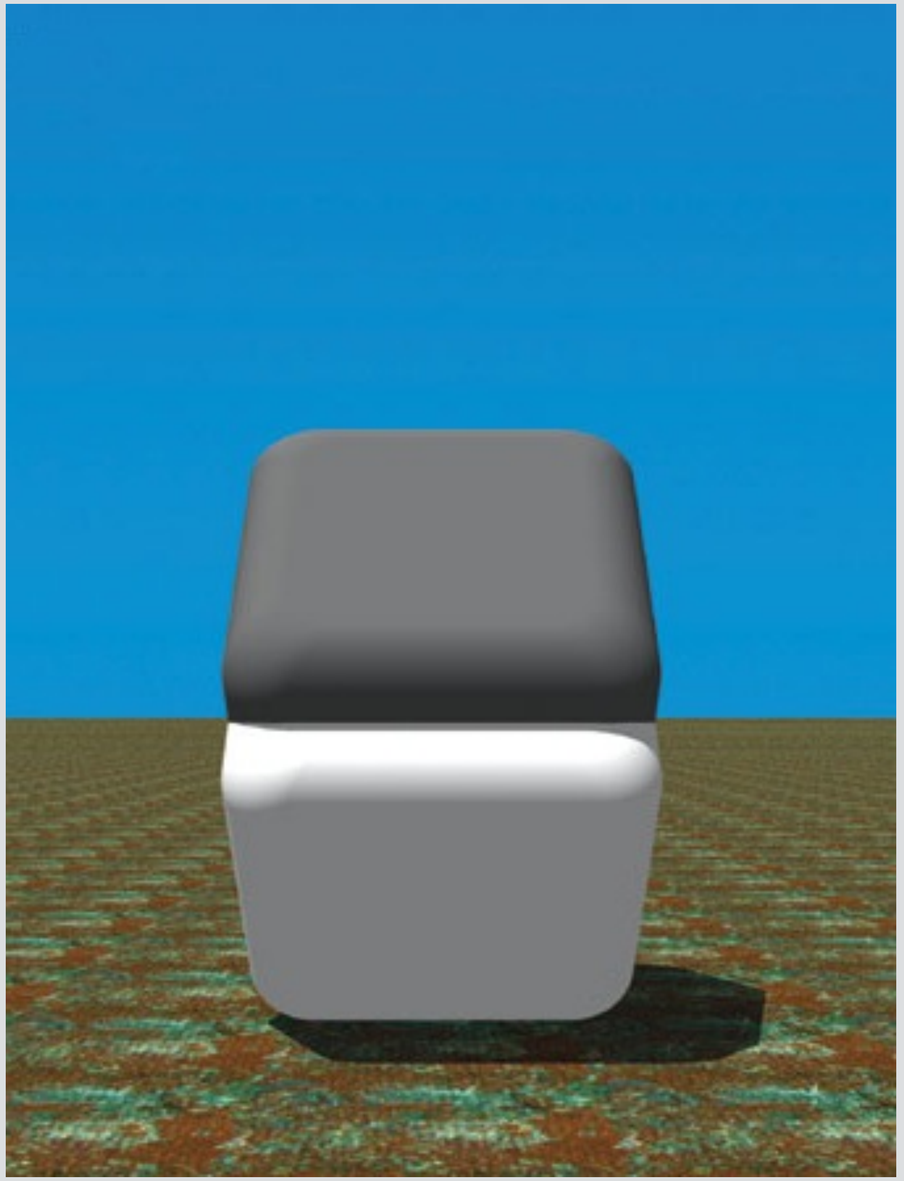
What we perceive does not correspond to physical properties of objects!

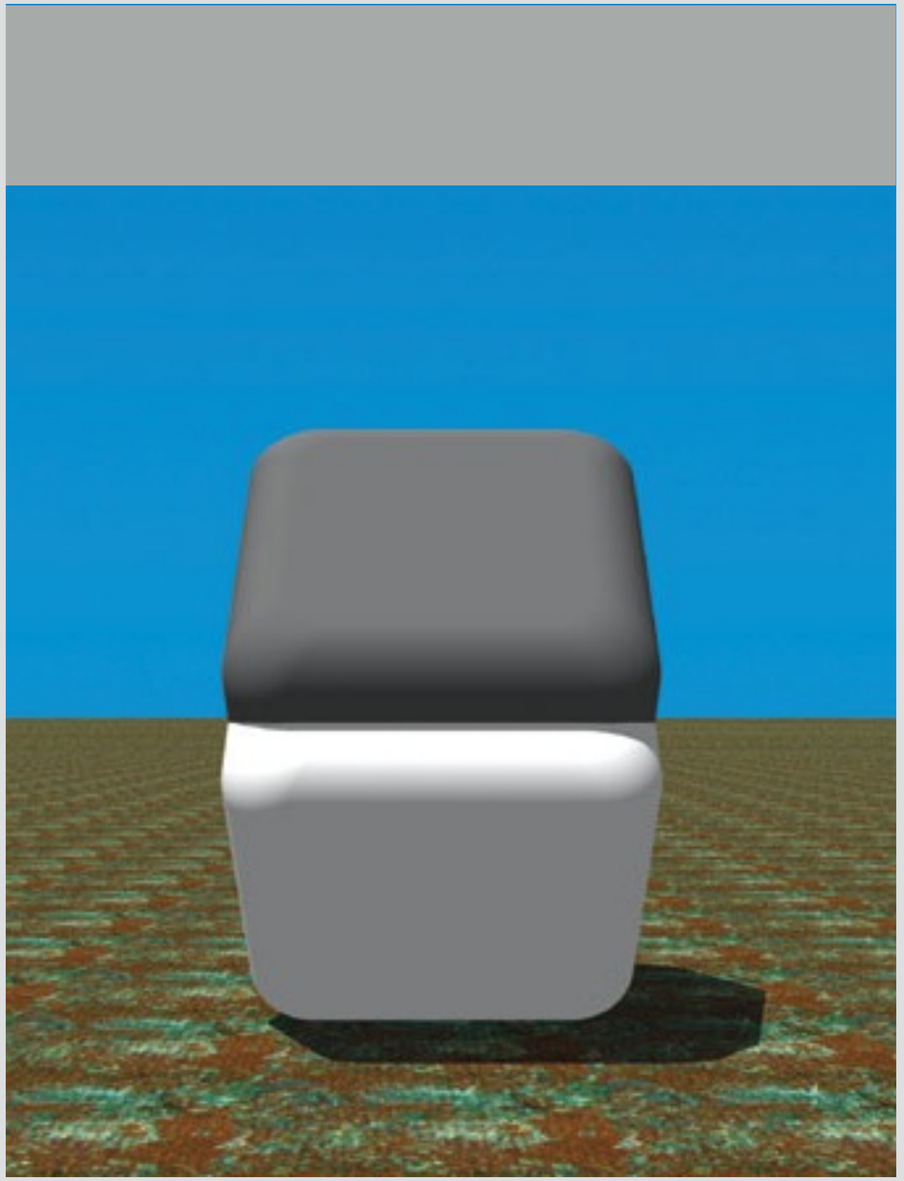


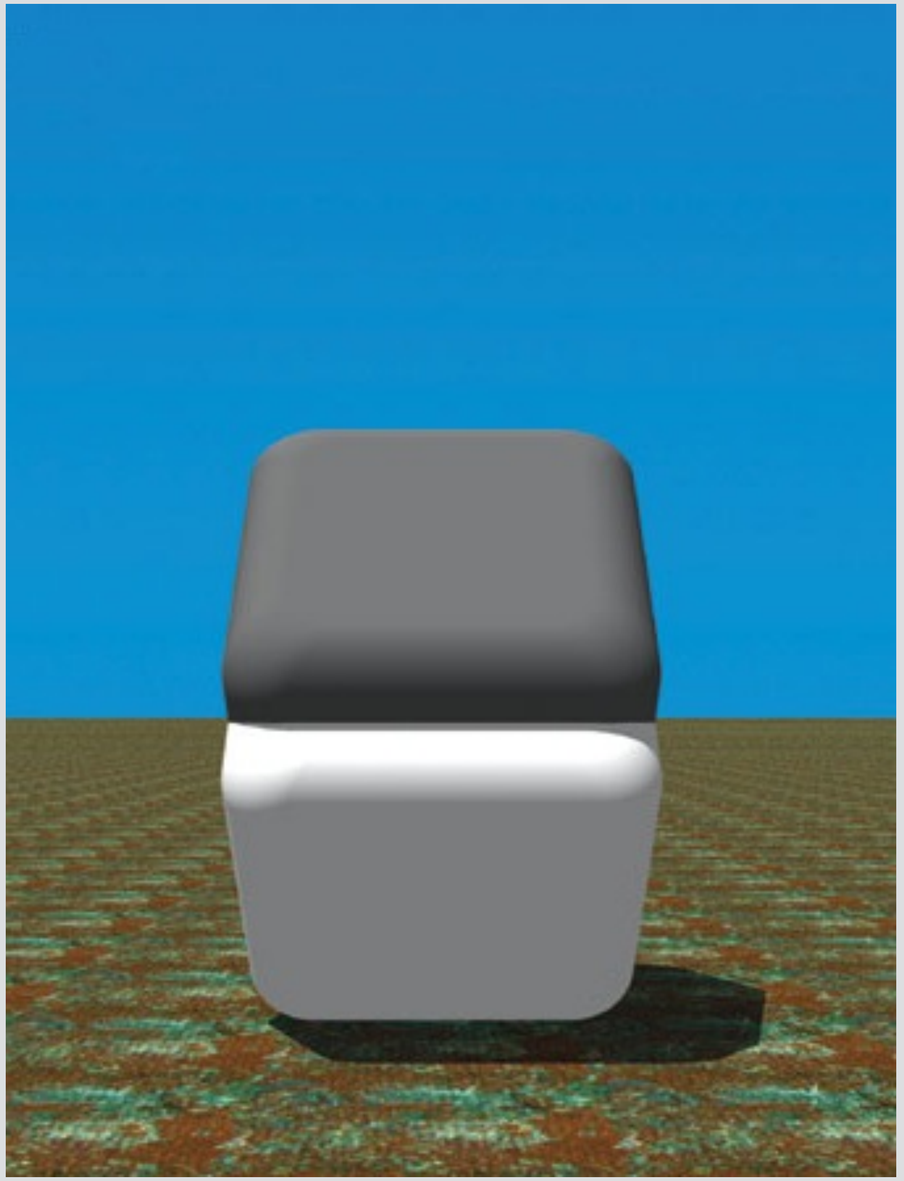












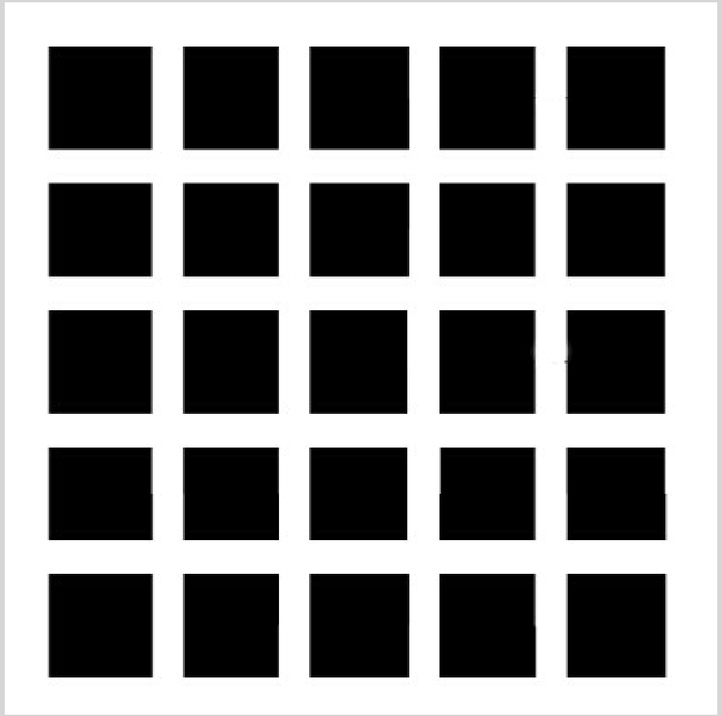
Asahi Figure

Akiyoshi Kitaoka 2005

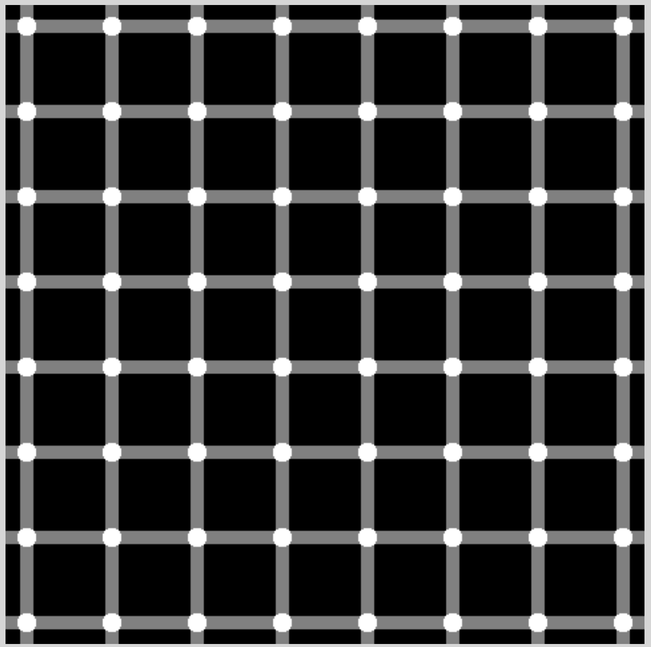
Asahi Figure

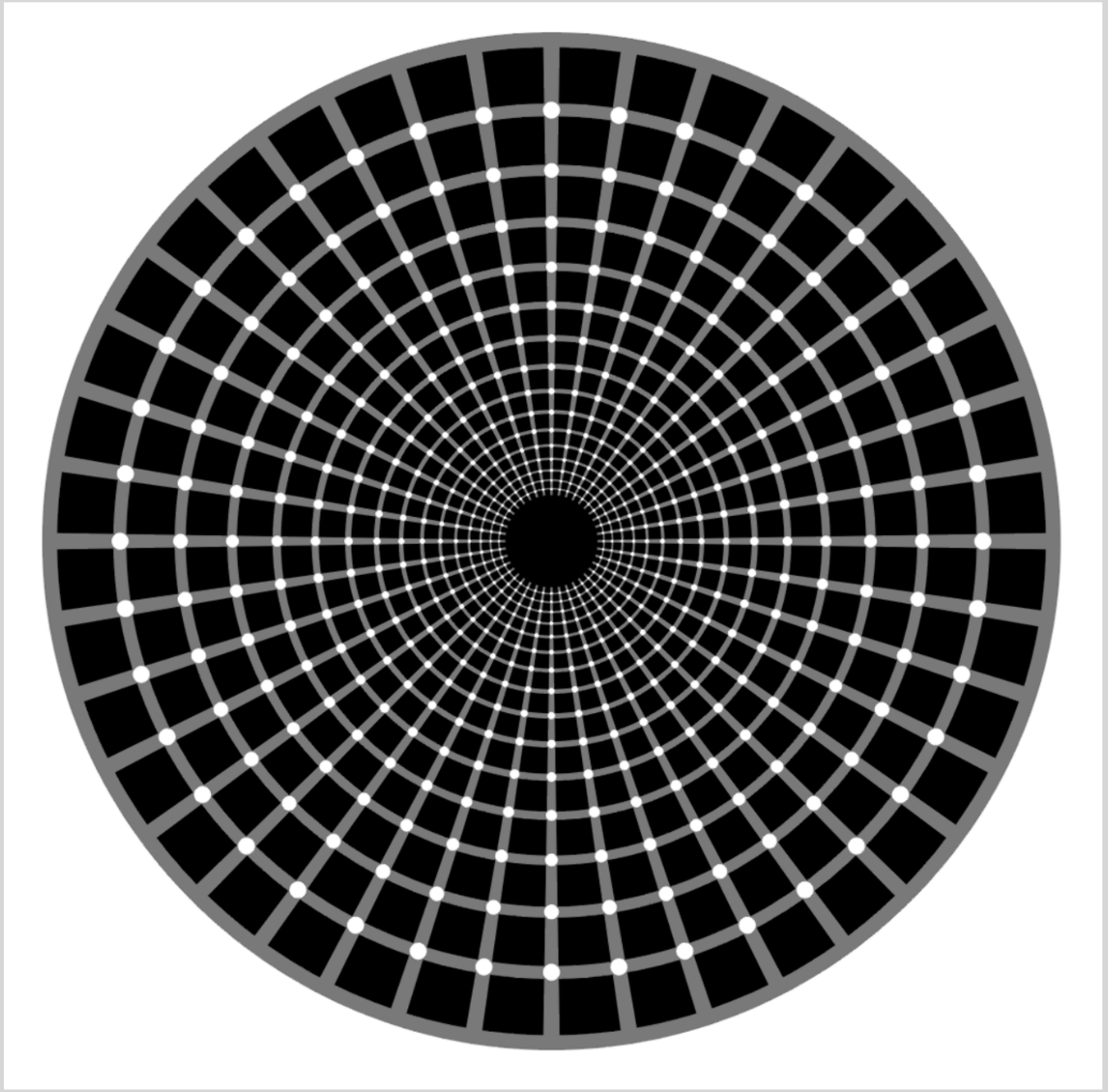
Akiyoshi Kitaoka 2005

Hermann Grid

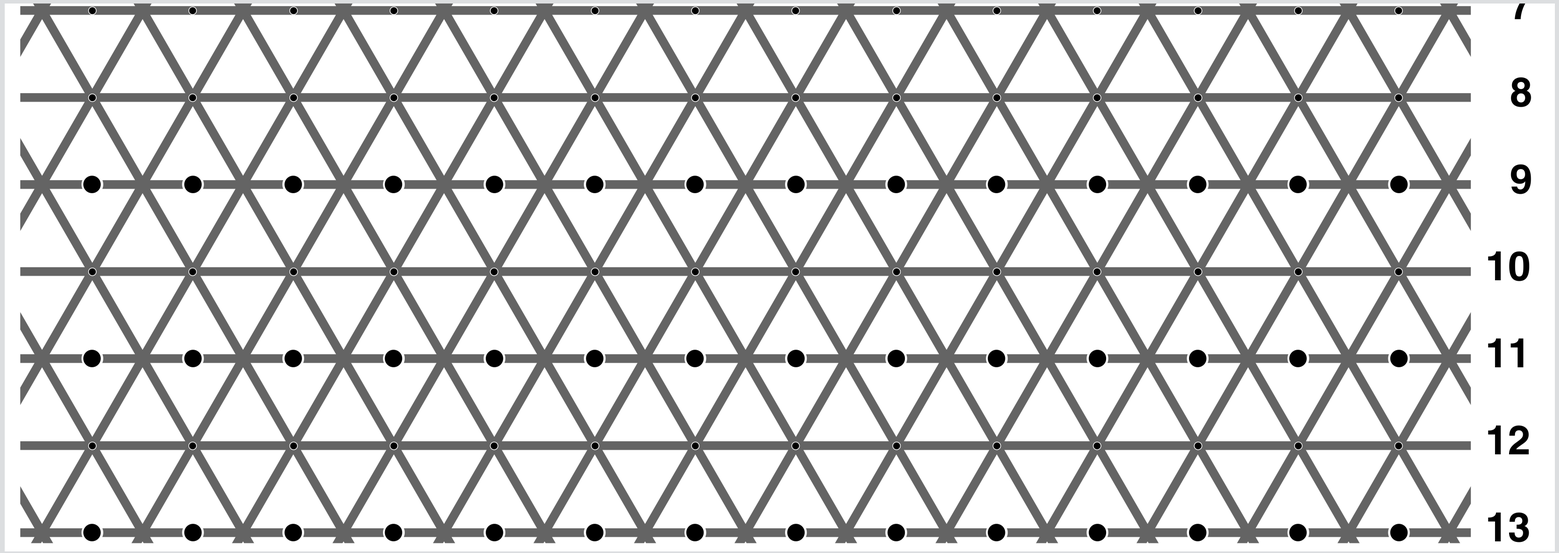


Enhanced Hermann Grid



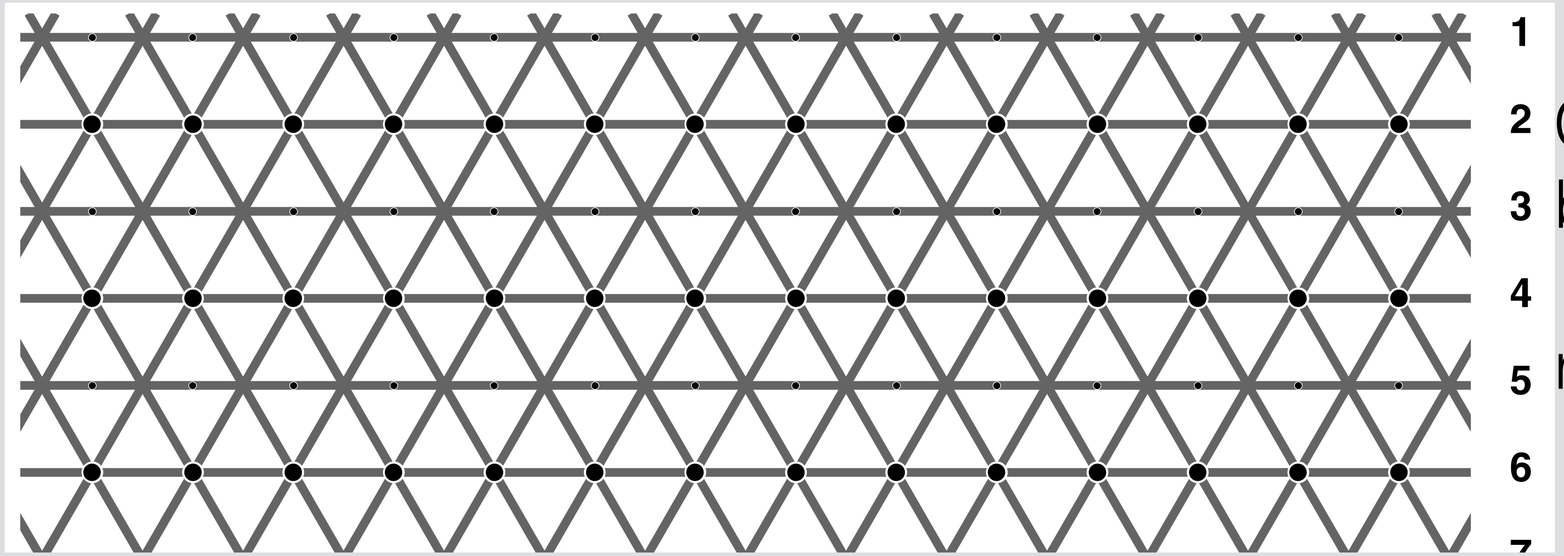


Akiyoshi Kitaoka



Count the black dots on odd-numbered rows

Ninio, J., & Stevens, K. A. (2000). Variations on the Hermann Grid: An Extinction Illusion. *Perception, 29*(10), 1209-1217. doi: 10.1068/p2985



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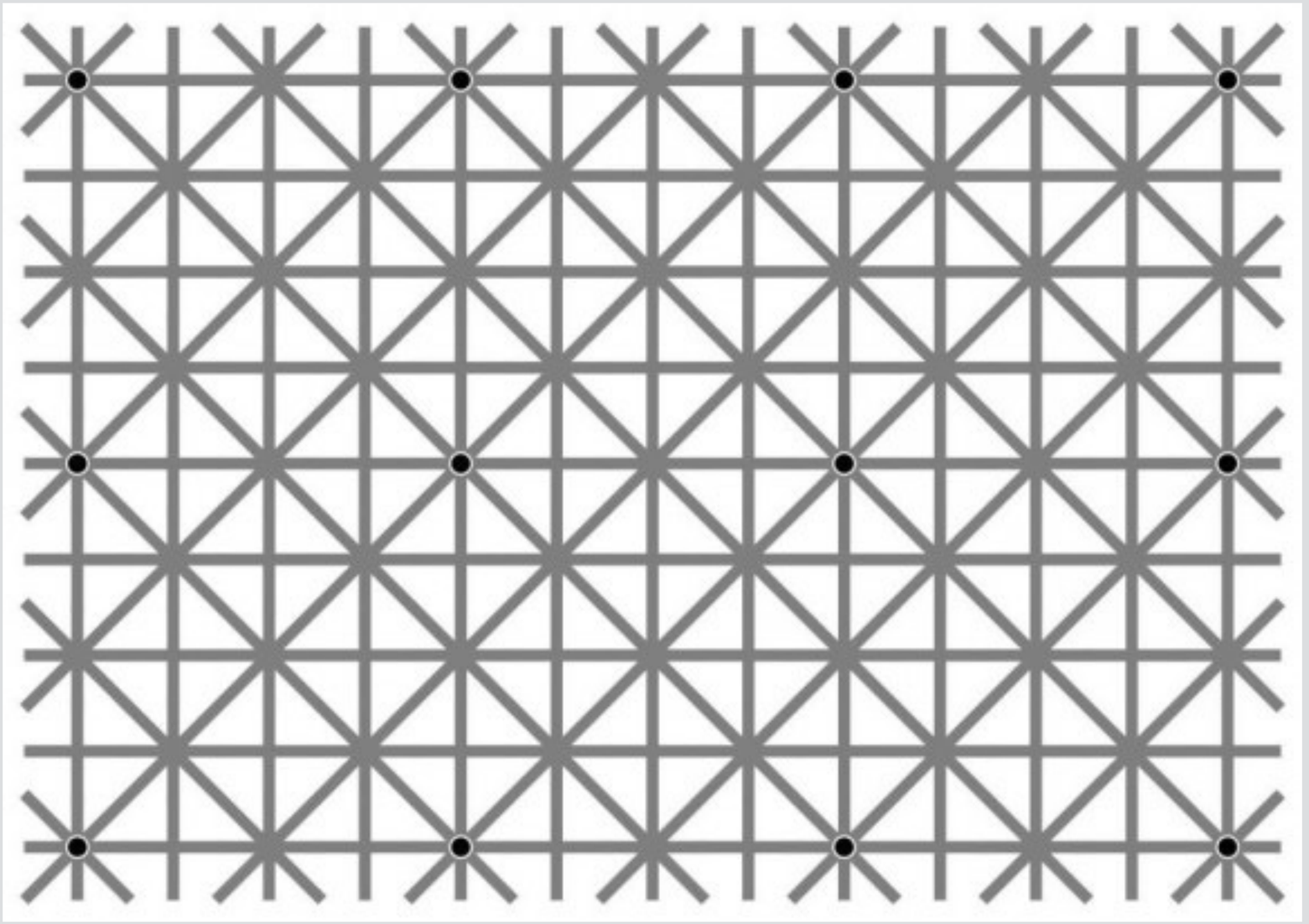

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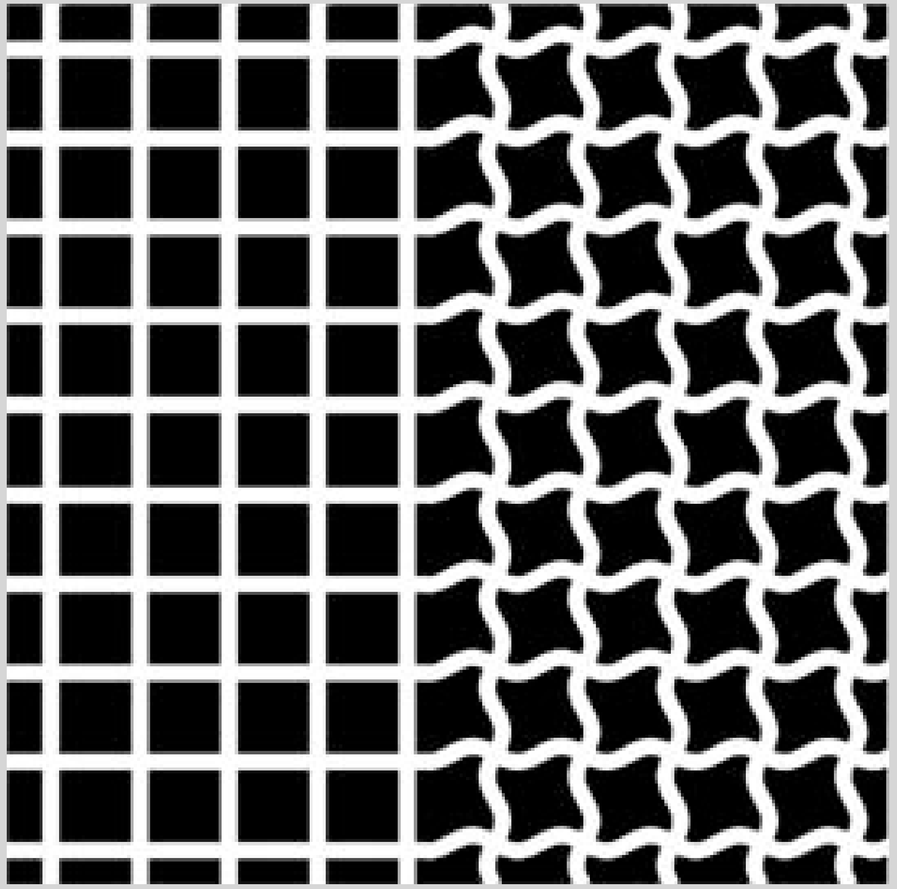
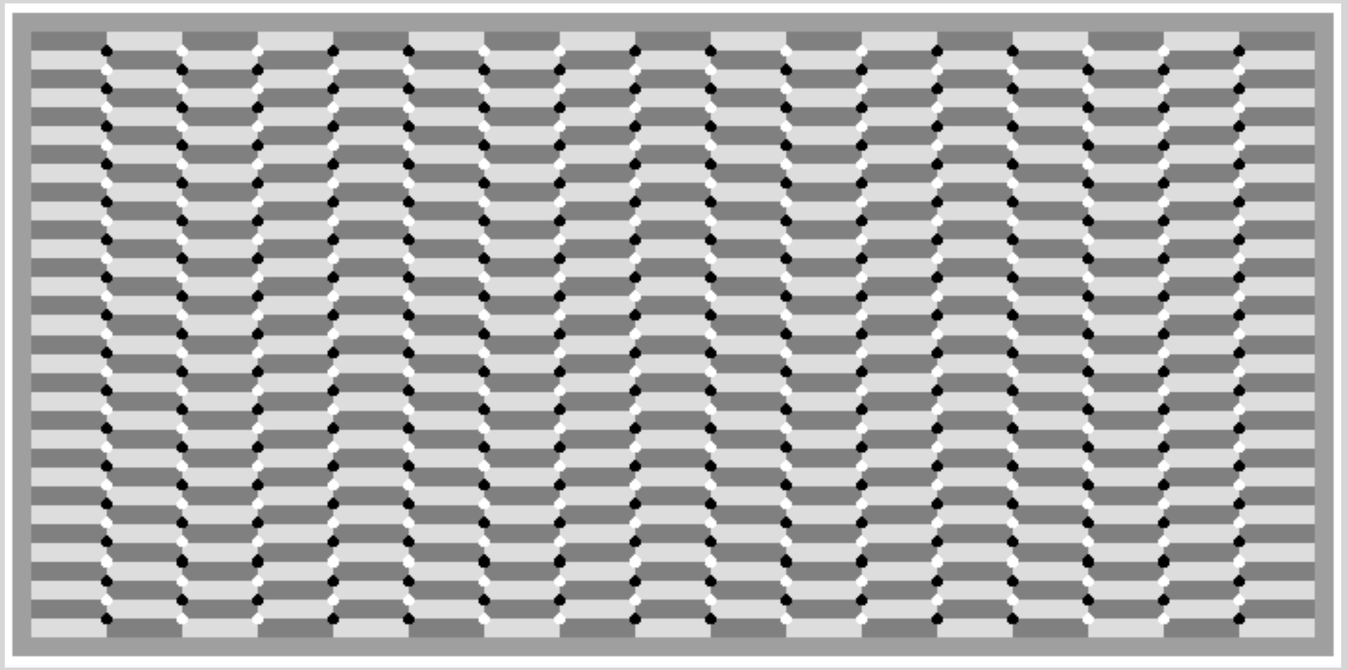
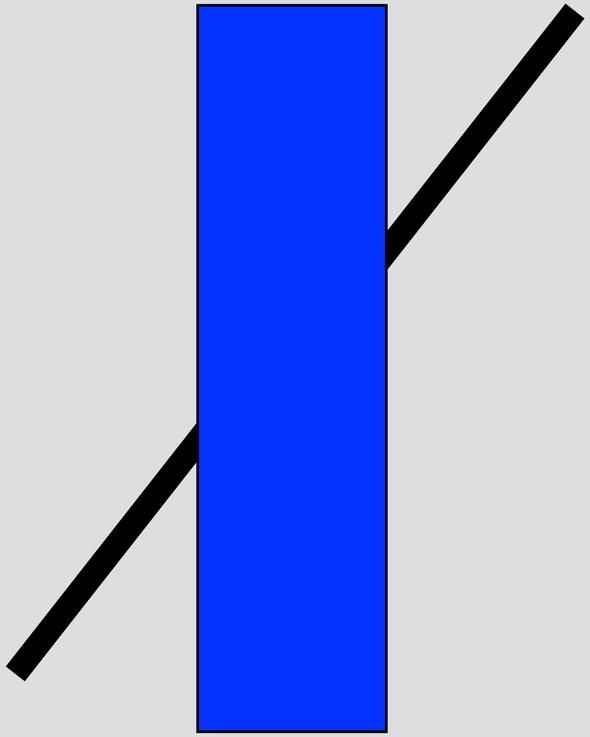
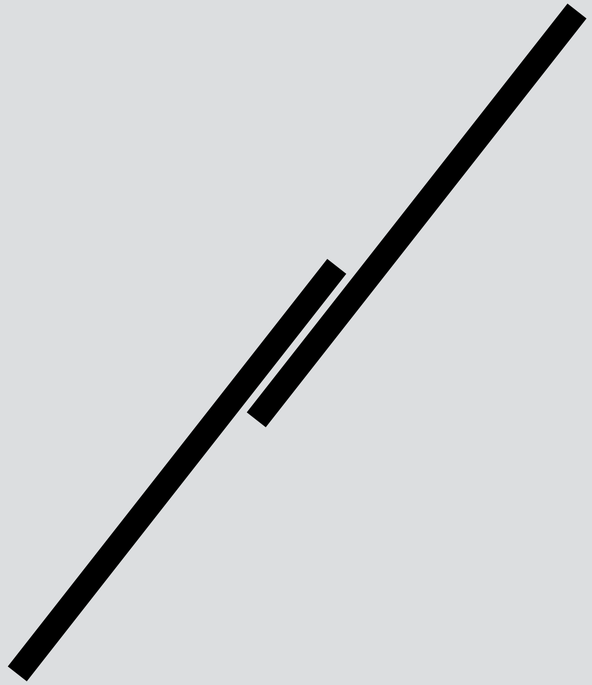
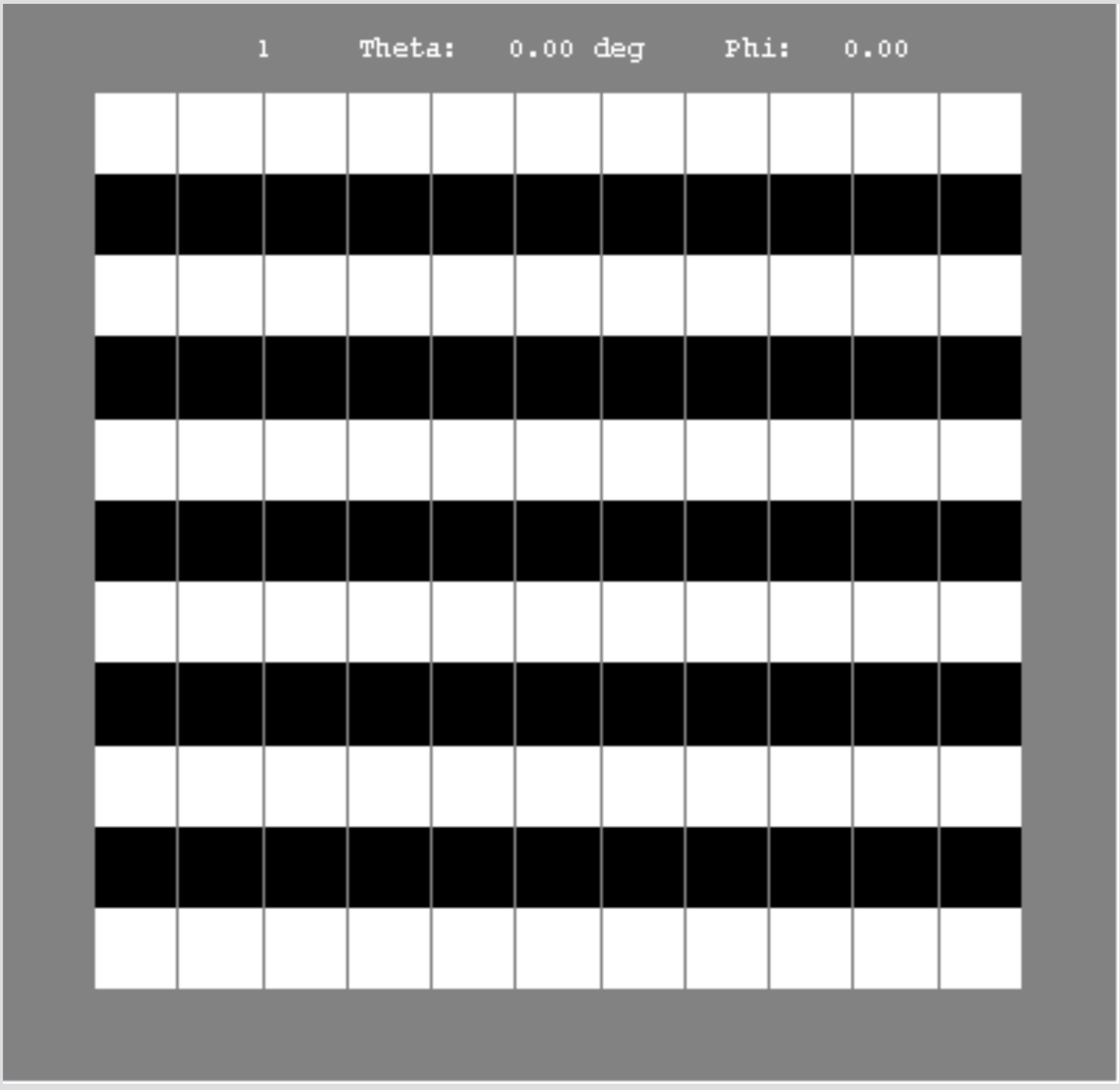








Mathematica
Demo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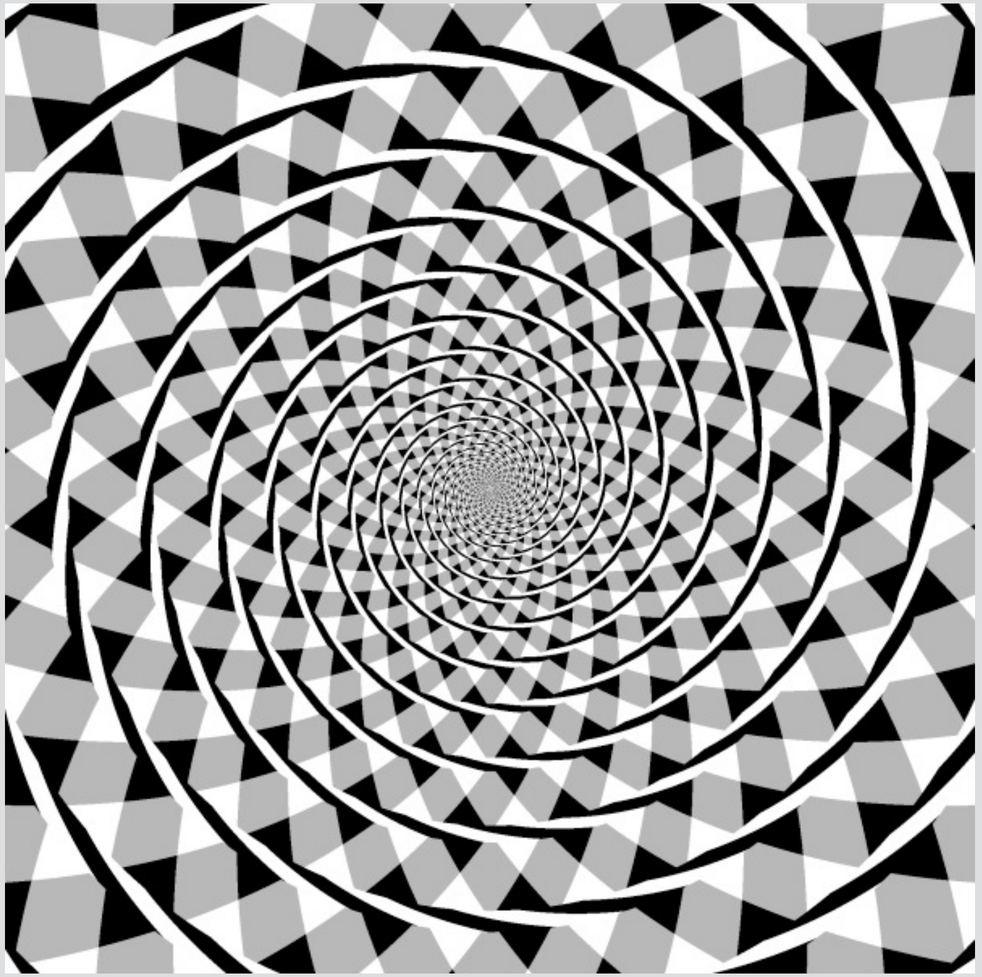

Fraser, J. (1908). A new visual illusion of direction. *British Journal of Psychology, 2*, 307–320.

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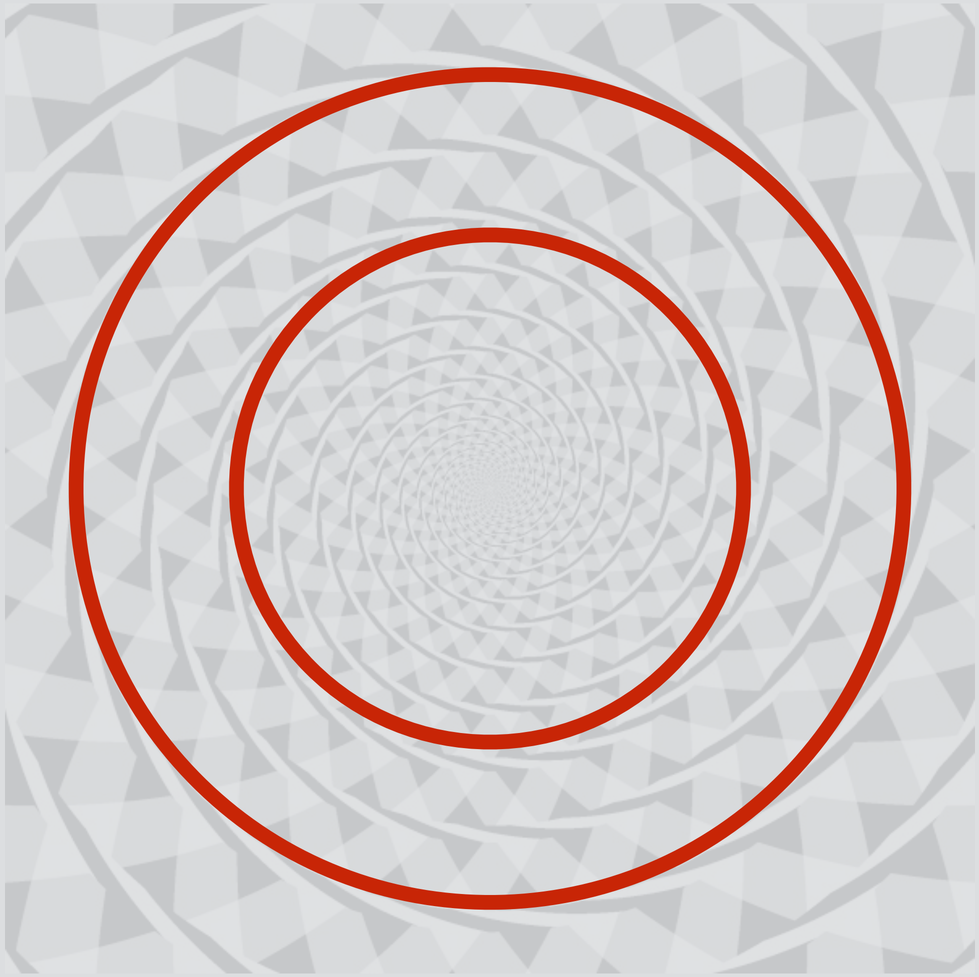

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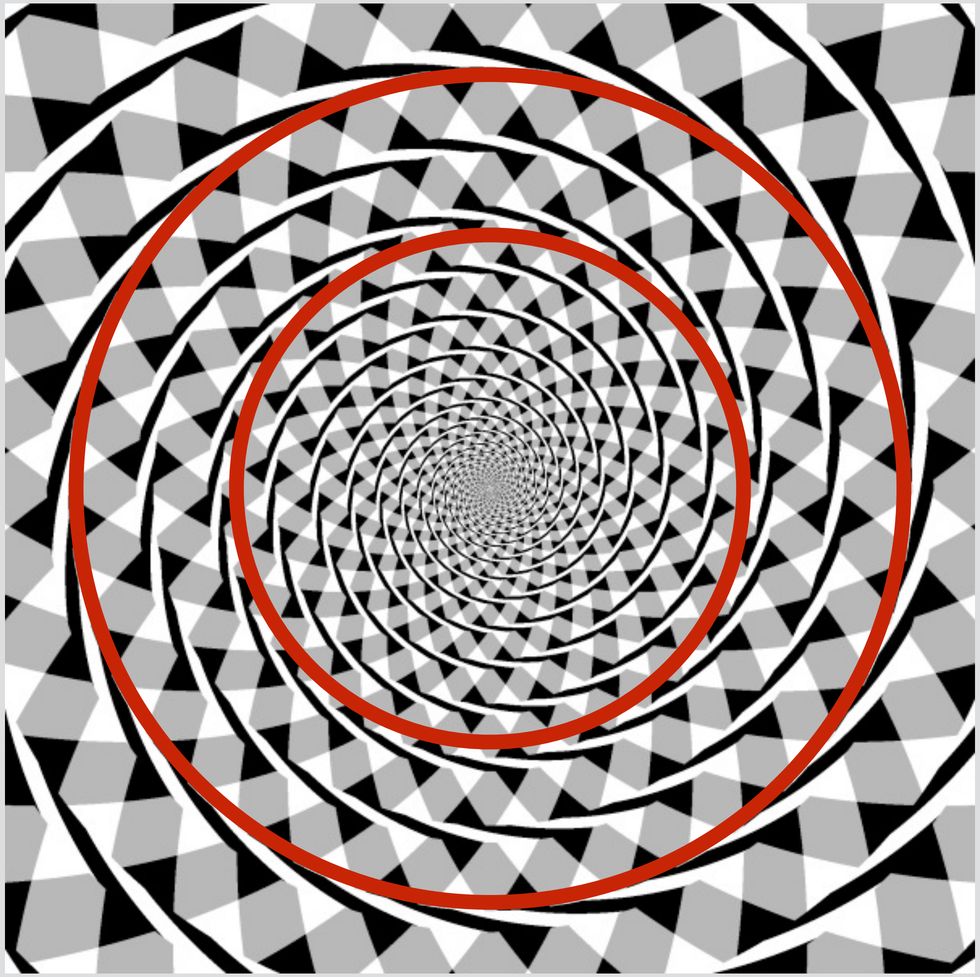
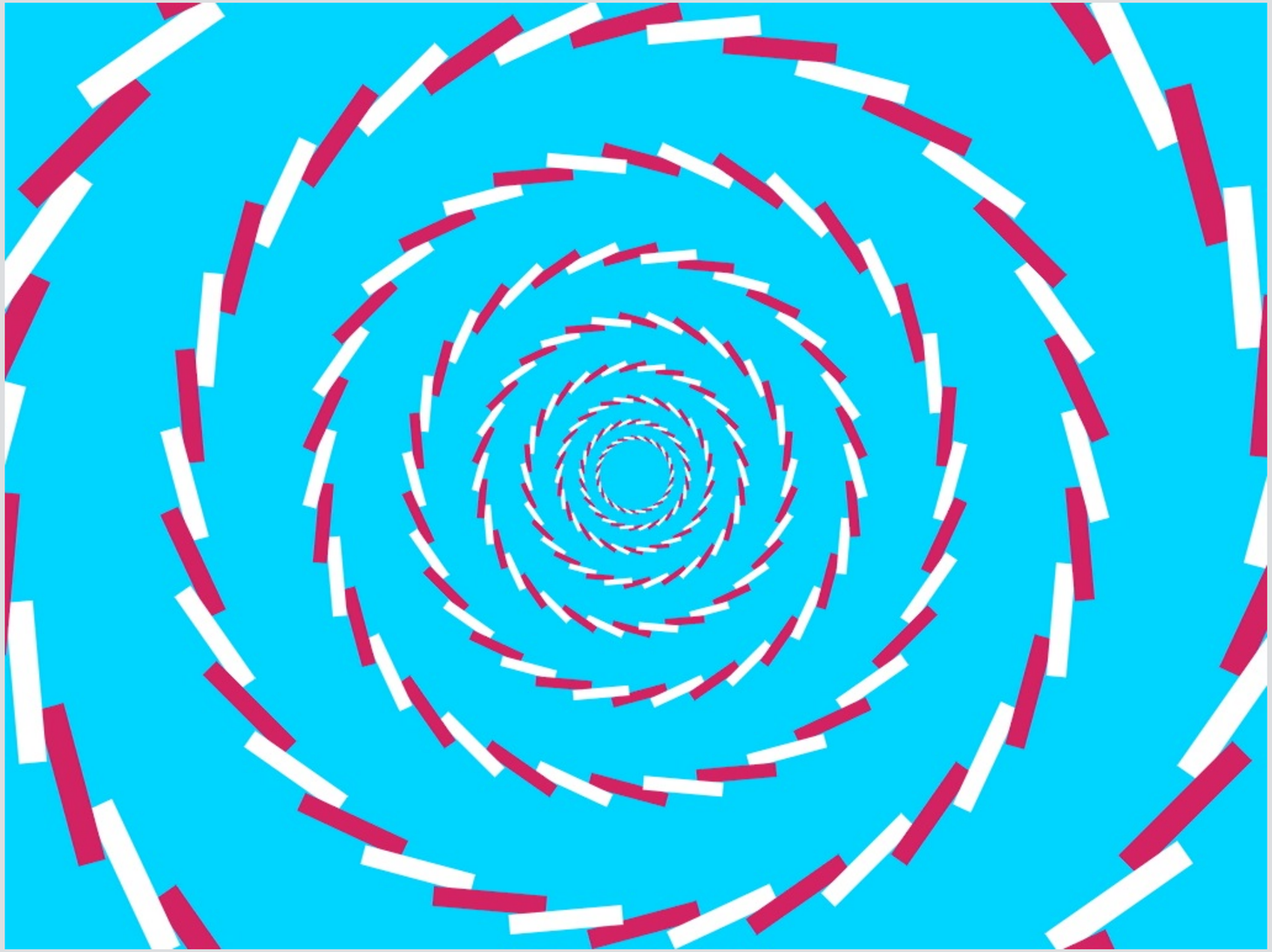
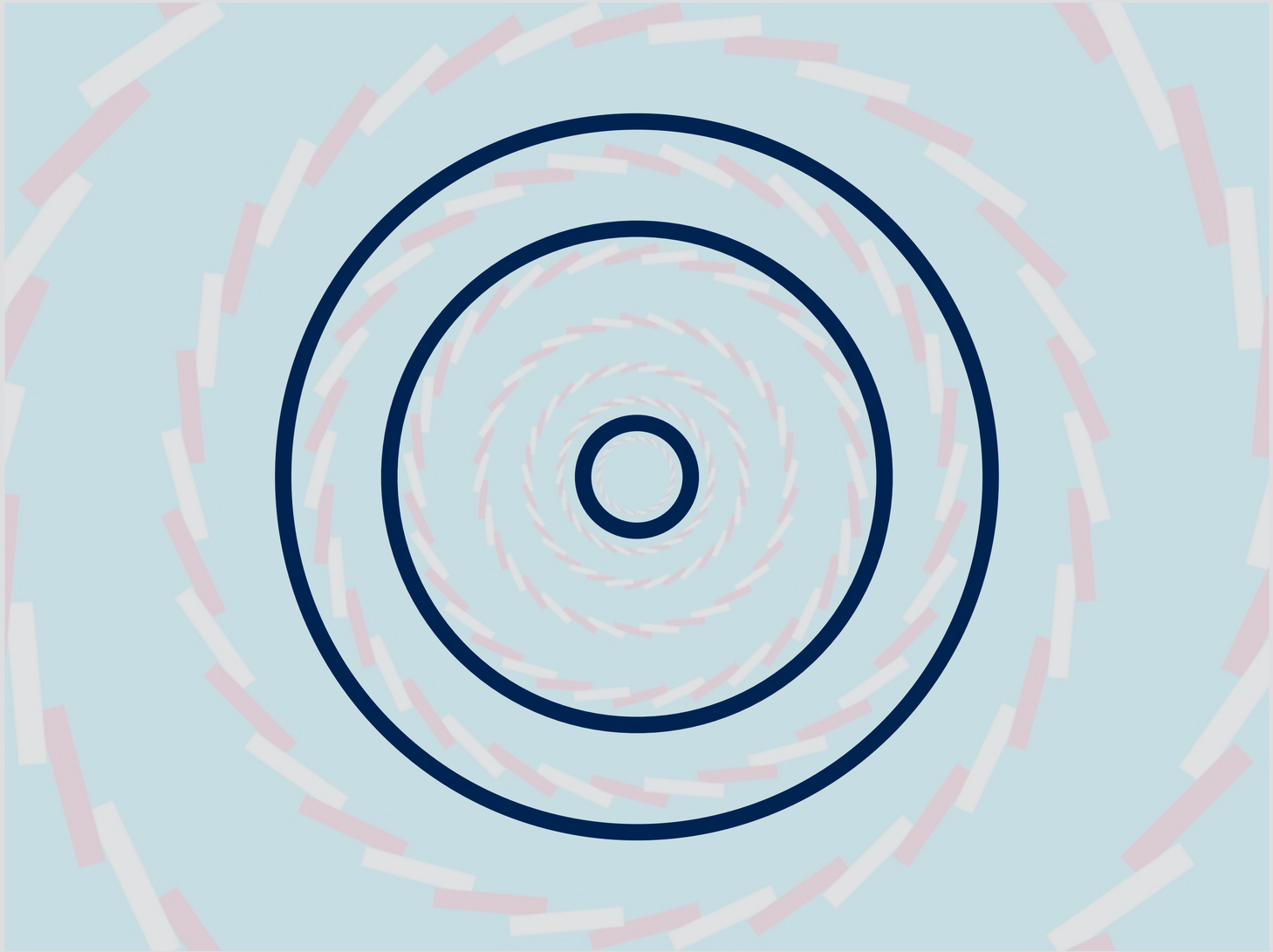


Fraser, J. (1908). A new visual illusion of direction. *British Journal of Psychology, 2*, 307–320.



Akiyoshi Kitaoka



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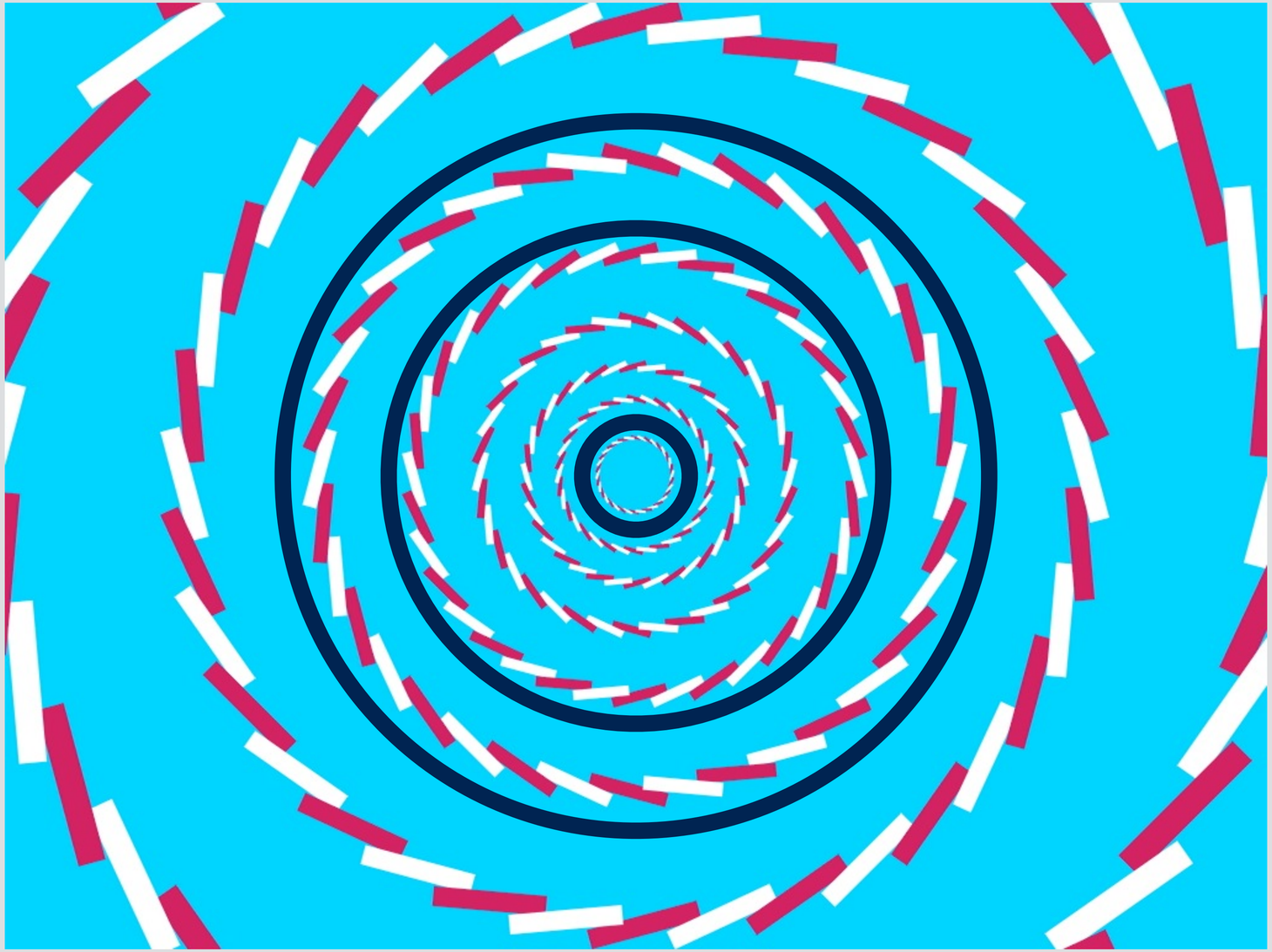

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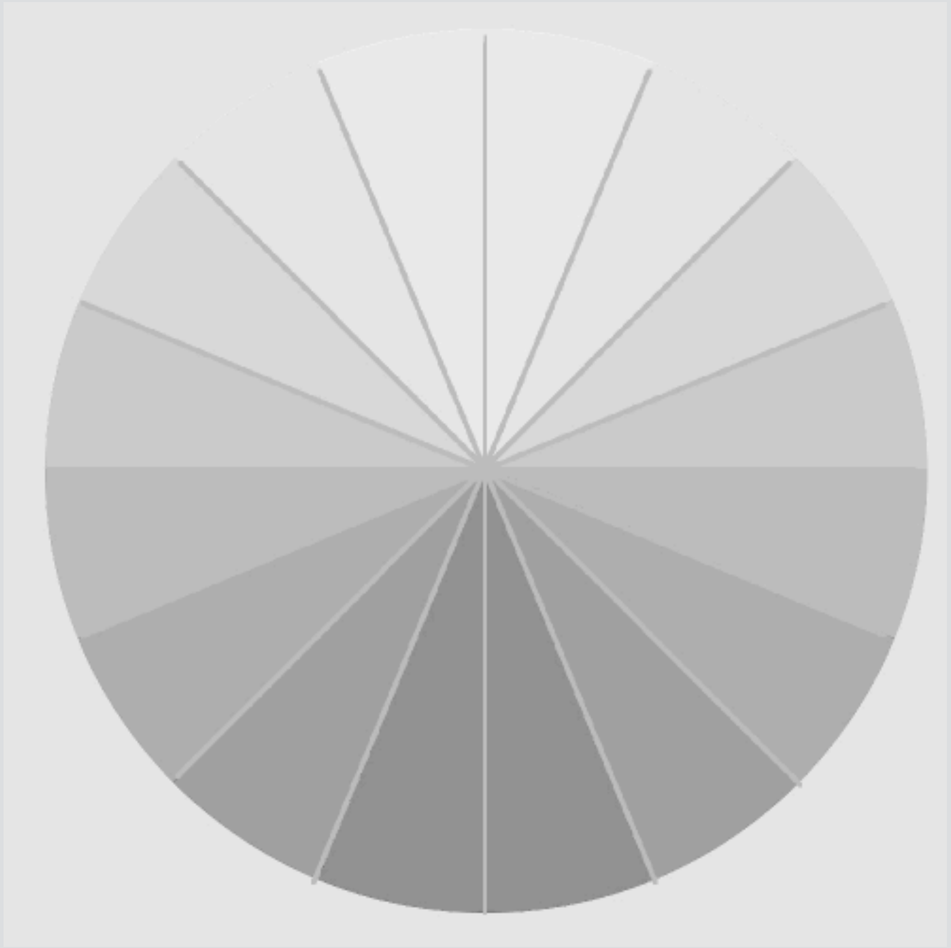
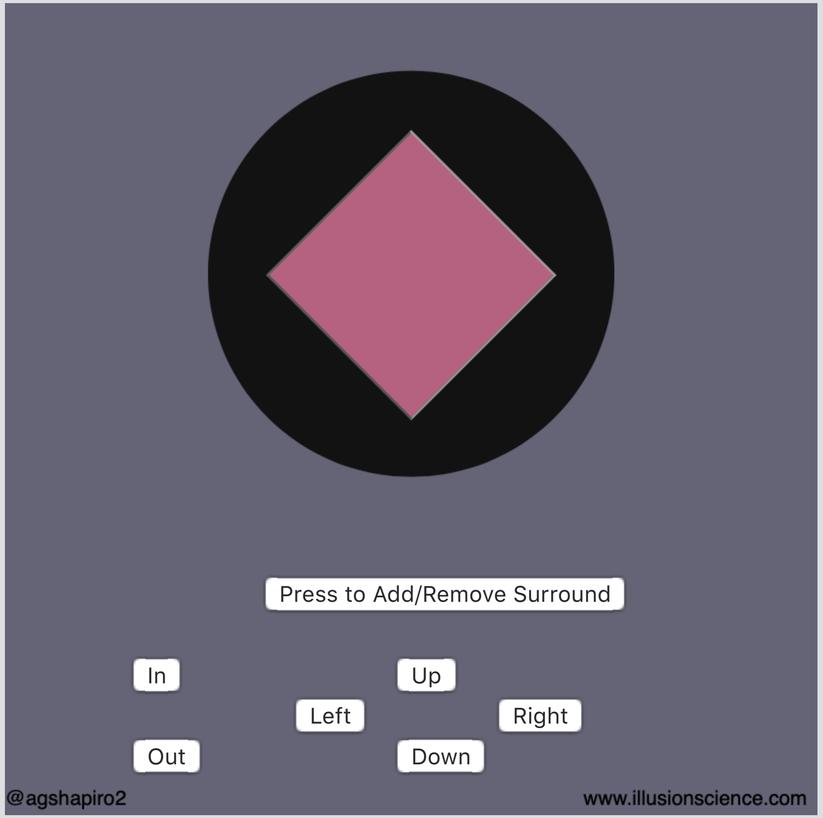


Anstis, S., & Rogers, B. (2011). Illusory rotation of a spoked wheel. *2*(7), 720-723.

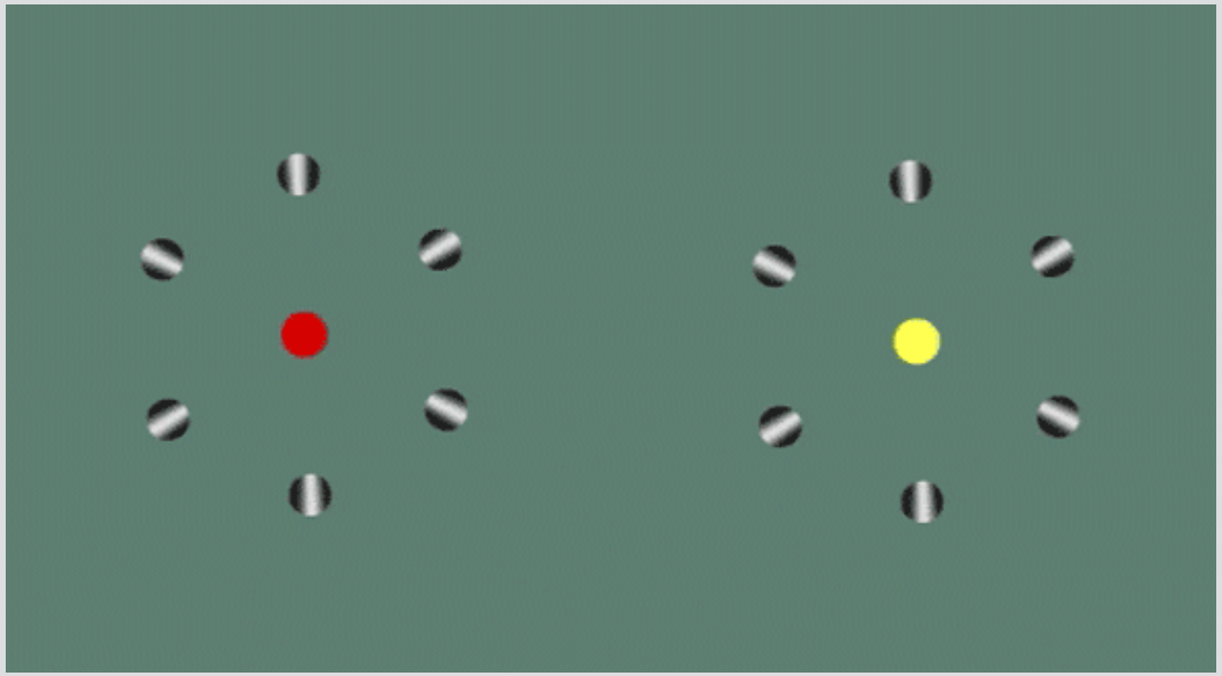
The Perpetual Diamond



http://illusionscience.com/the-perpetual-diamond/

Flynn, O. J., & Shapiro, A. G. (2018). The Perpetual Diamond: Contrast Reversals Along Thin Edges Create the Appearance of Motion in Objects. *i-Perception, 9*(6), 2041669518815708. doi:10.1177/2041669518815708

Demo



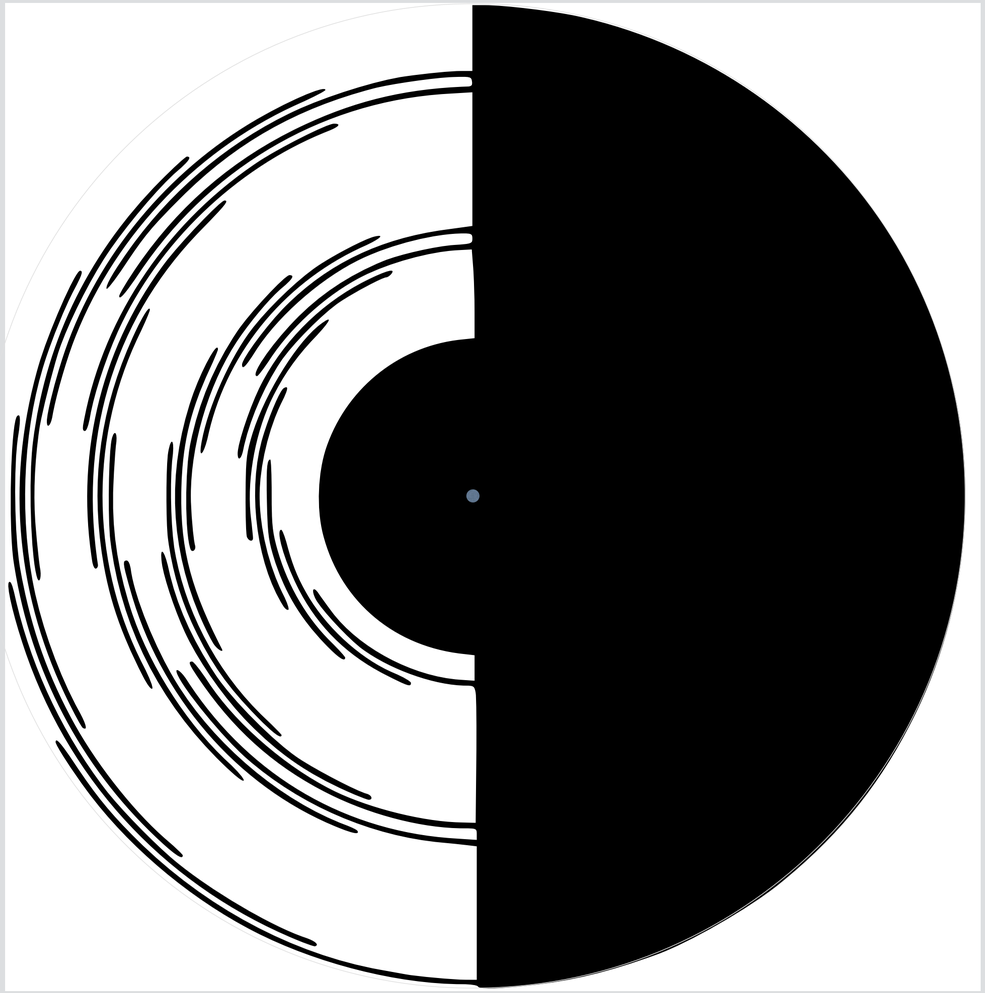
Now Let’s Talk About Color

Light has no color;
Color is created by the brain

Separate Streams for Color Vision

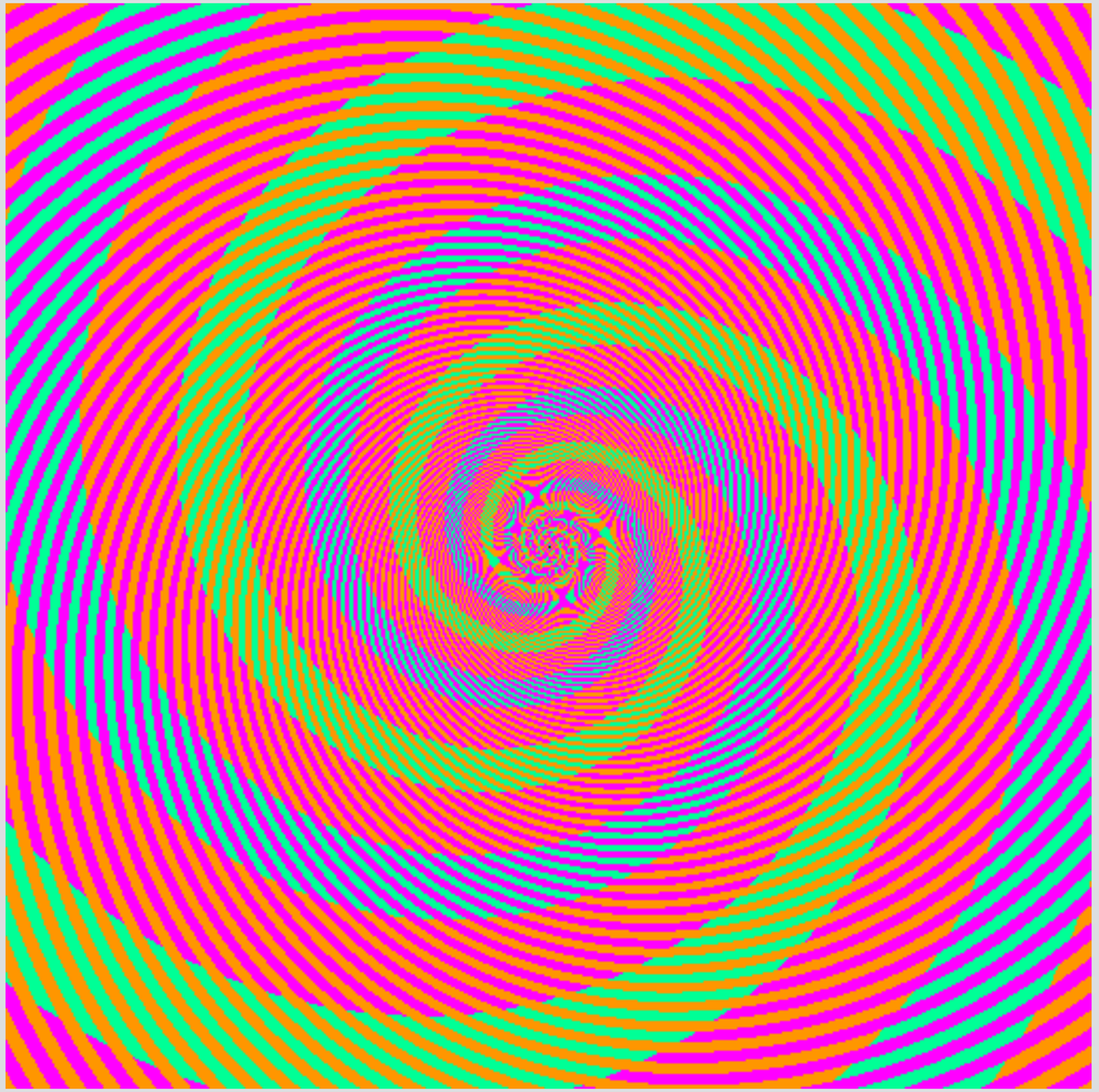
- Black and white (Luminance): High Resolution Channel
- Red-Green Opponent Channel: Low Resolution
- Yellow-Blue Opponent Channel: Low Resolution

Benham’s Disk



Charles E. Benham 1894

Demo



The blue and green spirals are the same “color” (r = 0, g = 255, b = 150)
"Green and blue spirals" by Akiyoshi Kitaoka (1961–)

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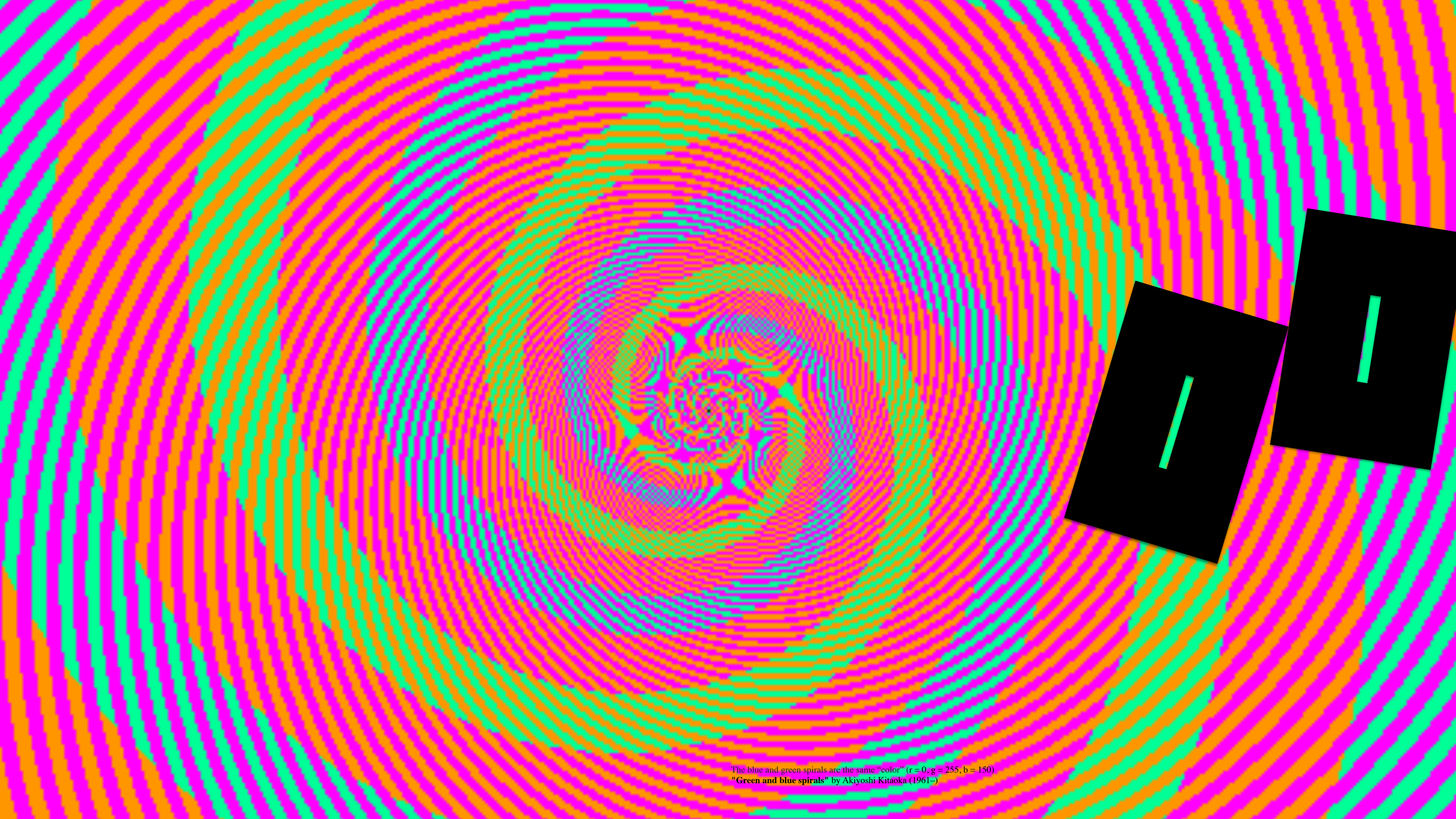
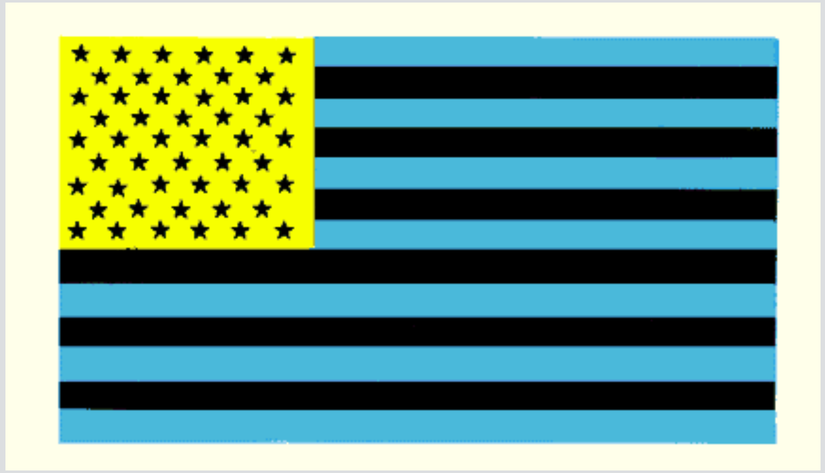
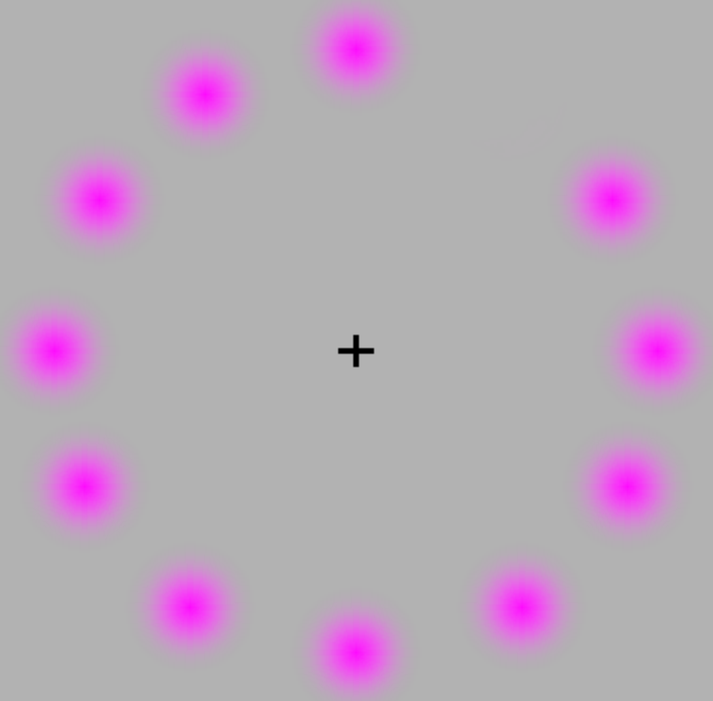
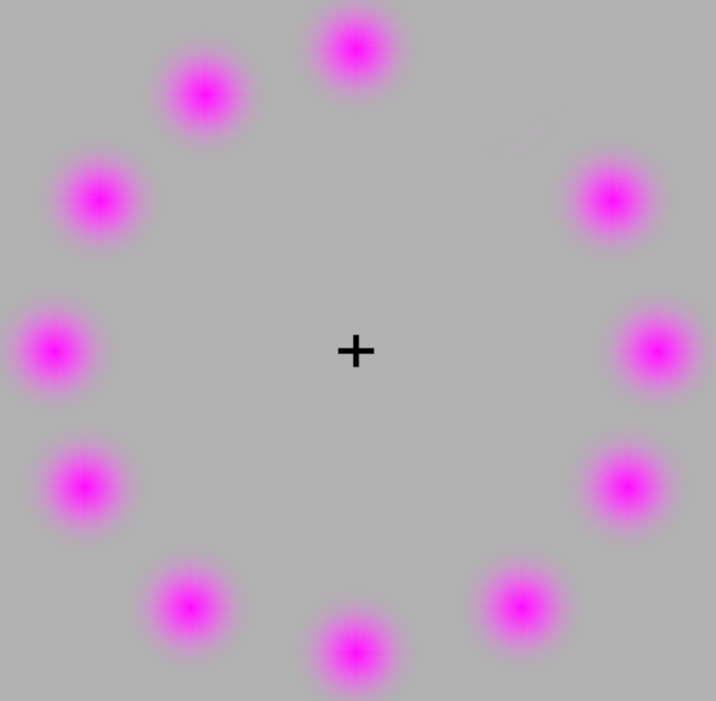


The blue and green spirals are the same "color" (r = 0, g = 255, b = 150)
"Green and blue spirals" by Akiyoshi Kitaoka (1961–)

Complimentary Afterimages



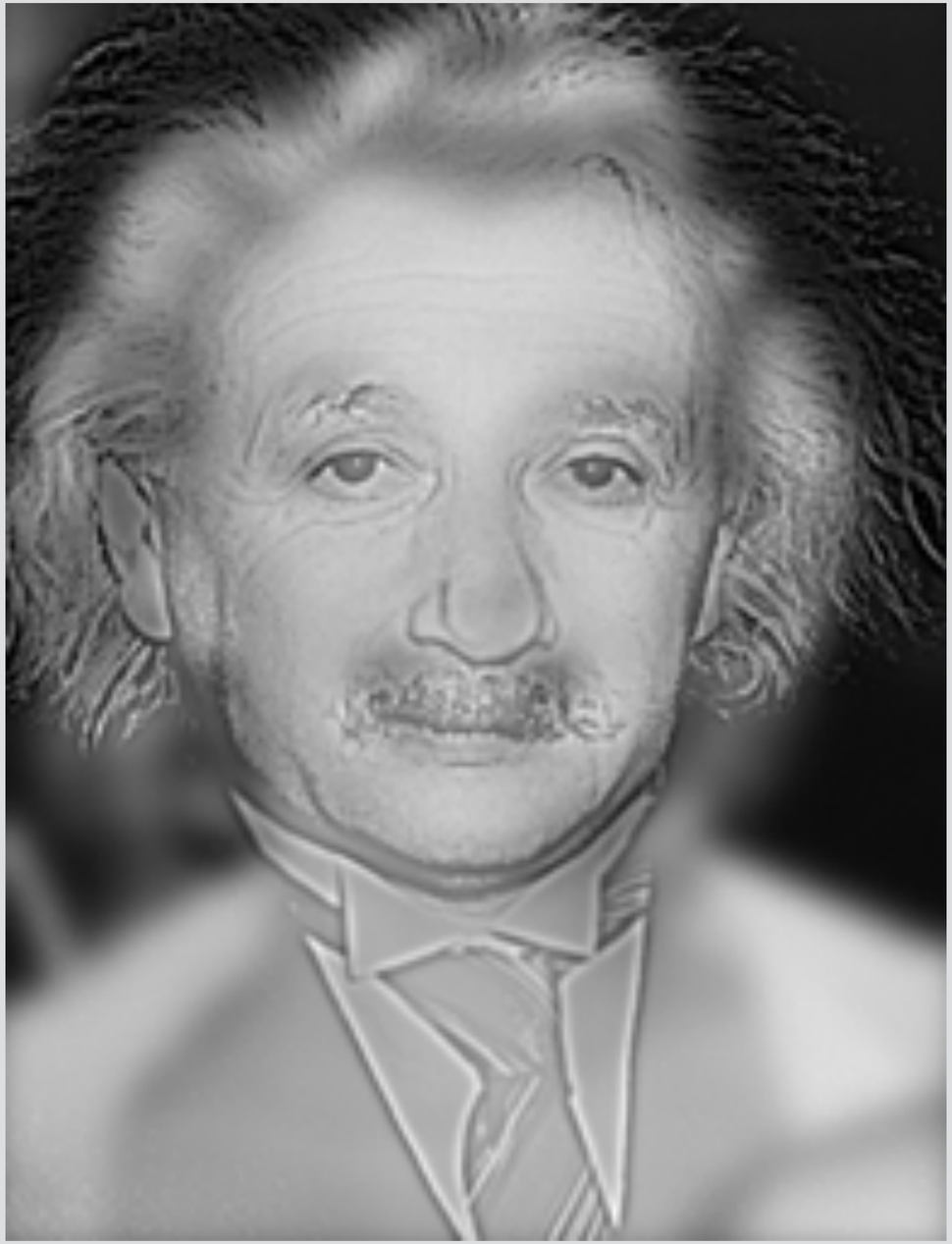




John Sadowski

http://www.johnsadowski.com/color_illusion_tutorial.html

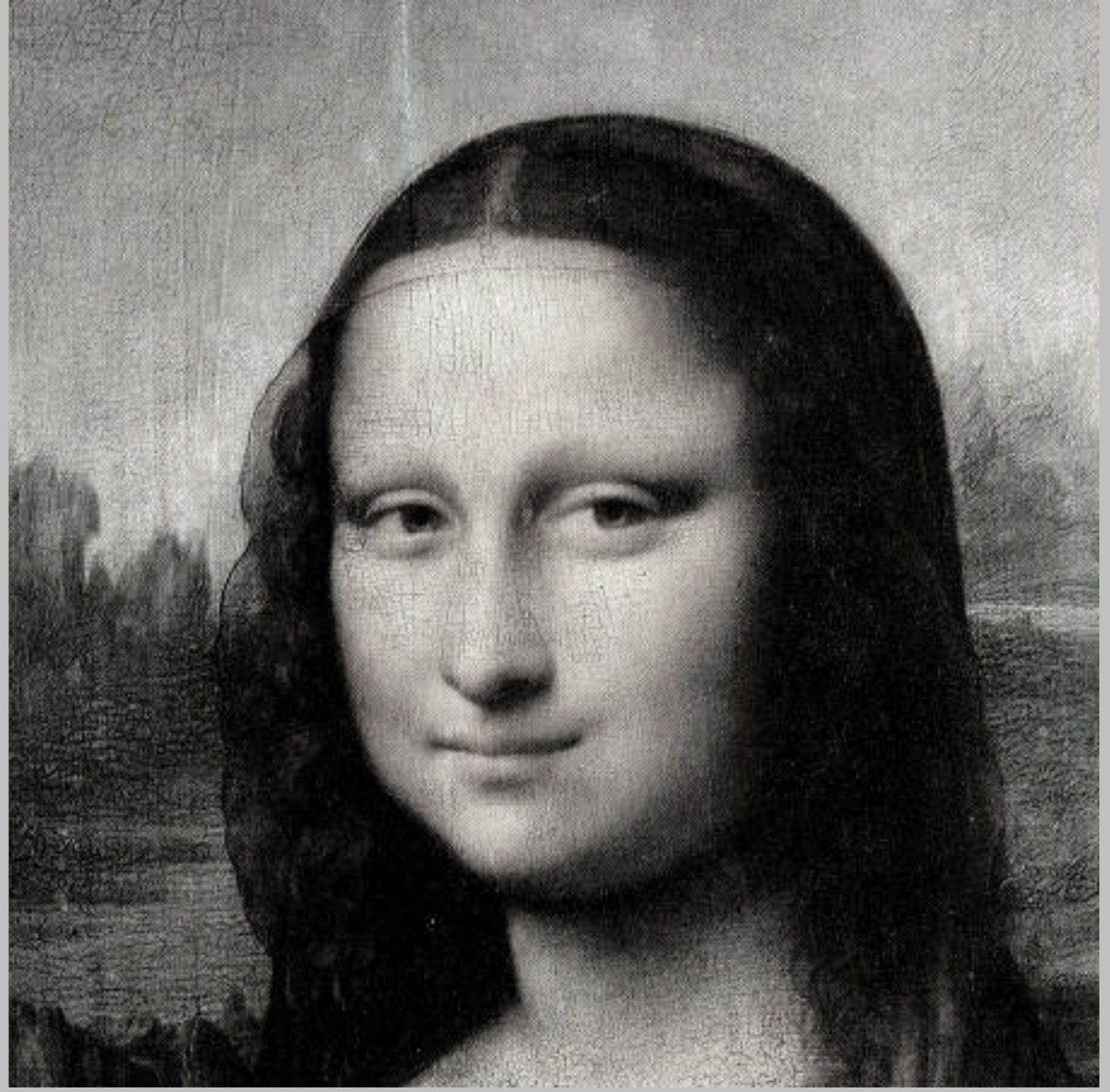
Separate streams for different sizes



Schyns, P. G., & Oliva, A. (1999). Dr. Angry and Mr. Smile: When categorization flexibly modifies the perception of faces in rapid visual presentations. *Cognition, 69*(3), 243-265.

Demo

Schyns, P. G., & Oliva, A. (1999). Dr. Angry and Mr. Smile: When categorization flexibly modifies the perception of faces in rapid visual presentations. *Cognition, 69*(3), 243-265.



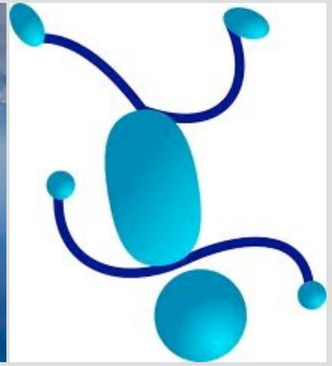
Faces are special

96% 91% 85% 90%



Mean Percent Correct





82% 86% 84% 86

Yin, R. K. (1969). Looking at upside-down faces. *Journal of Experimental Psychology, 81*(1), 141–145.

Figure 2.

Figure 1.

Thompson, P. G. 1980. Margaret Thatcher: A new illusion. *Perception,* 9(4), 483–484.

Figure 1.

Figure 2.

Thompson, P. G. 1980. Margaret Thatcher: A new illusion. *Perception,* 9(4), 483–484.

Carbon, C.-C., Schweinberger, S. R., Kaufmann, J. M., & Leder, H. (2005). The Thatcher illusion seen by the brain: An event-related brain potentials study. *Cognitive Brain Research, 24*(3), 544-555. doi: 10.1016/j.cogbrainres.2005.03.008

Carbon, C.-C., Schweinberger, S. R., Kaufmann, J. M., & Leder, H. (2005). The Thatcher illusion seen by the brain: An event-related brain potentials study. *Cognitive Brain Research, 24*(3), 544-555. doi: 10.1016/j.cogbrainres.2005.03.008

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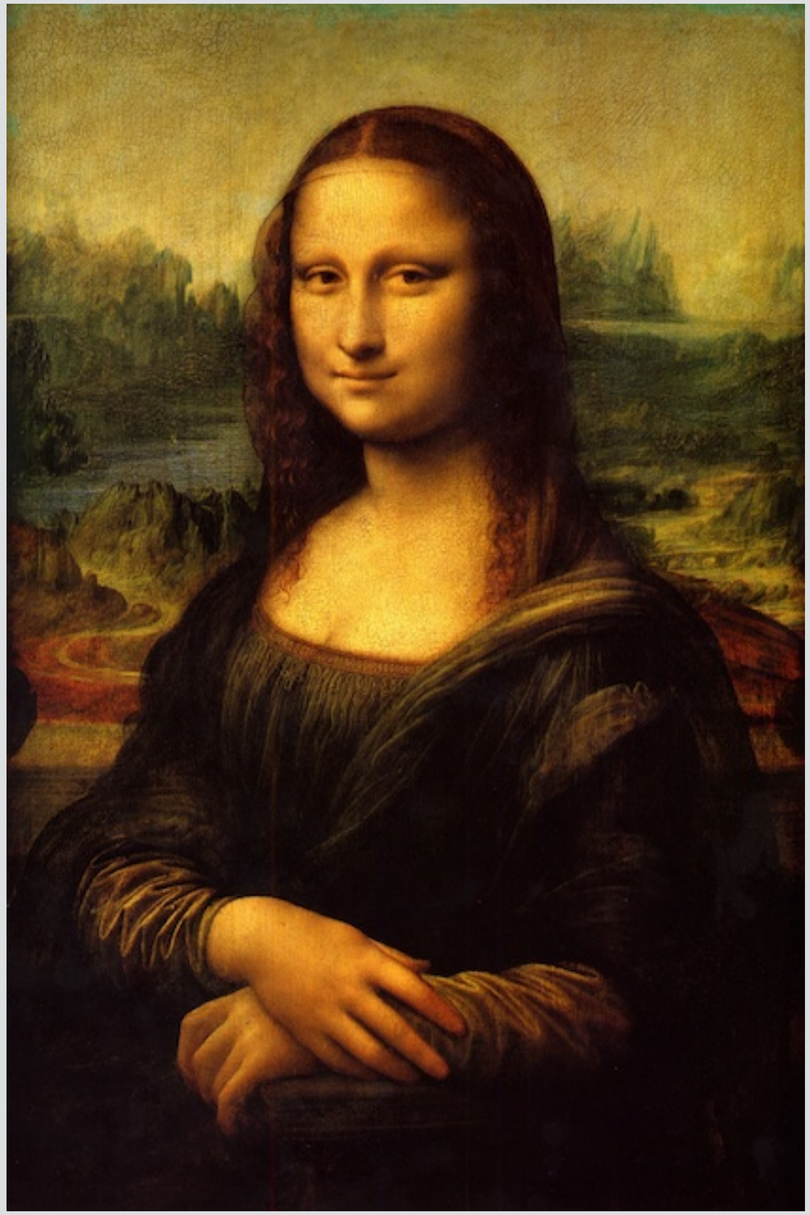
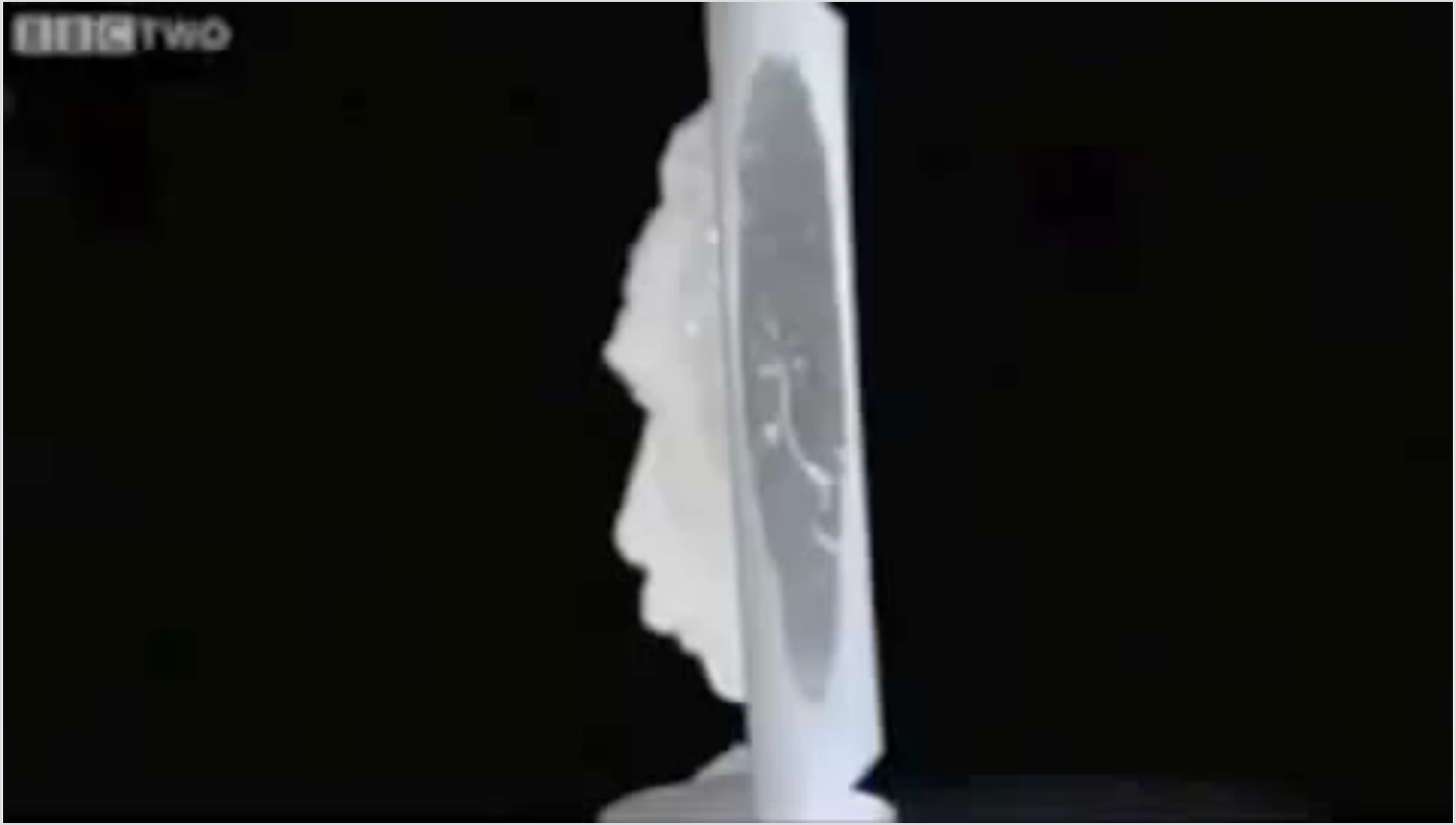


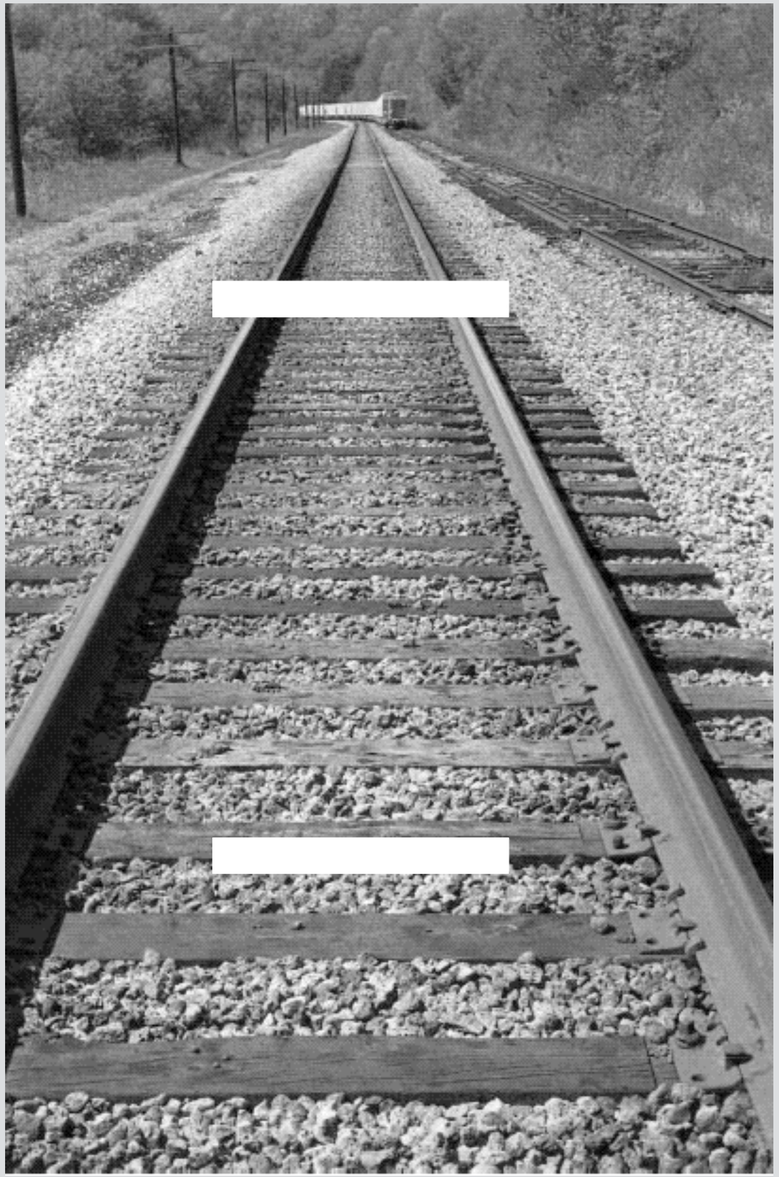

BBC TWO

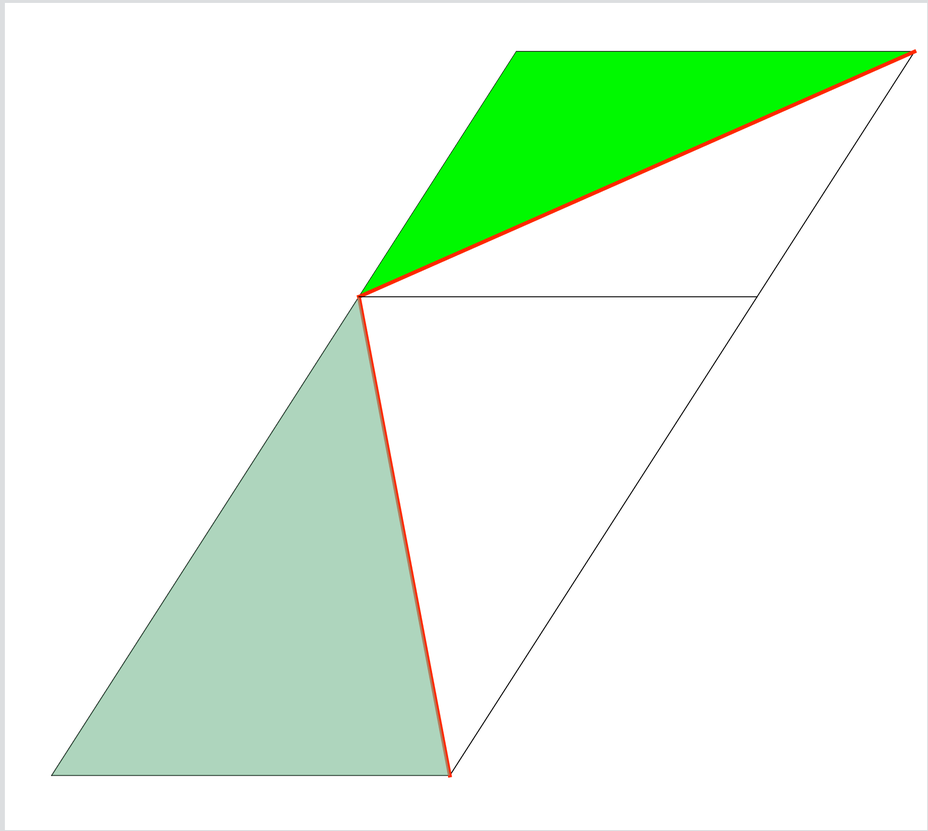
The Likelihood Principle or
“Keep it Simple, if you can”

Crazy Circle by brusspup

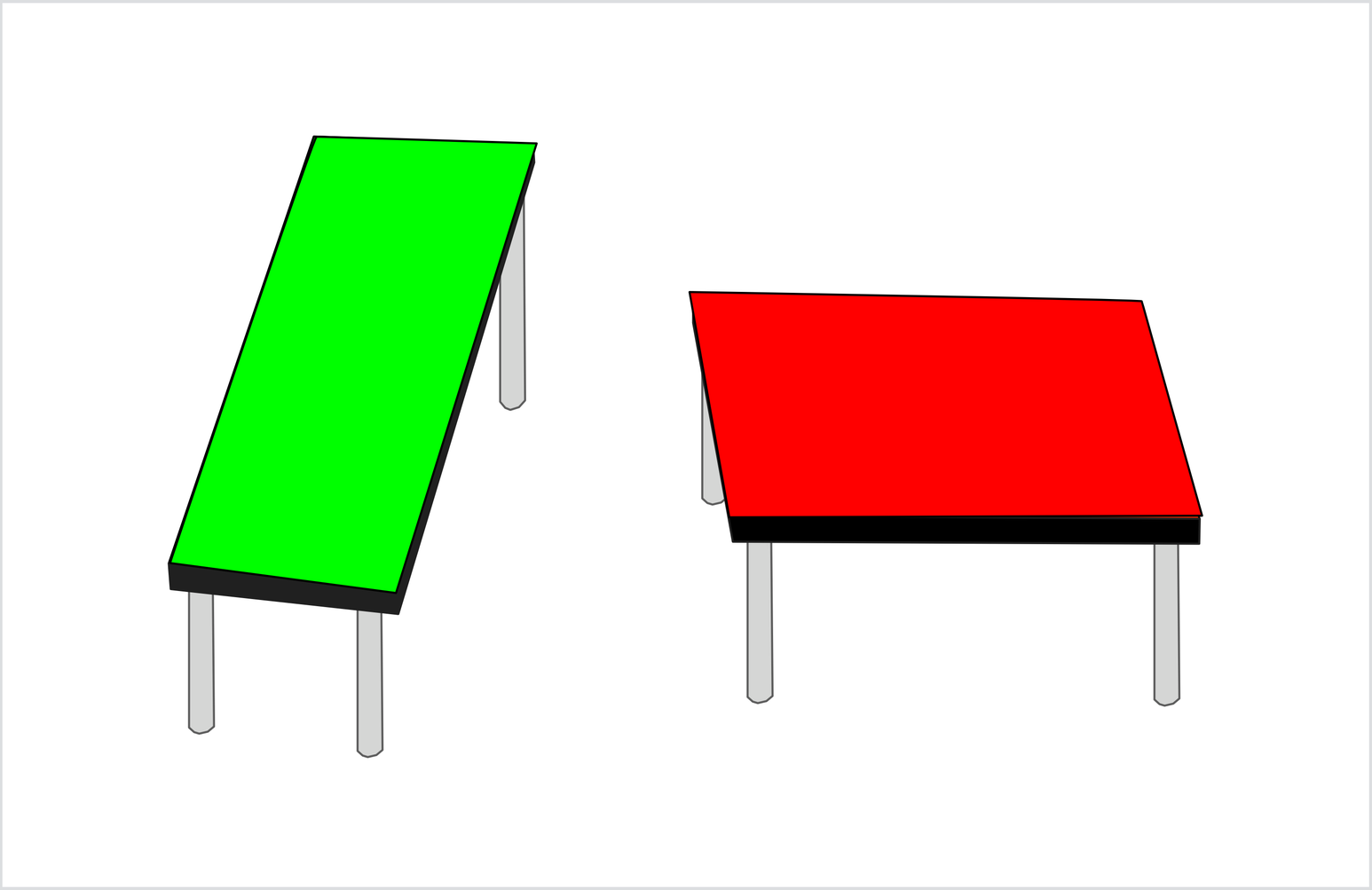
https://www.youtube.com/user/brusspup/videos

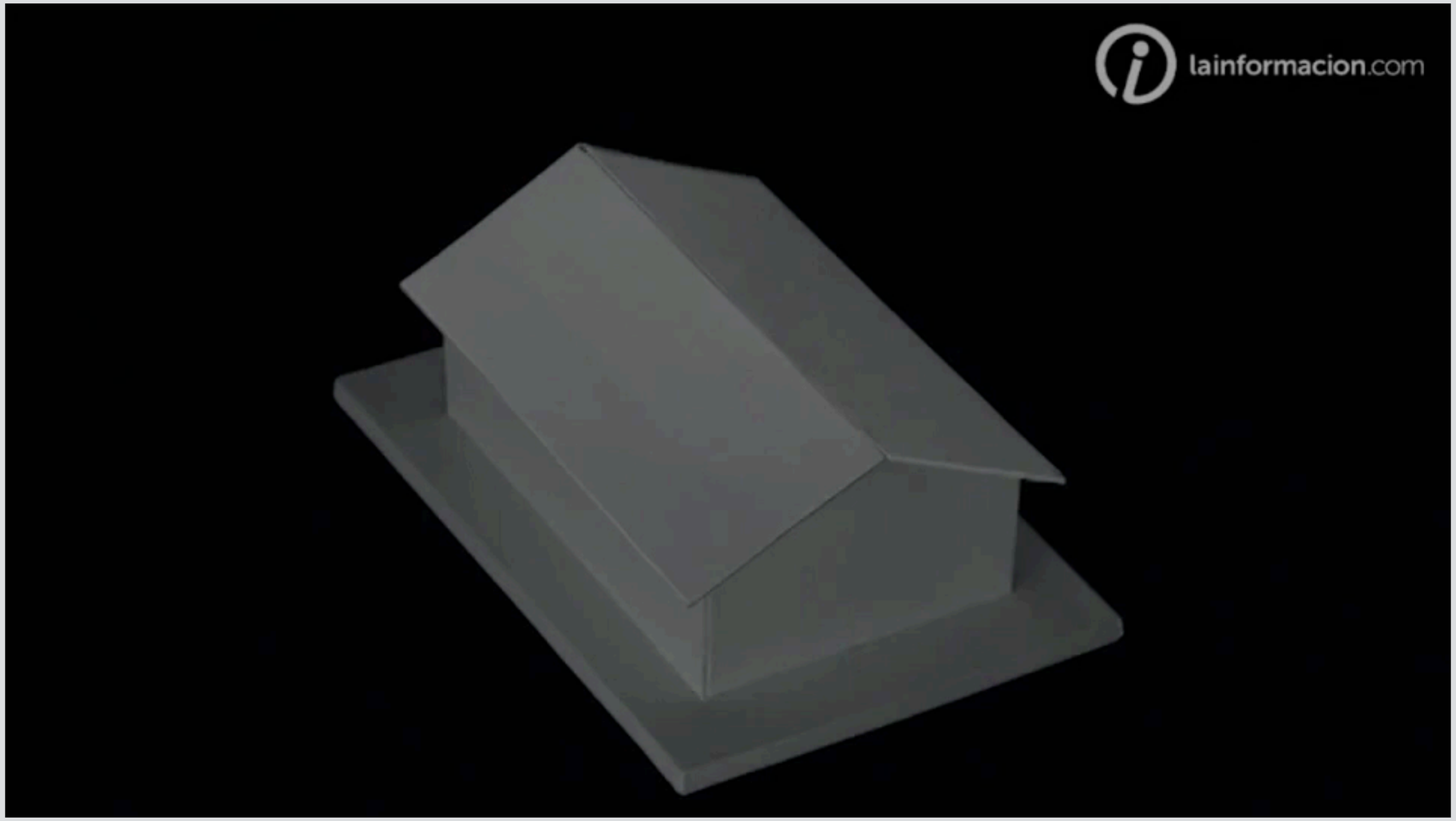
Size and Distance Information





Mathematica
Demo

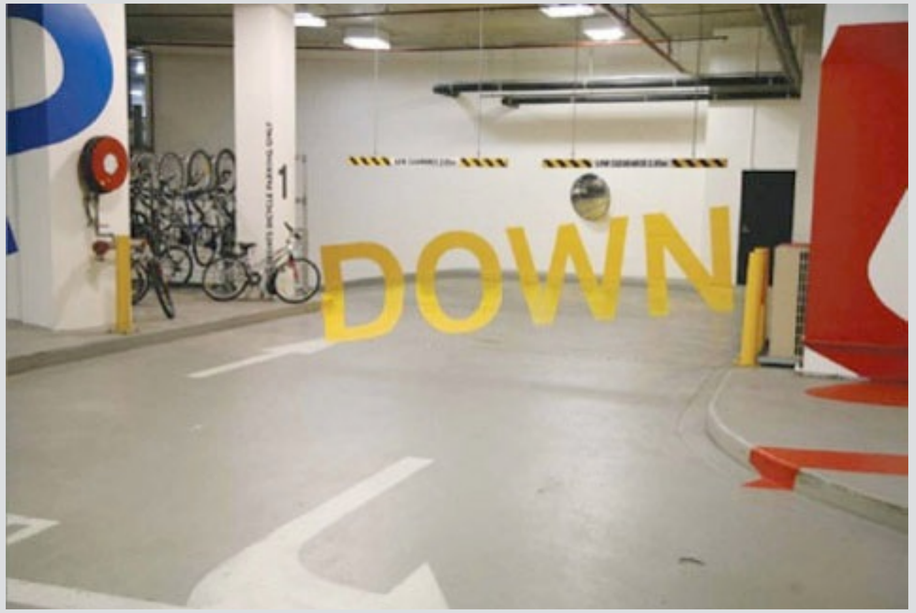




Kokichi Sugihara


MAKE POVERTY HISTORY
JULIAN BEEVER


GRIT


DOWN


DOWN

Rubik's Cube by brusspup (http://www.youtube.com/user/brusspup)

Attention

Focus of Attention

- Two Teams: White and Black
- Count the number of times the White team passes the ball

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University of Illinois

Focus of Attention

- Two Teams: White and Black
- Count the number of times the White team passes the ball

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University of Illinois

Focus of Attention

- So, how many times did the White team pass the ball?
  - Correct answer is 14
- What did the gorilla do?
  - There was a gorilla!! Honest

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Focus of Attention

- Perception can be incomplete and inaccurate

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One More Time

- Count the number of passes made by the white T-shirt team.

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University of Illinois

One More Time

- How many times did the white team pass the ball?
- 16 is the correct answer
- How many saw the gorilla?
- How many noticed the curtain changing color?
- How many noticed the missing black team player?

Daniel J. Simons
University of Illinois


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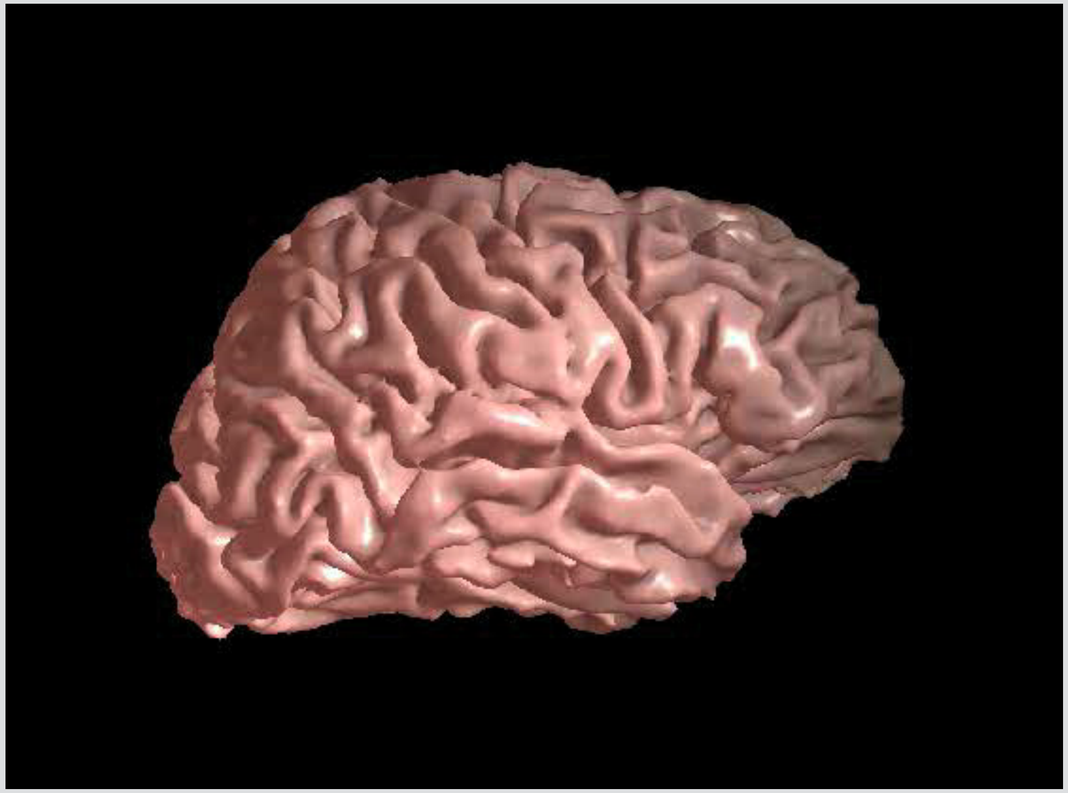
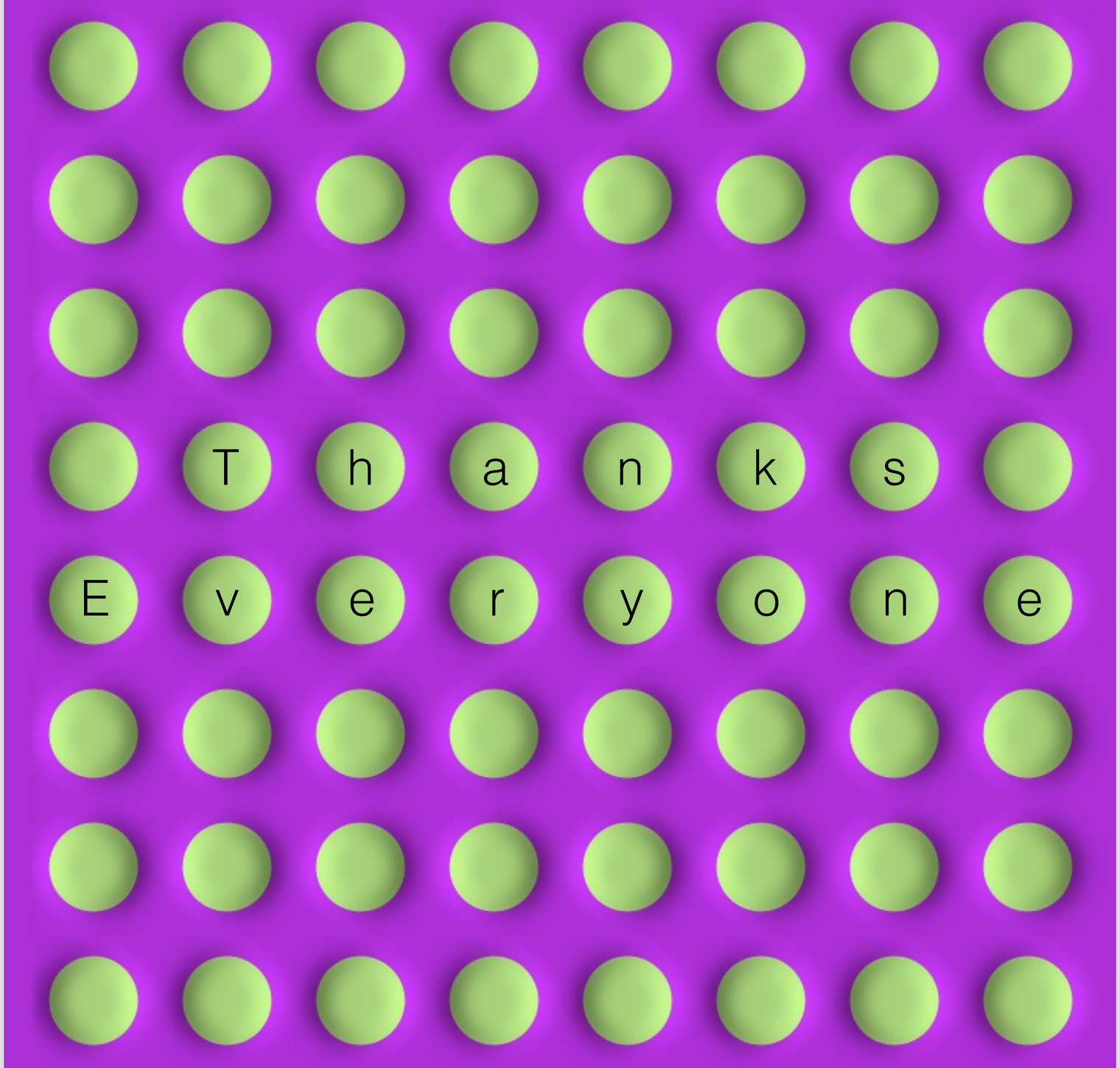
Summary

- We see with our brain, not with our eyes
- **What** is out there and **where** is it?
- The brain creates our perception of reality from multiple streams of information
- Sometimes perceptions are “wrong” (Illusions)

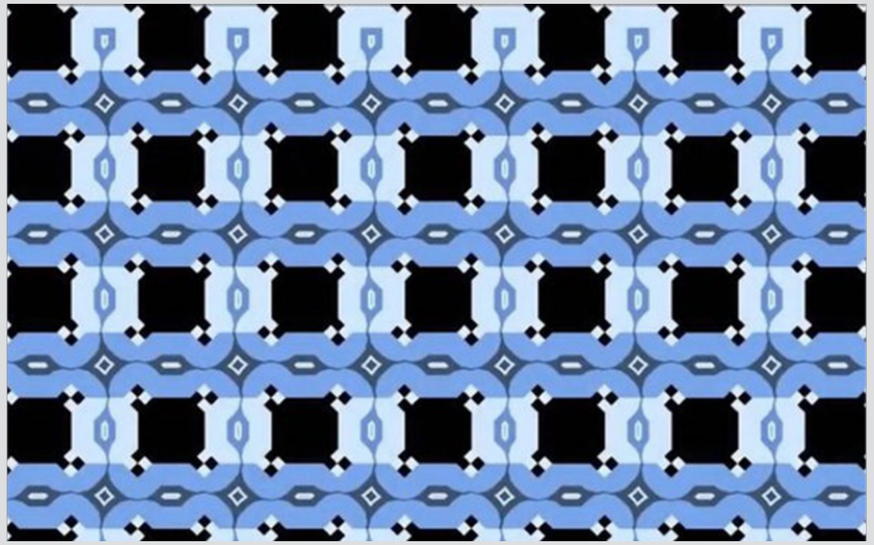


Science:

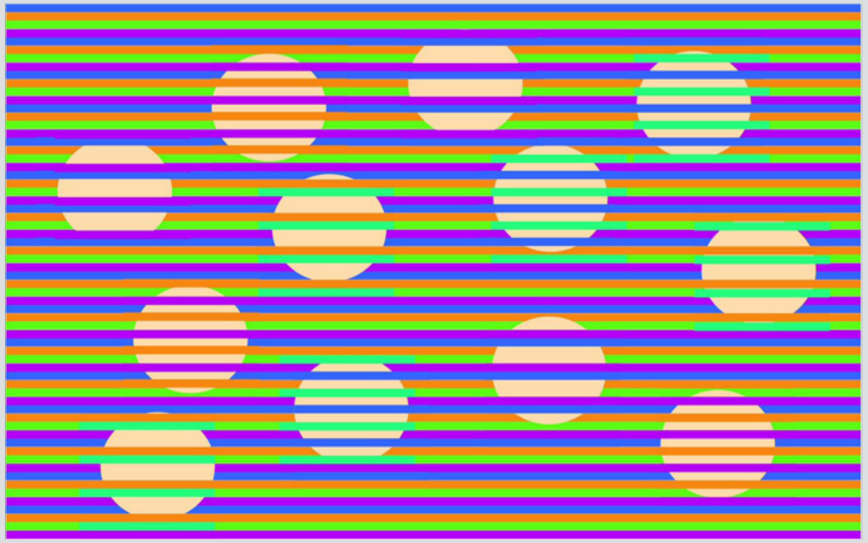
The Unfolding of Knowledge


Thanks
Everyone


CU Wizards WEBINAR
GRAVITY!
Prof. Alysia Marino & Gwen Eccles
Saturday
November 14
9:30-10:30 am
WWW.COLORADO.EDU/CUWIZARDS



http://nautil.us/blog/12-mind_bending-perceptual-illusions



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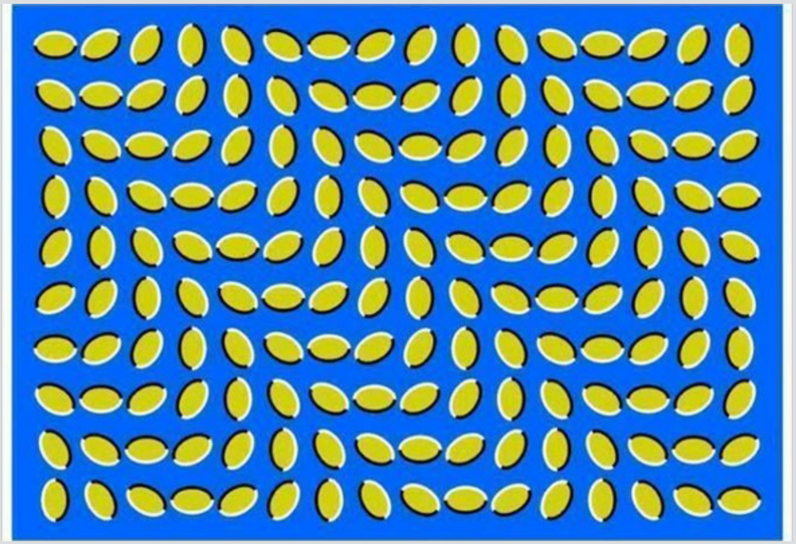

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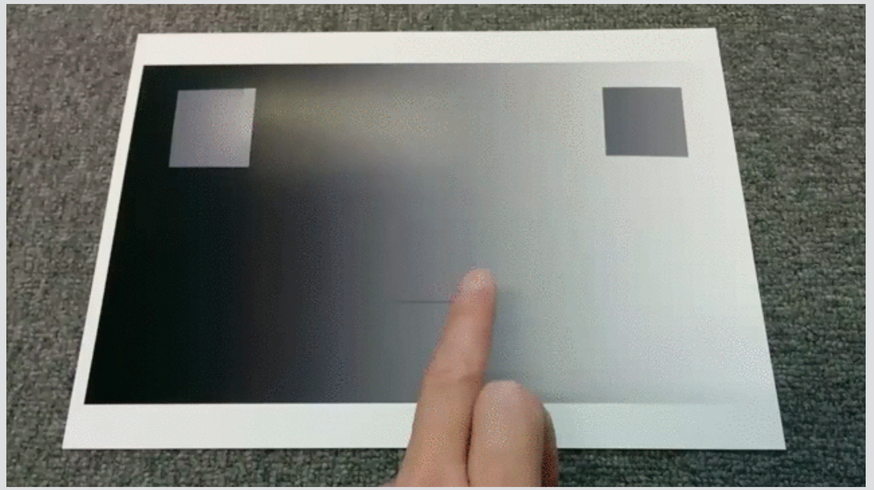

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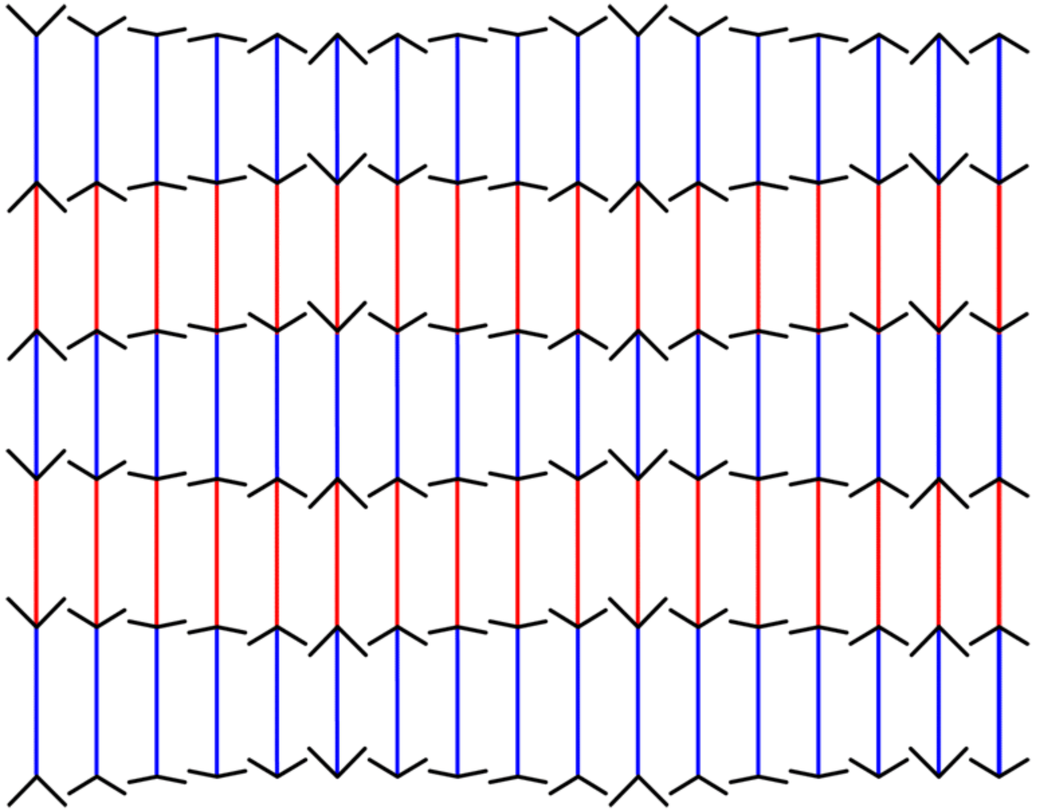
Müller-Lyer Sinusoidal Waves

New variant by Gianni A. Sarcone

Though the **blue** and **red** segments seem to oscillate, they are always the **same length**! **Nothing moves except the arrows** at the endpoints of each color segment...



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