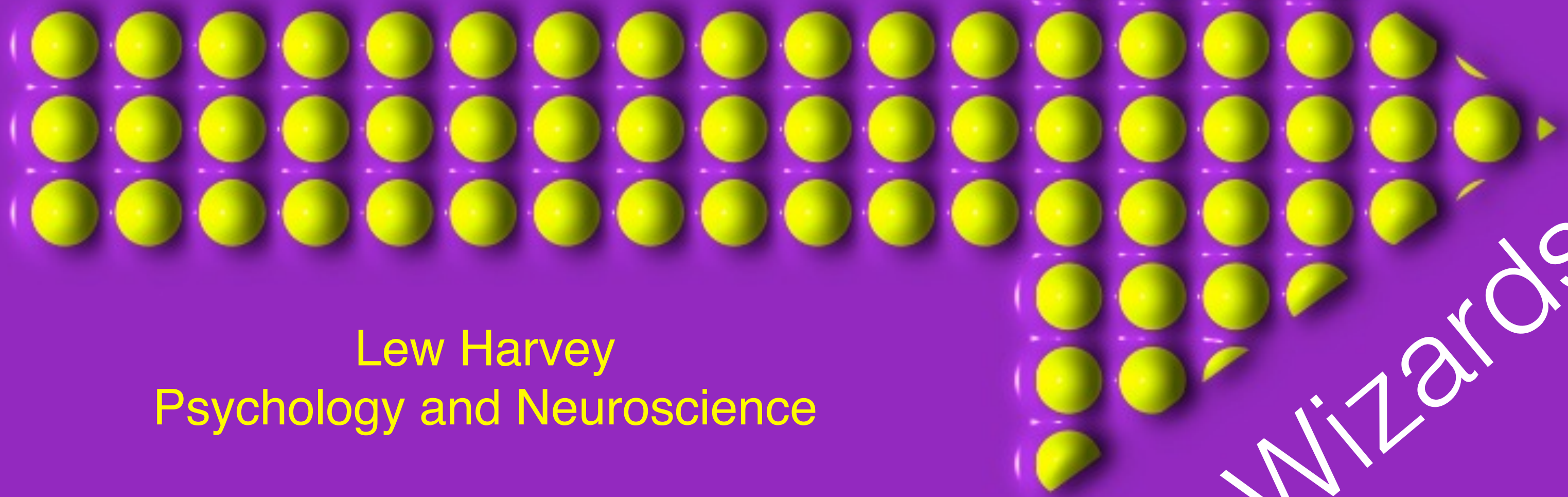


Illusion and Reality: The Science of Perception



Lew Harvey
Psychology and Neuroscience

CU
Wizards

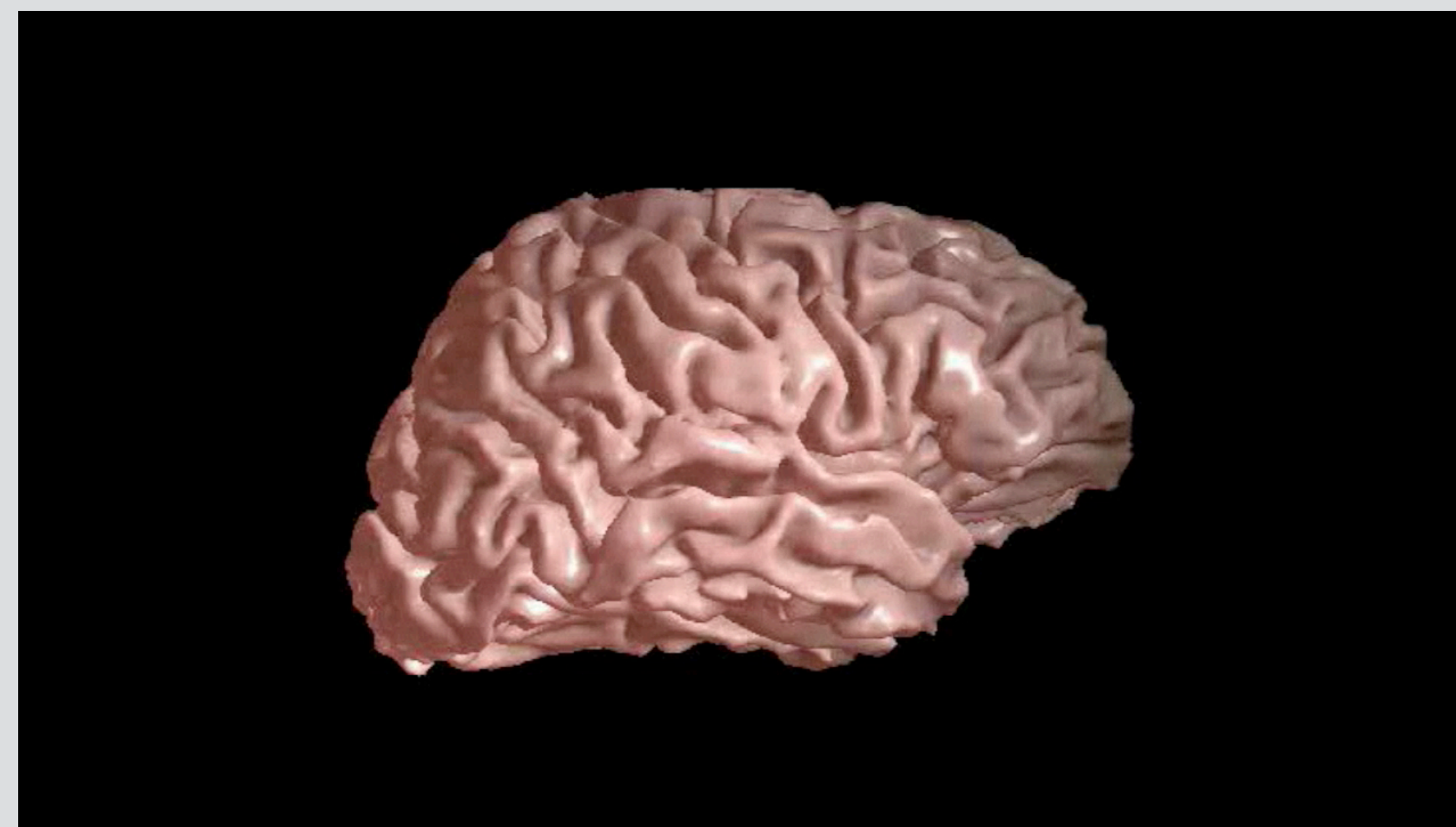
With the Support of:

- 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)

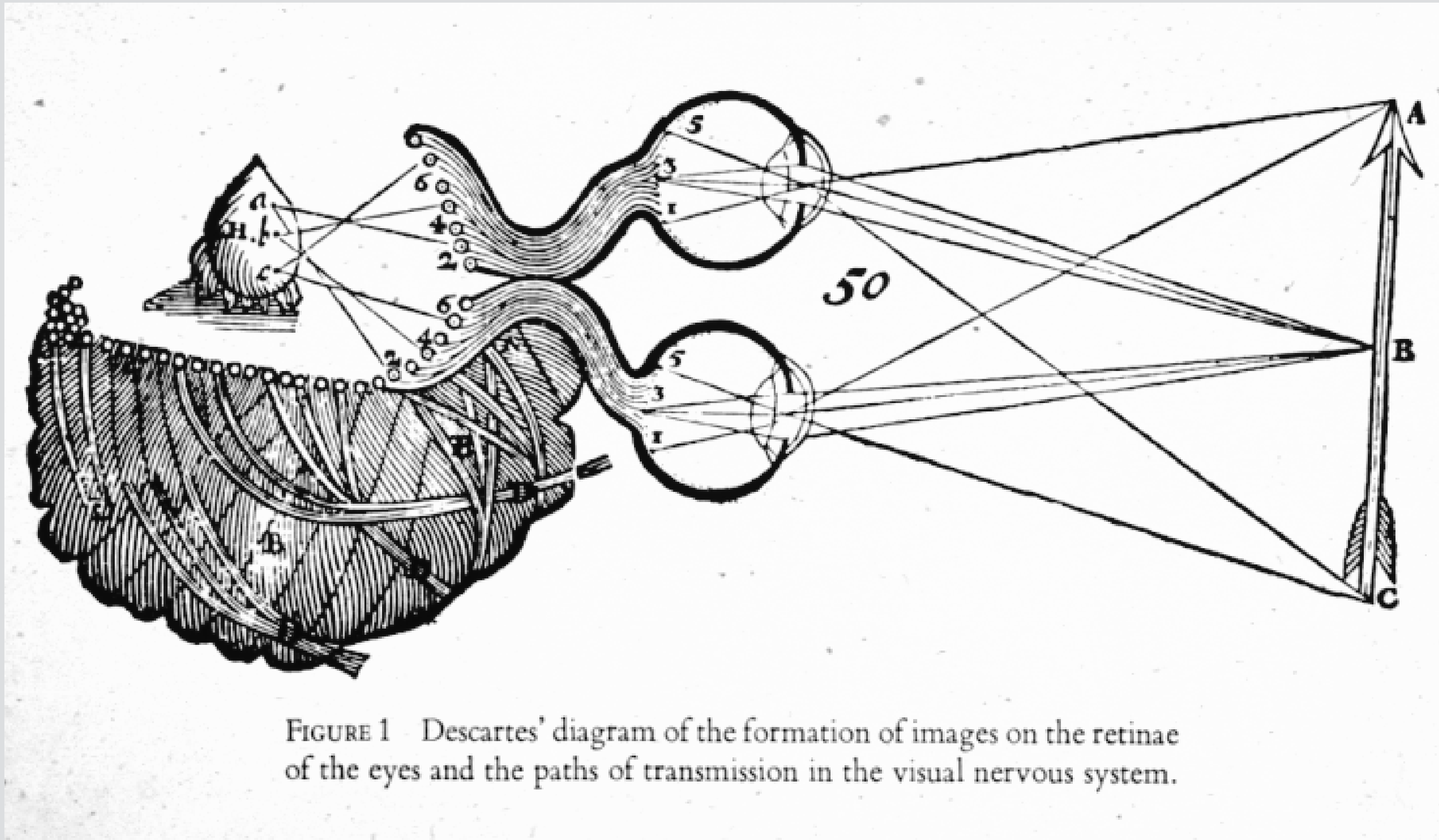
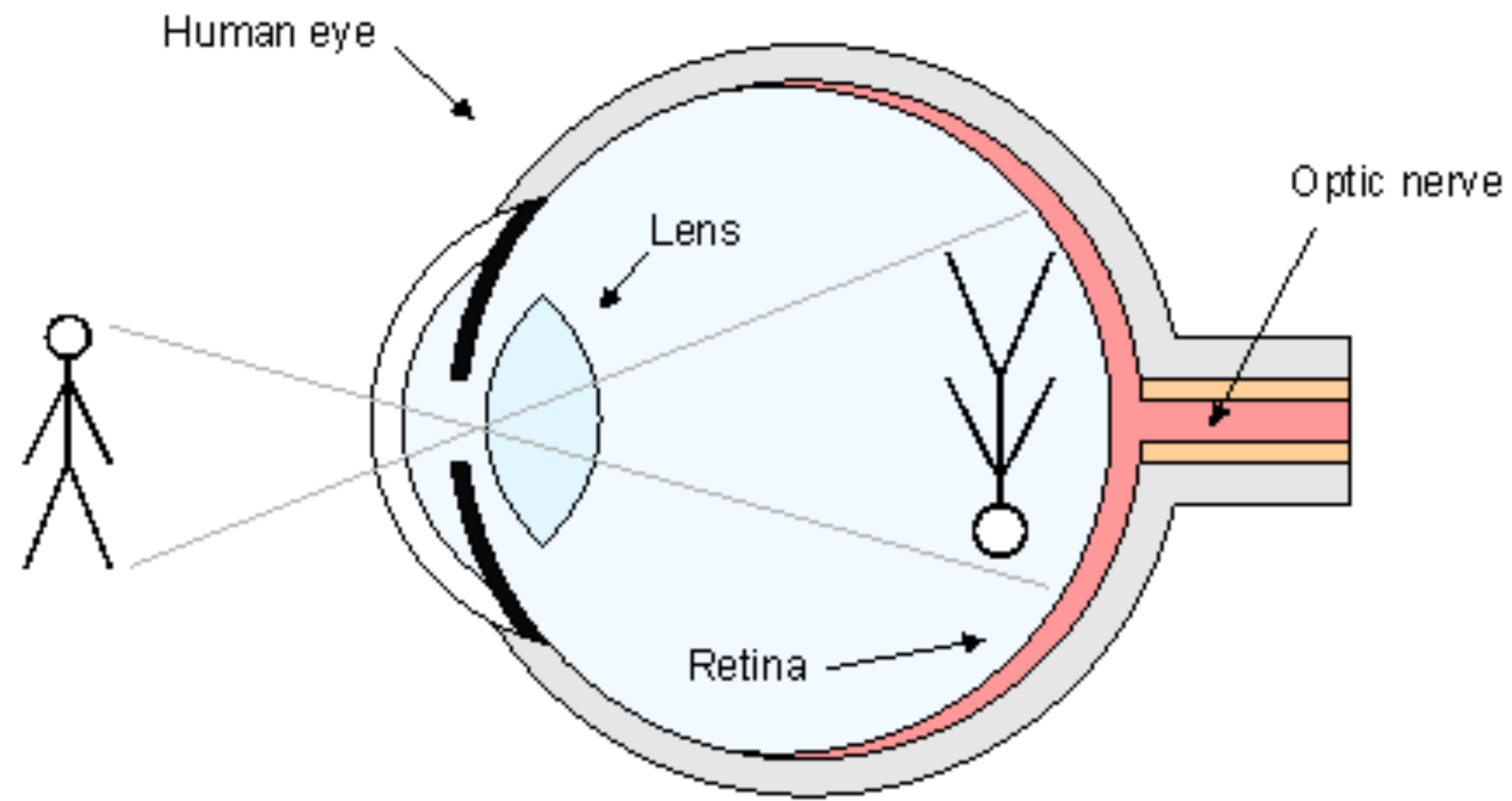


FIGURE 1 - Descartes' diagram of the formation of images on the retinae of the eyes and the paths of transmission in the visual nervous system.

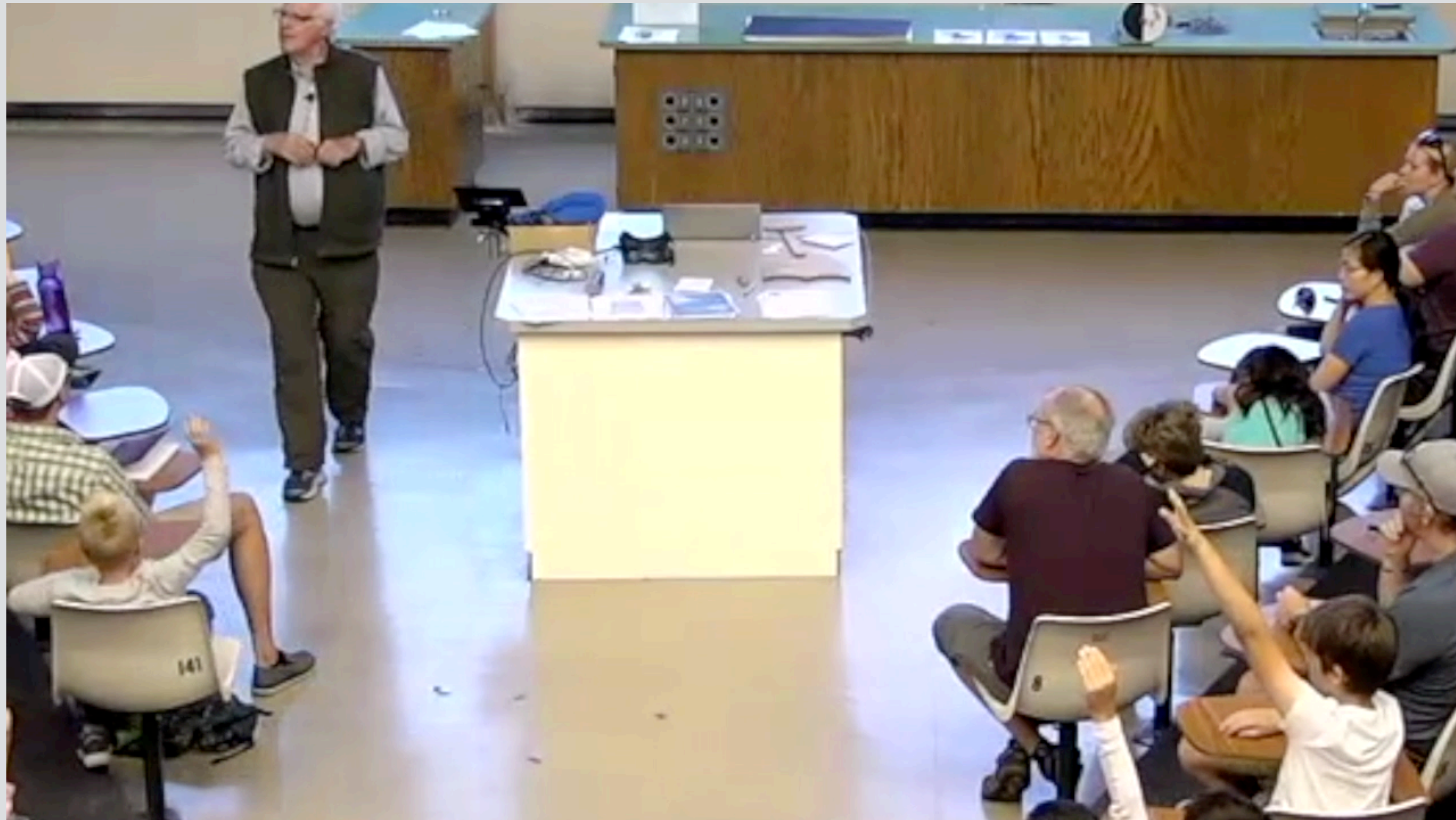


Images are inverted on their way to the retina at the back of the eye

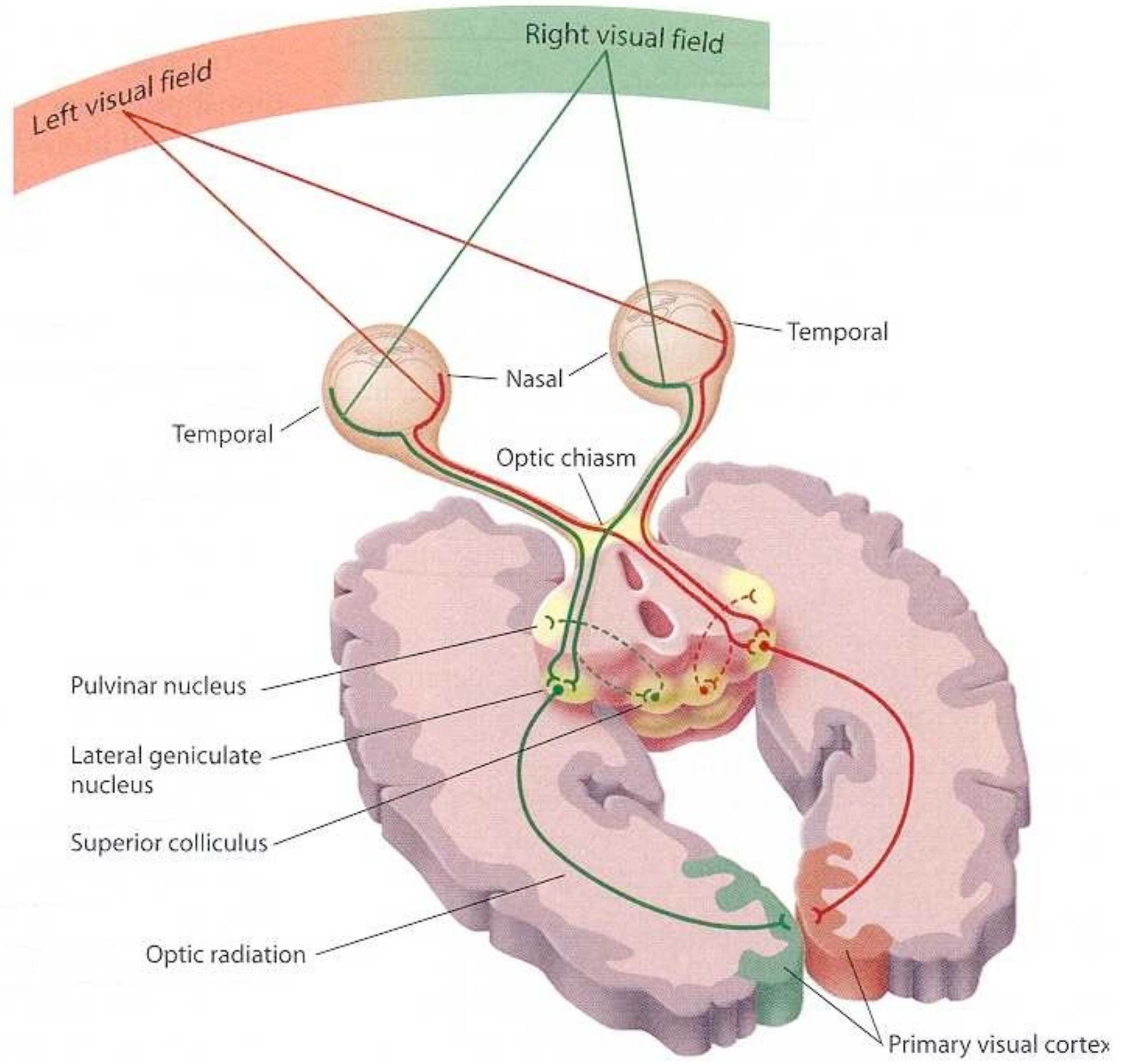
Use Prisms to Distort Retinal Image



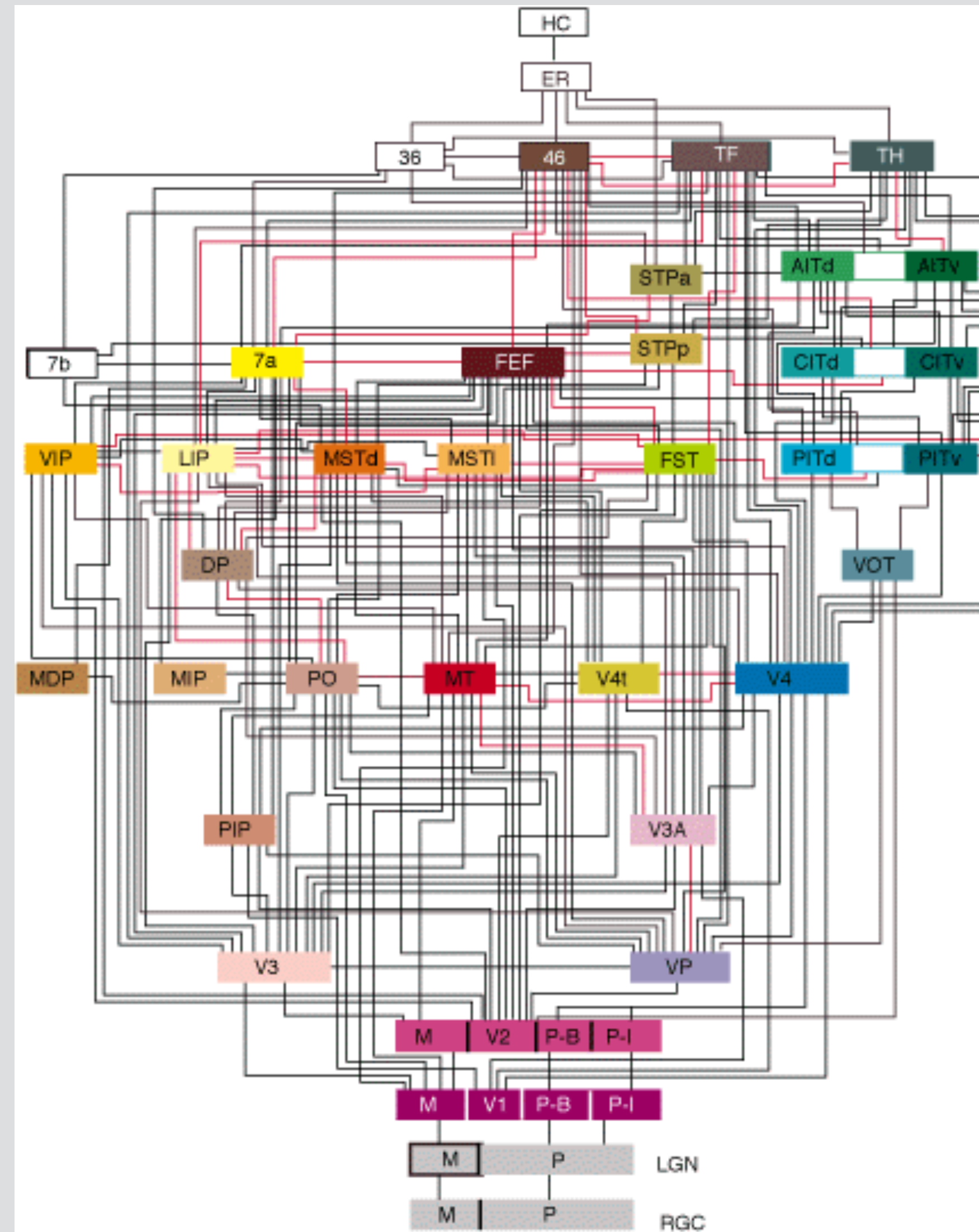
Effect of Optical Distortion



Our Brain can rather quickly
adapt to optical distortion!

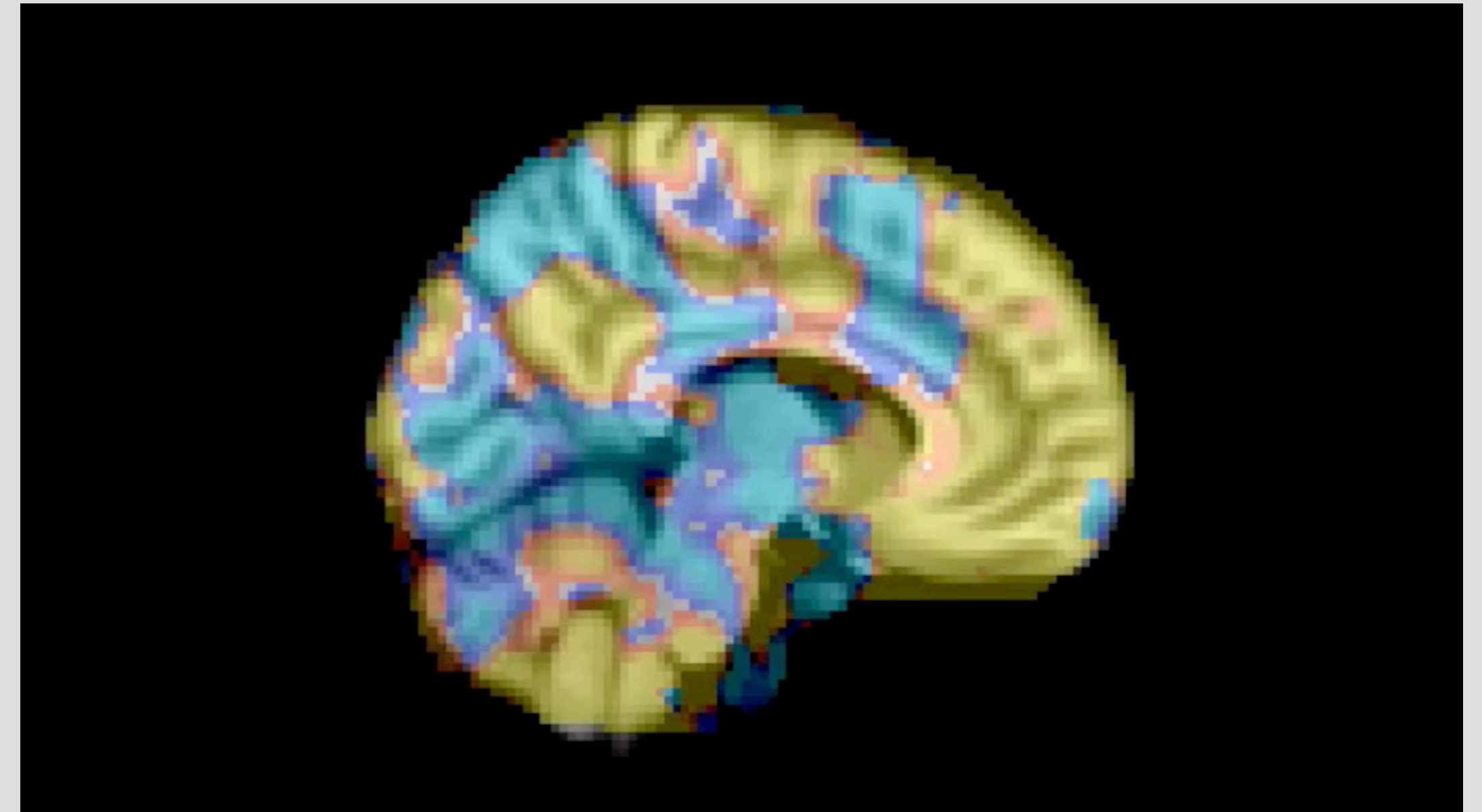
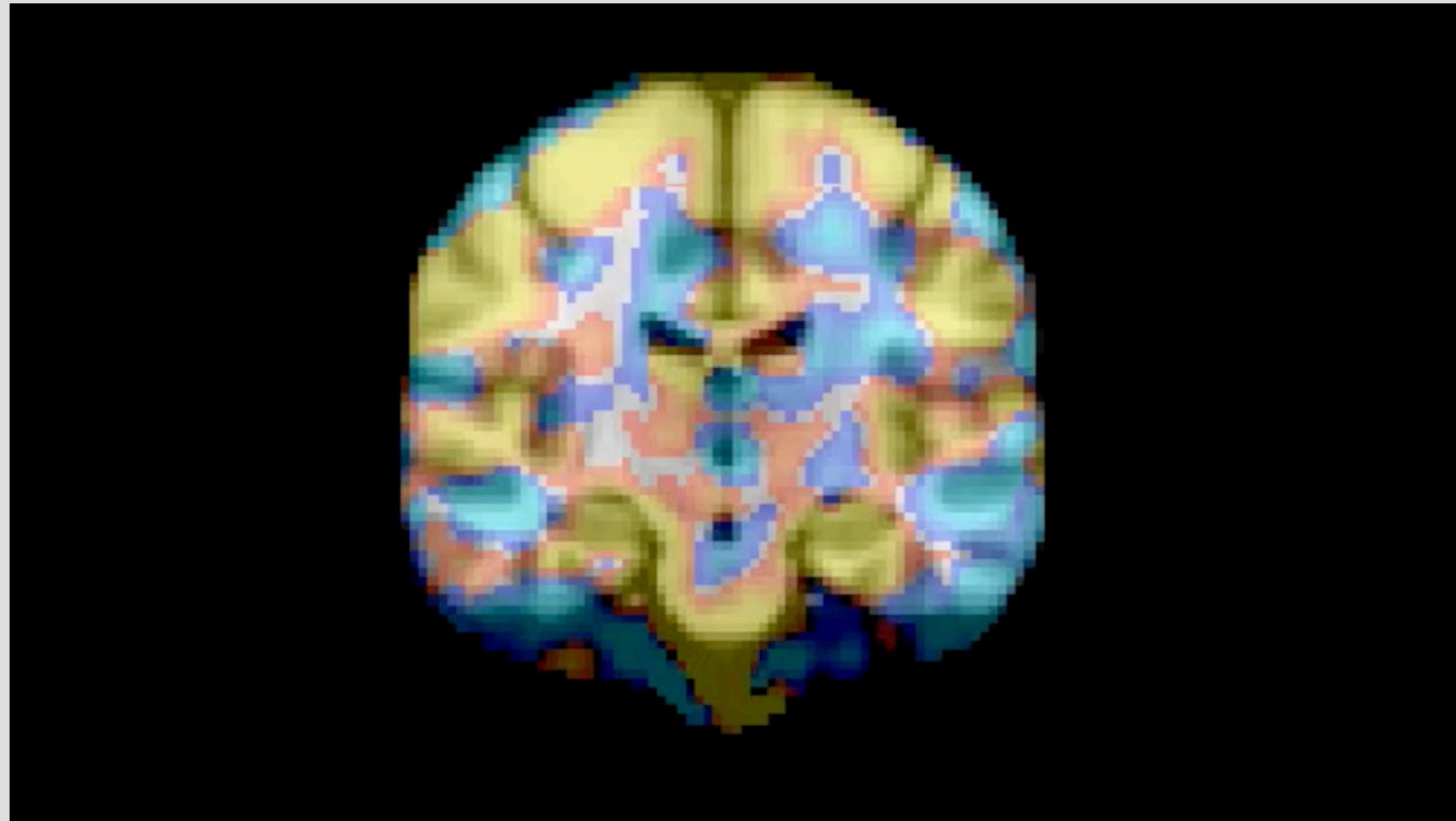


Visual Pathways, circa 1991



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

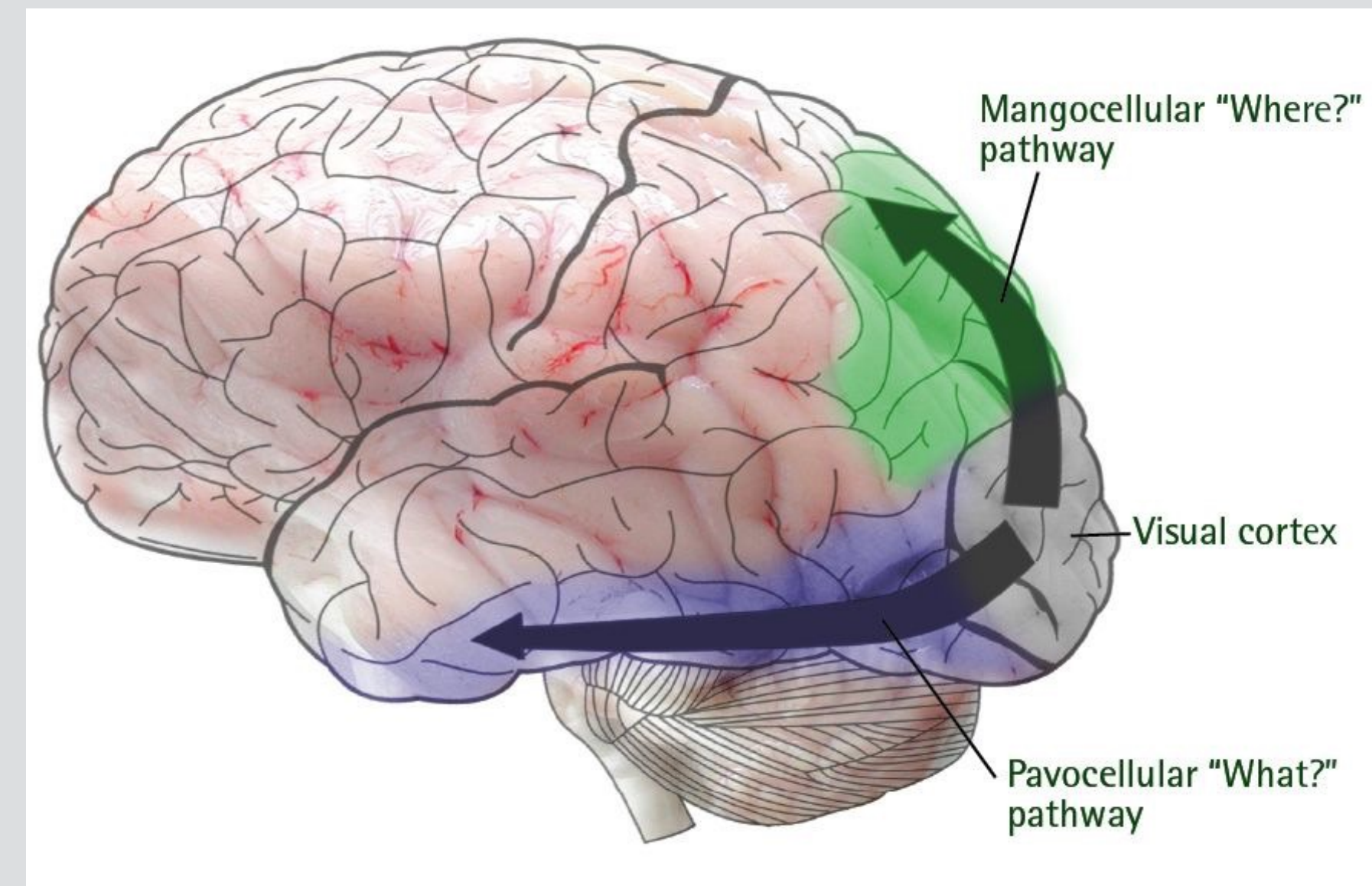
Brain Networks, circa 2016
Default Mode Network (DMN)
Activity “At Rest”



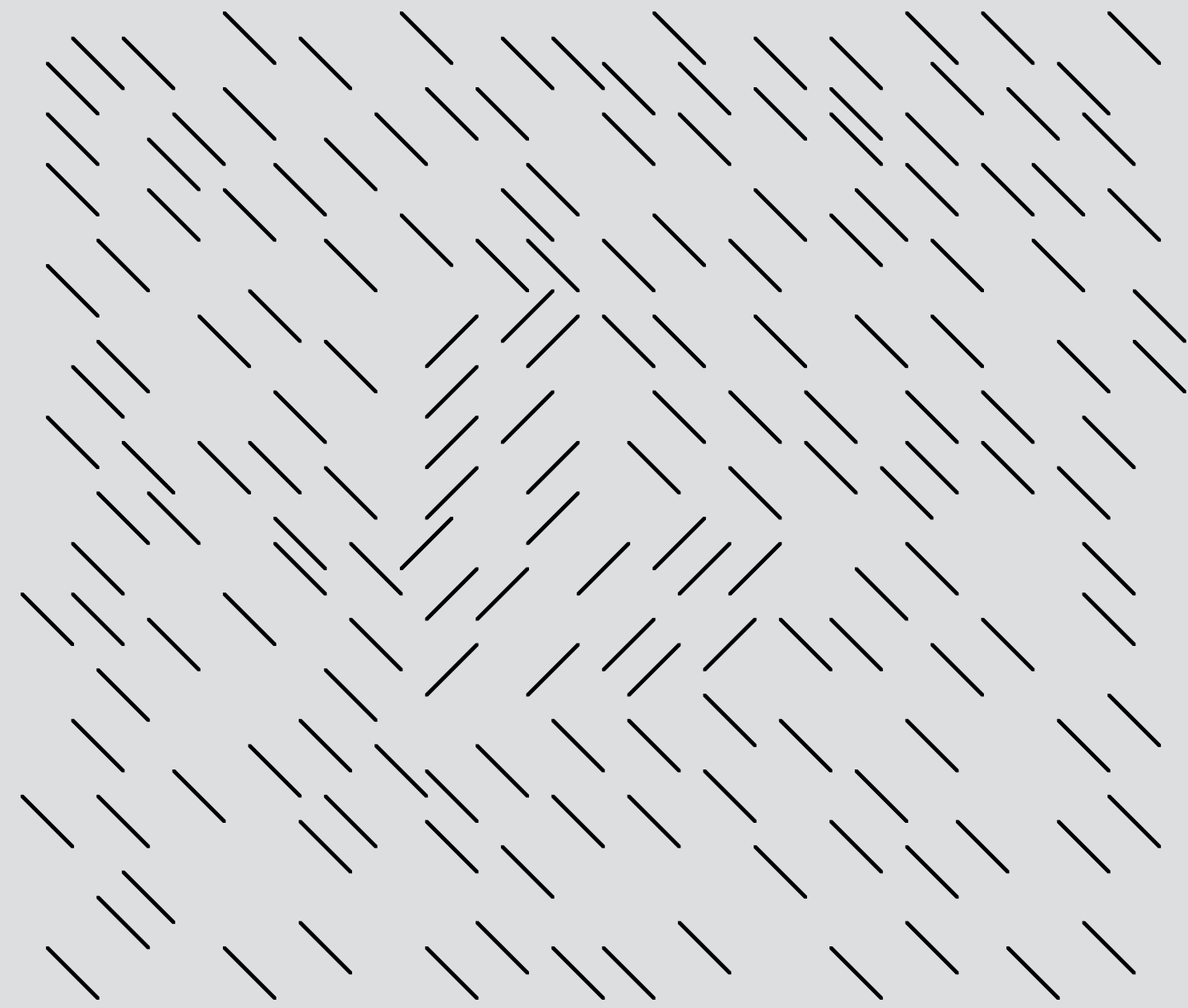
Videos created by Andrew E. Reineberg
Department of Psychology and Neuroscience
University of Colorado Boulder

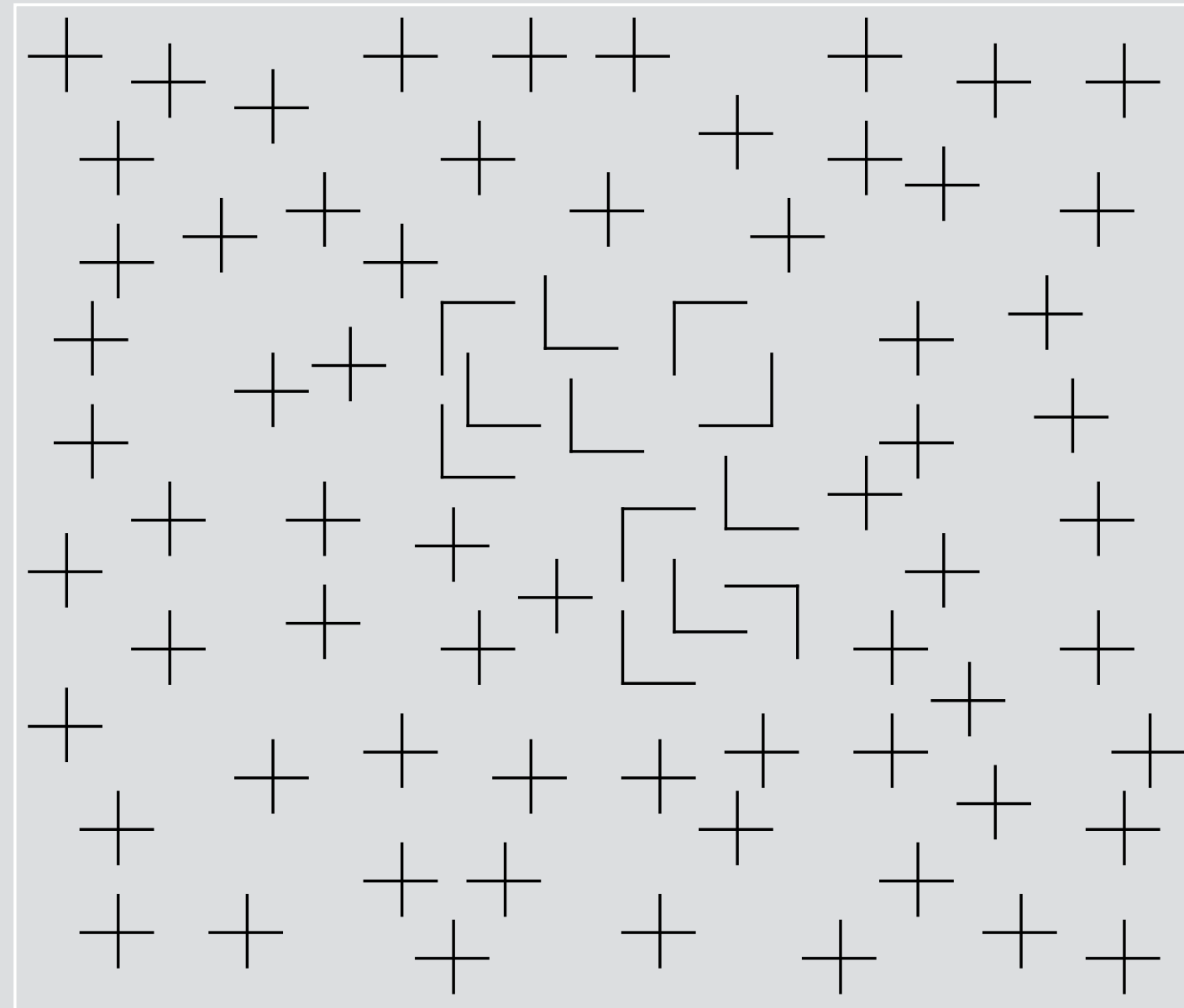
Analysis & Dynamic Interaction

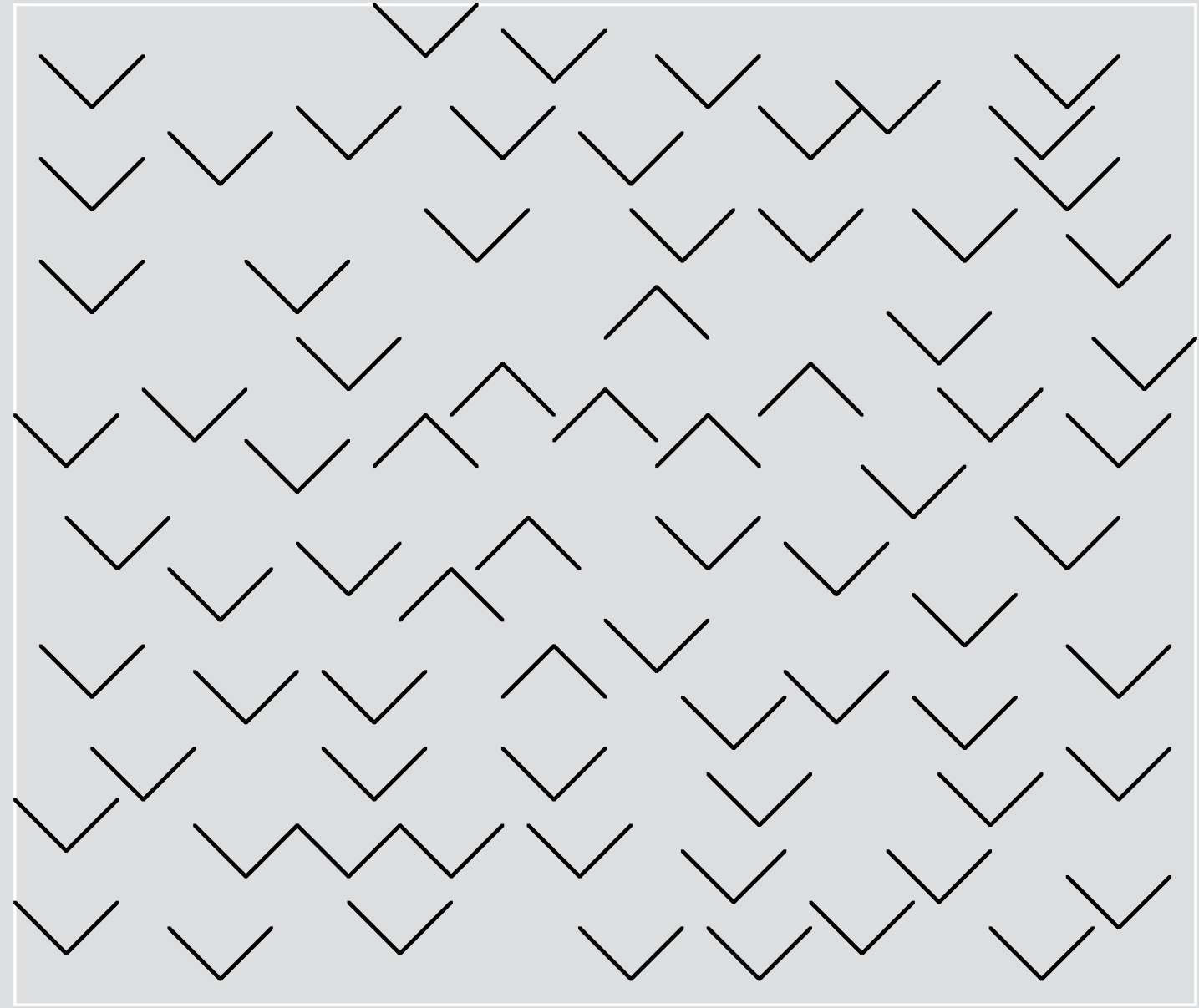
- Sensory input is broken into separate streams of information
 - Lines & edges
 - movement
 - angles & orientation,
 - size & scale
 - color
- Over 50% of cortex has visual responses
- Reality is constructed from these component parts using goals, expectations, biases, rewards.

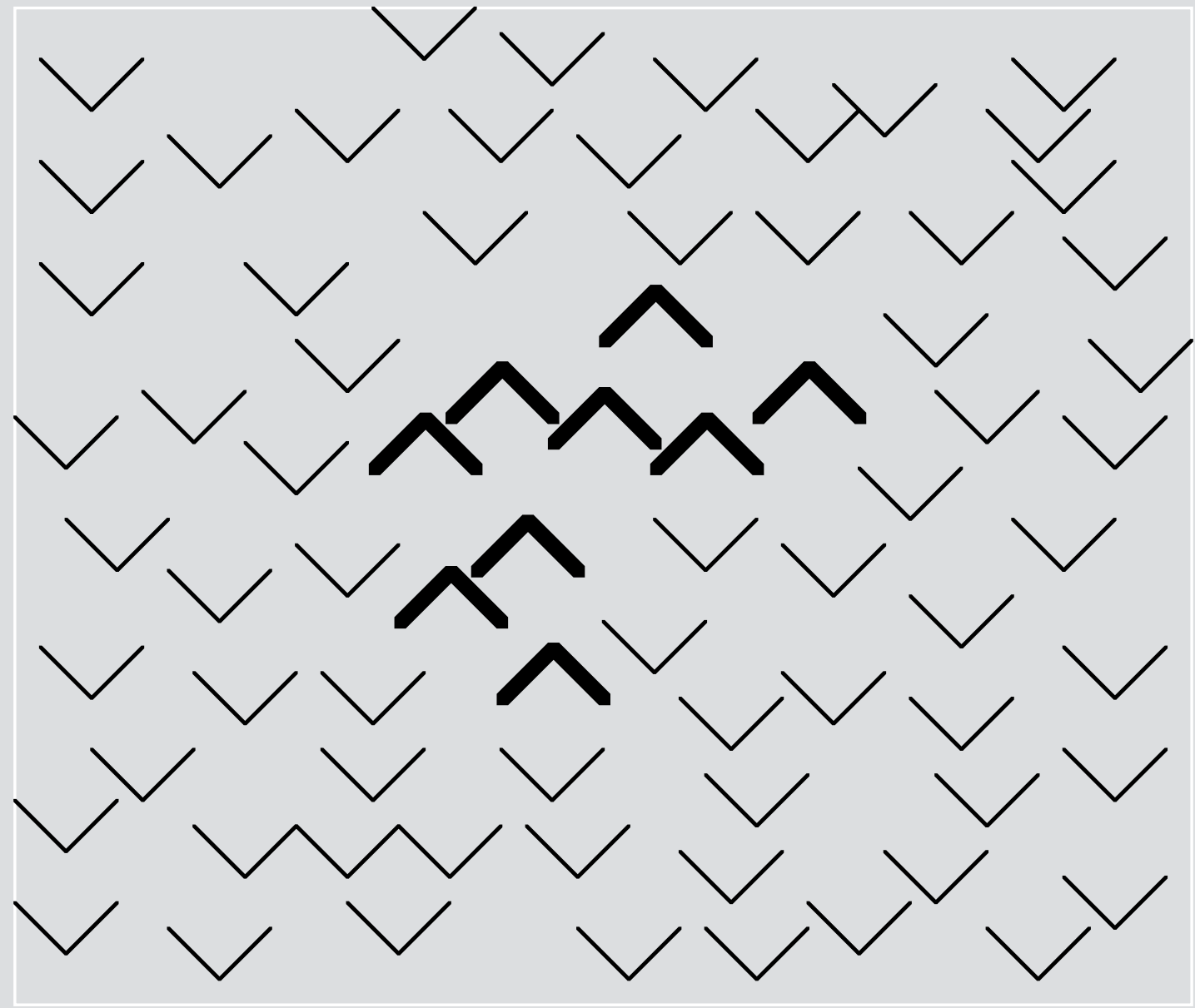


Lines and Edges
Angles and Orientations

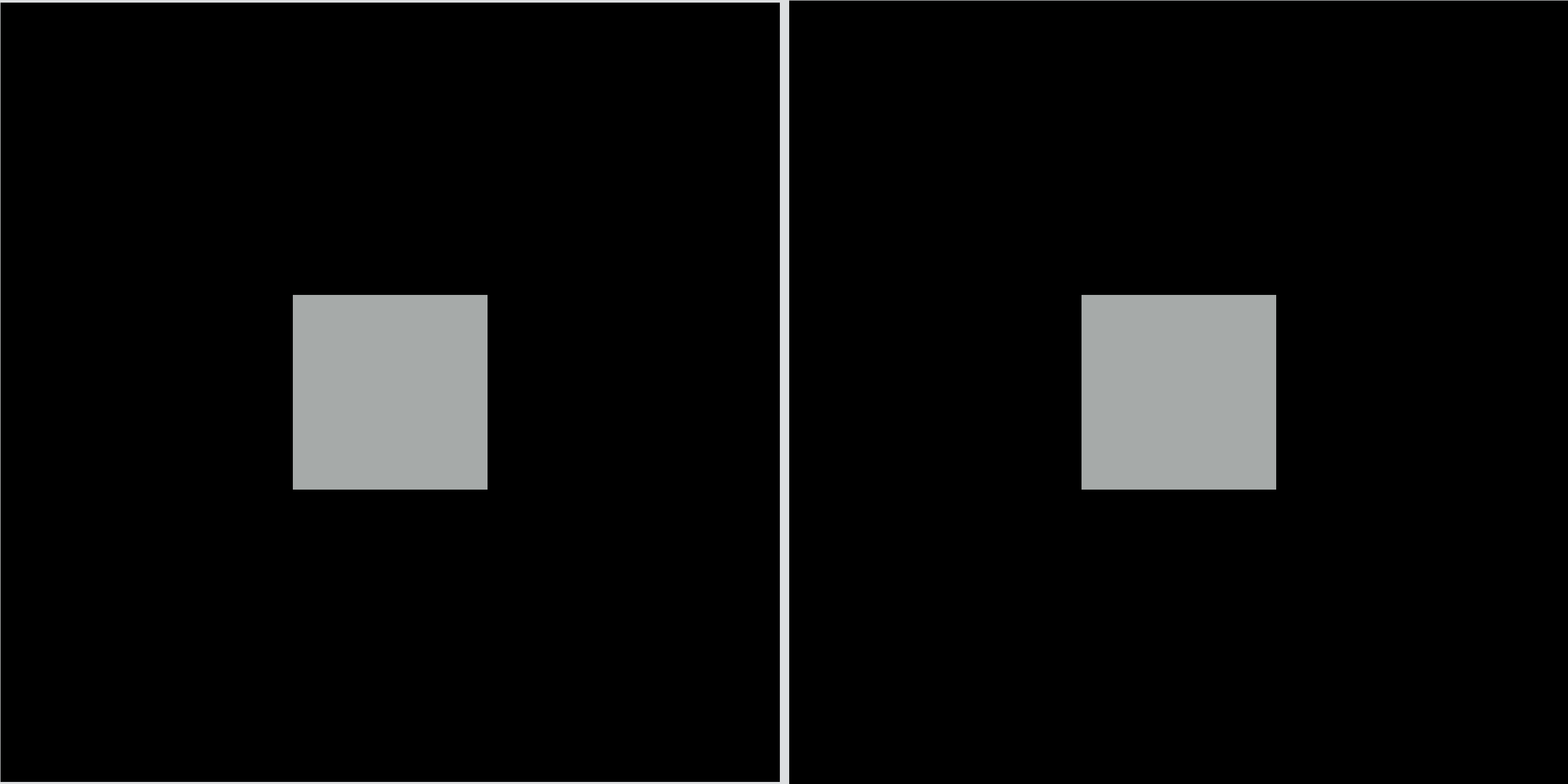


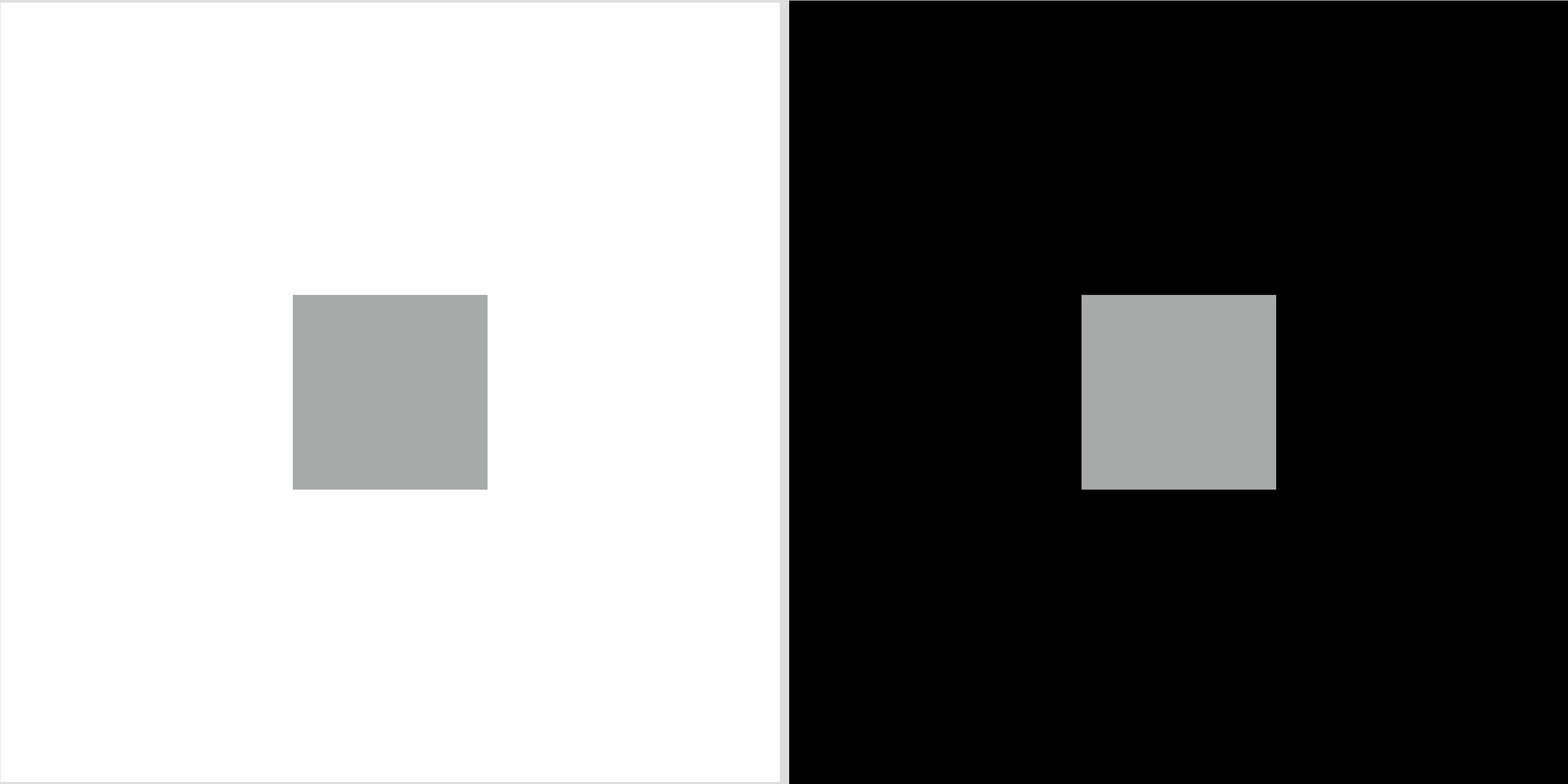


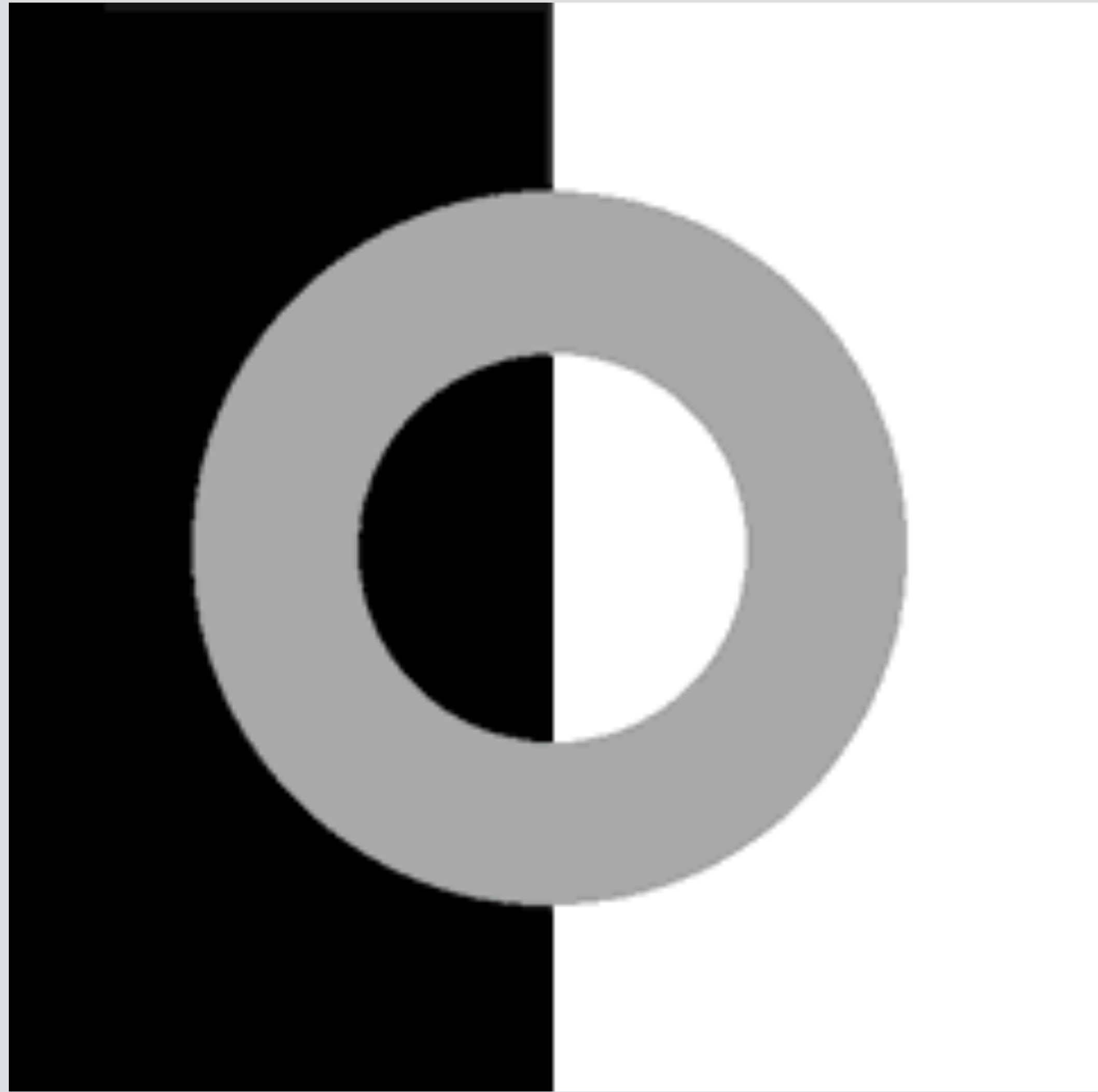


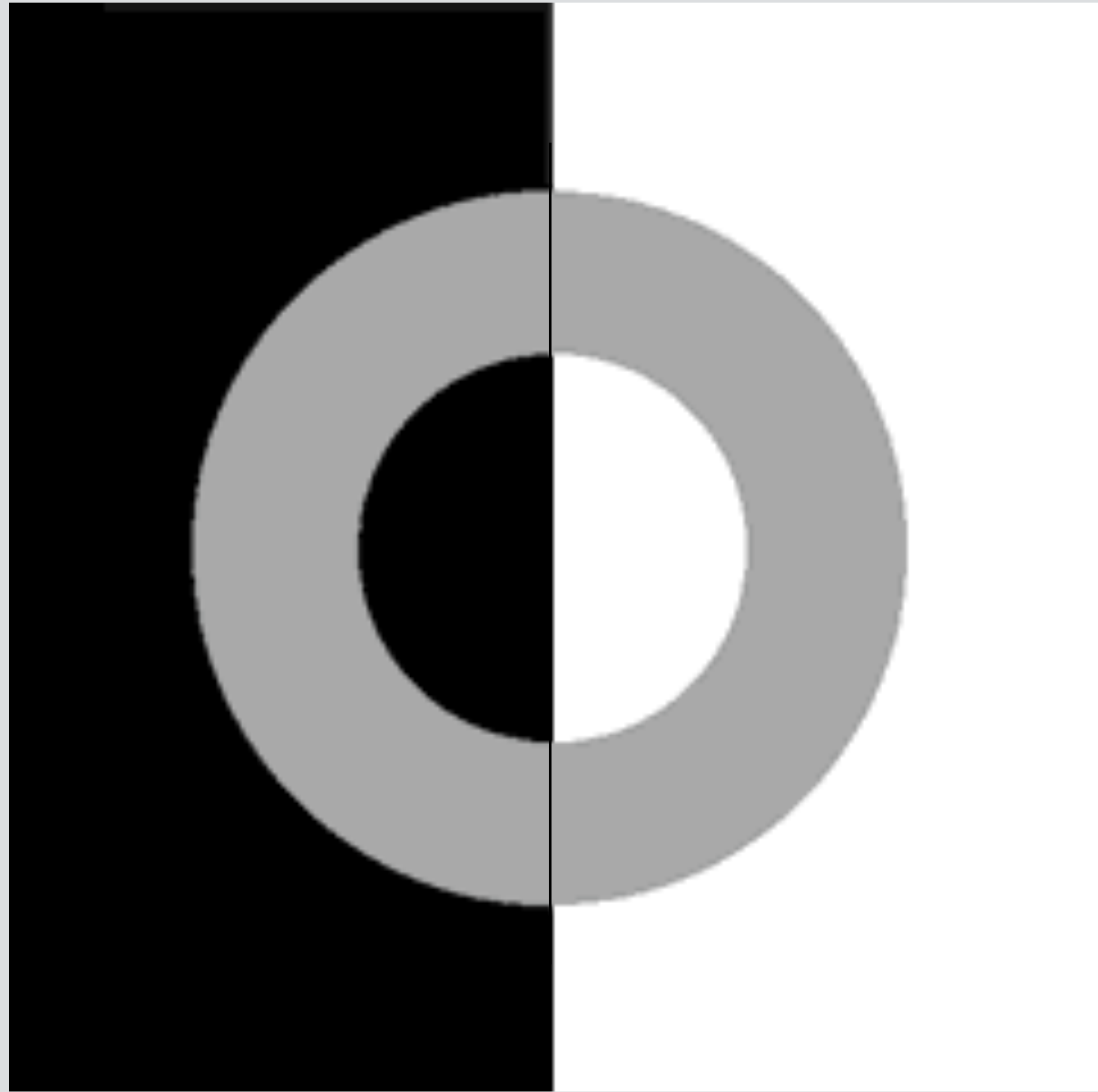


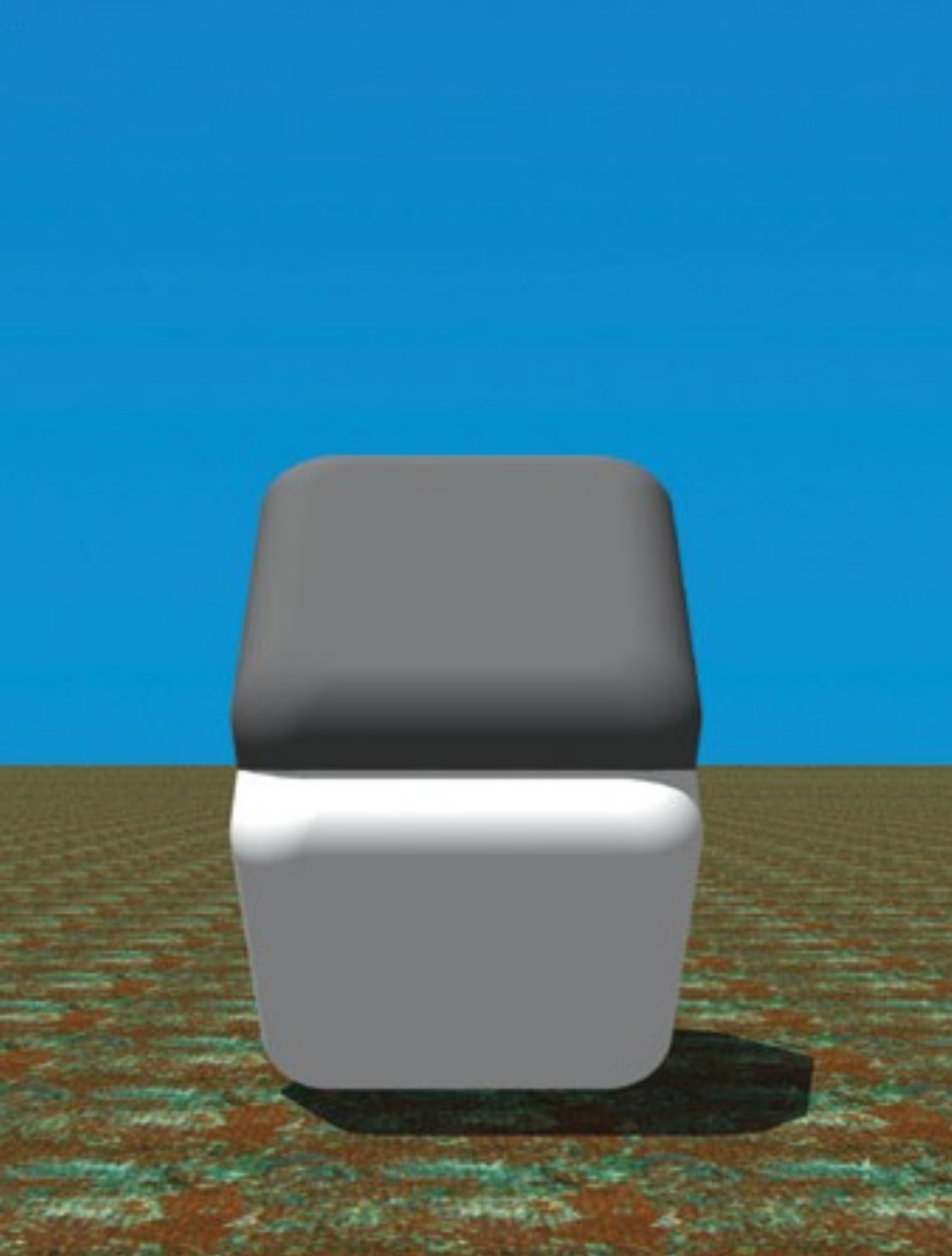
*What we perceive does not correspond to physical
properties of objects!*

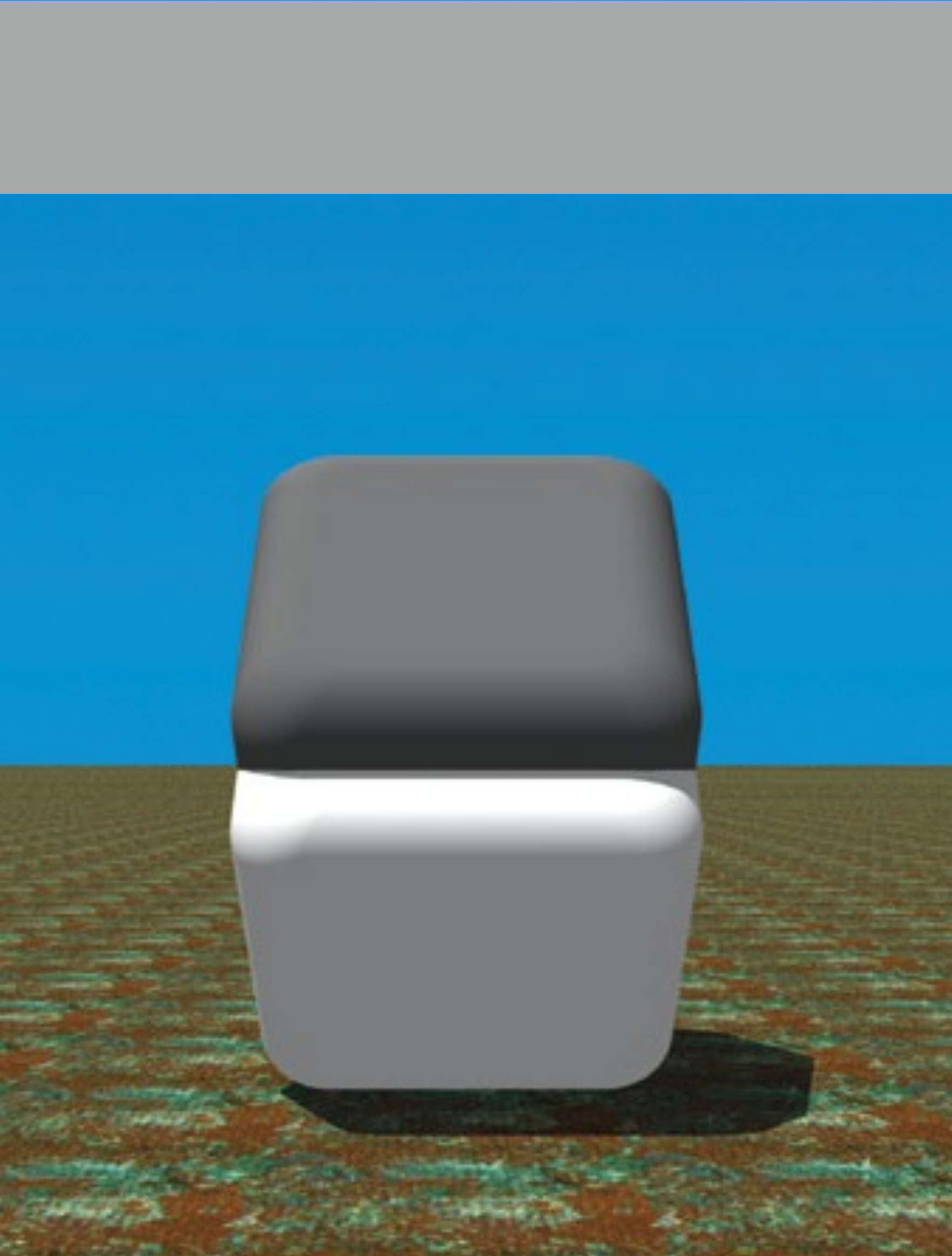


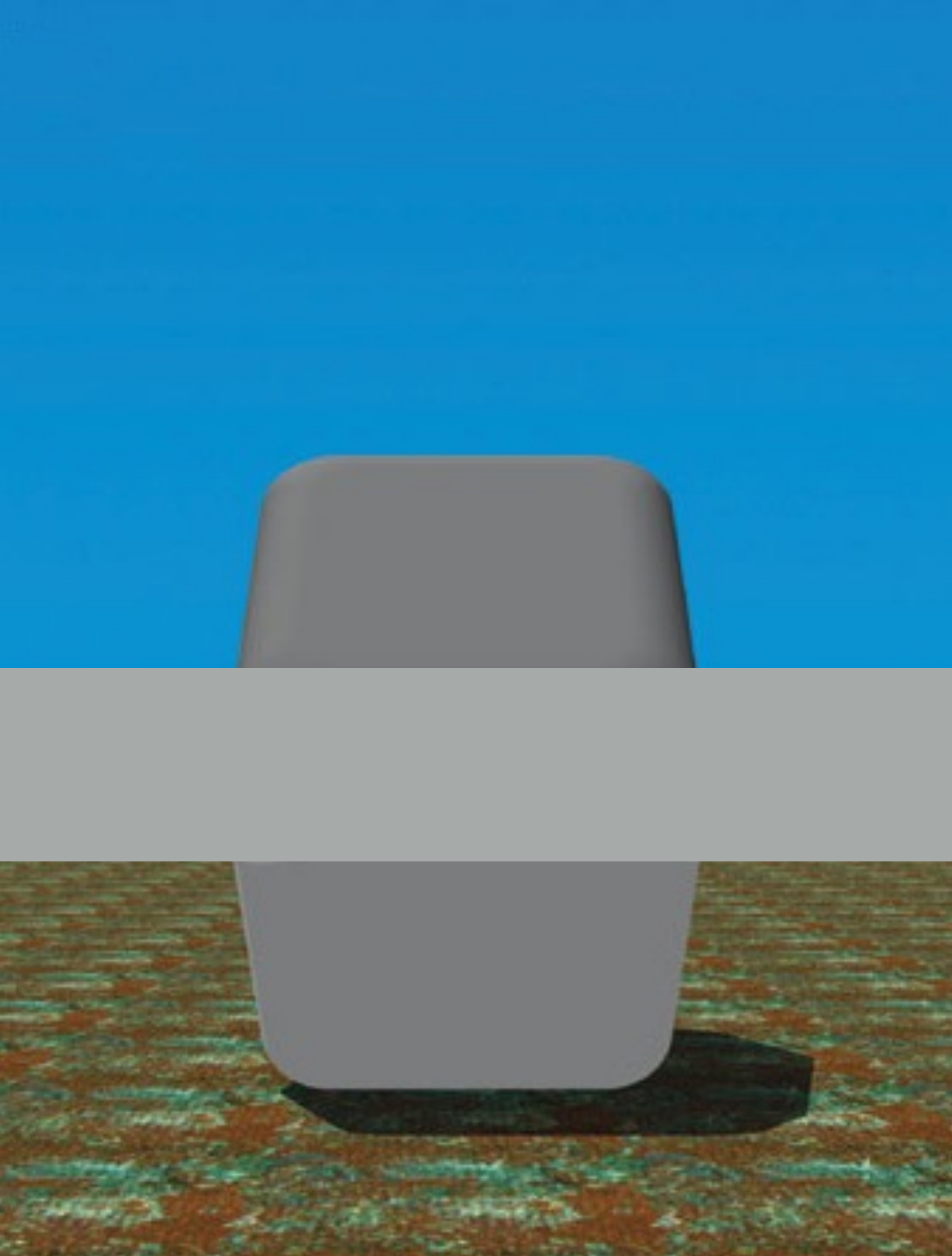


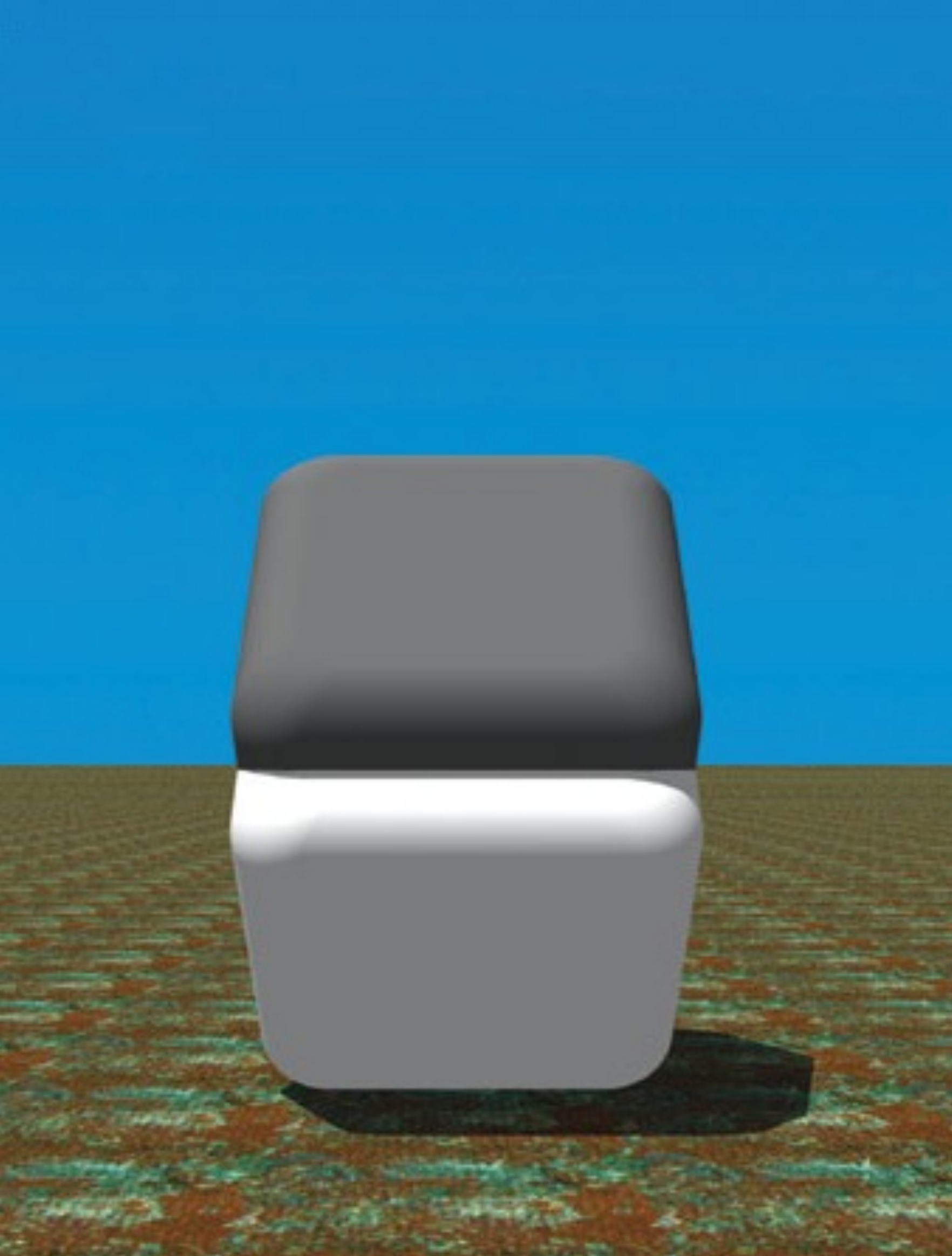




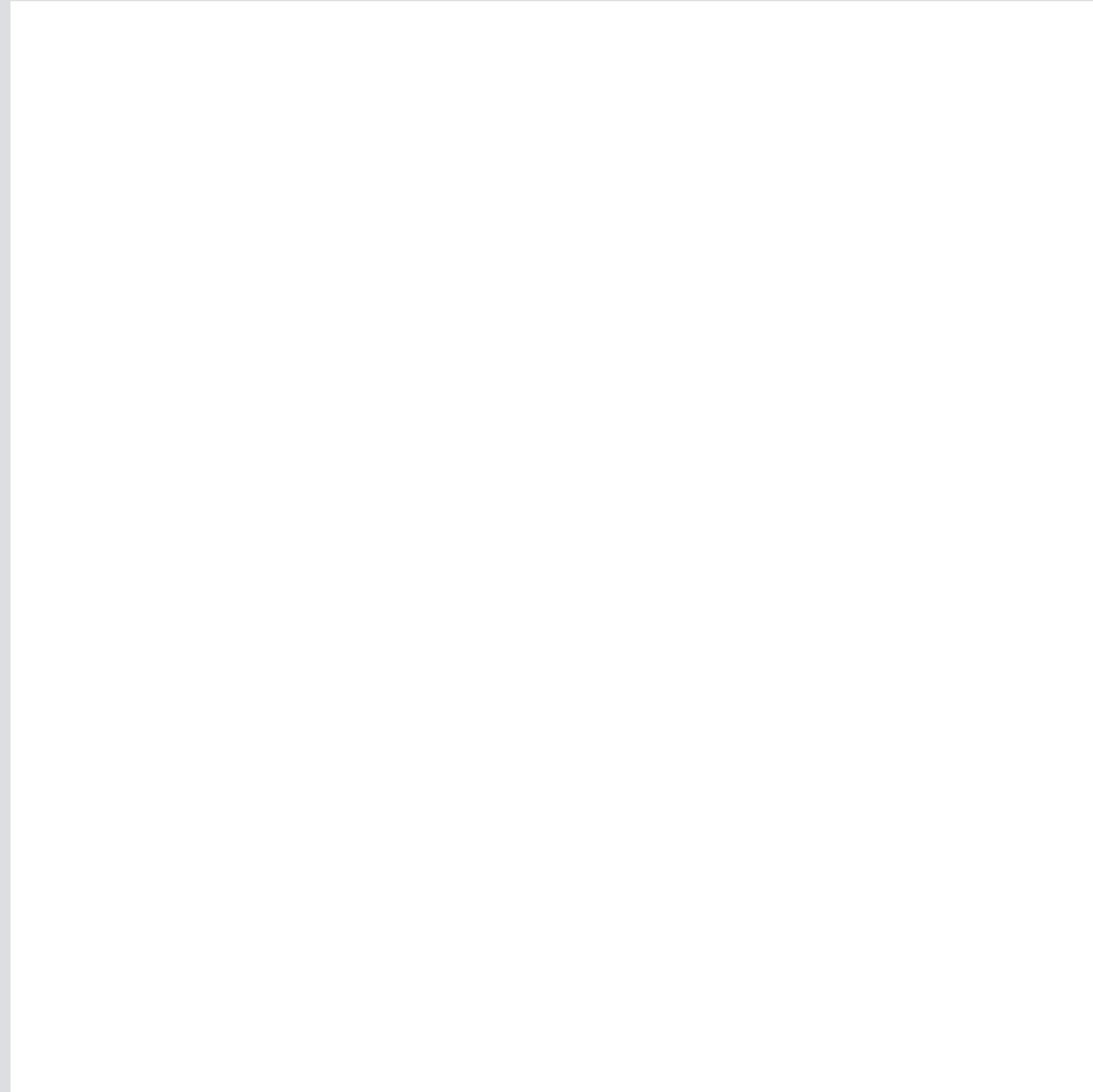






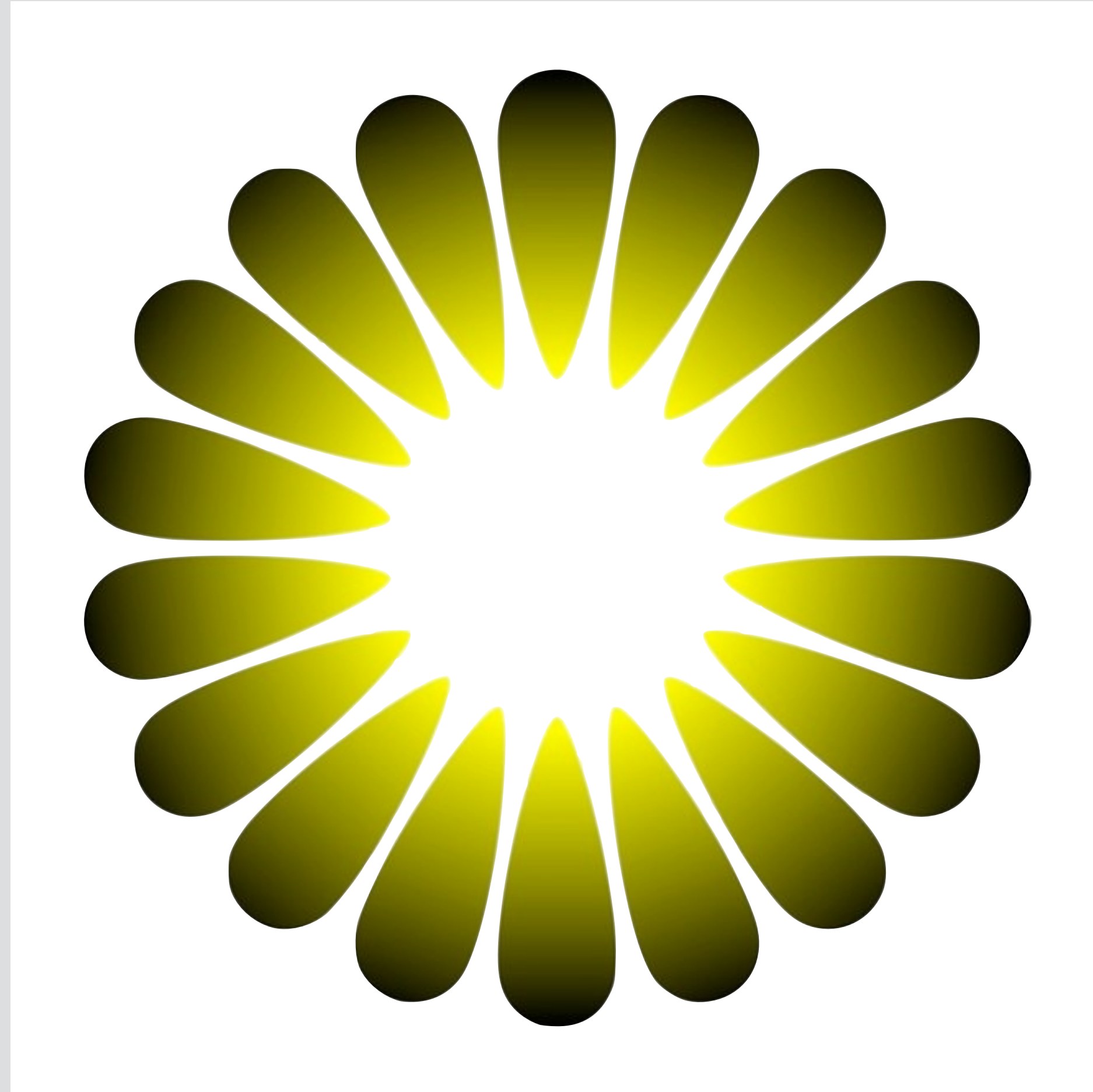


Asahi Figure



Akiyoshi Kitaoka 2005

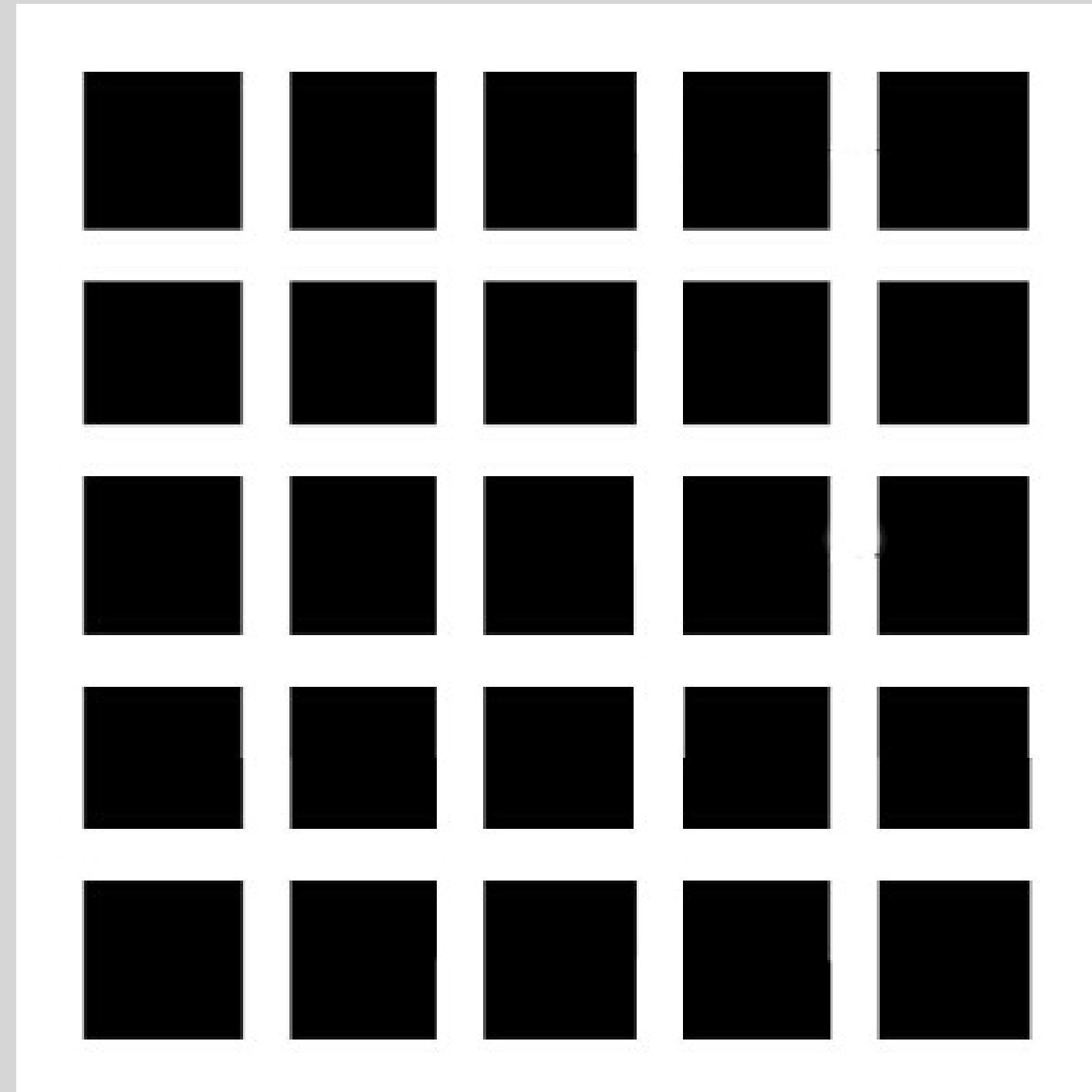
Asahi Figure



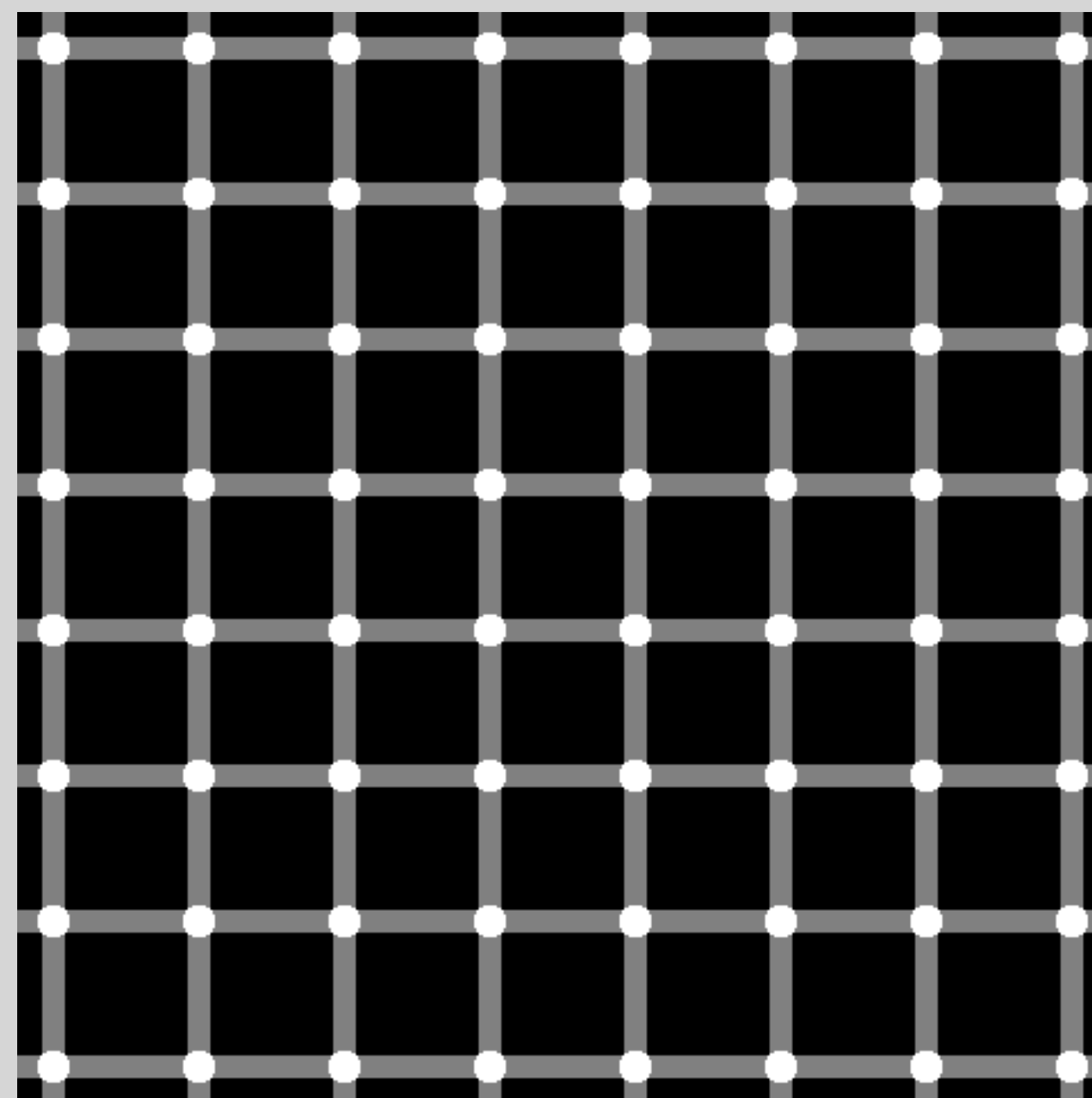
Akiyoshi Kitaoka 2005

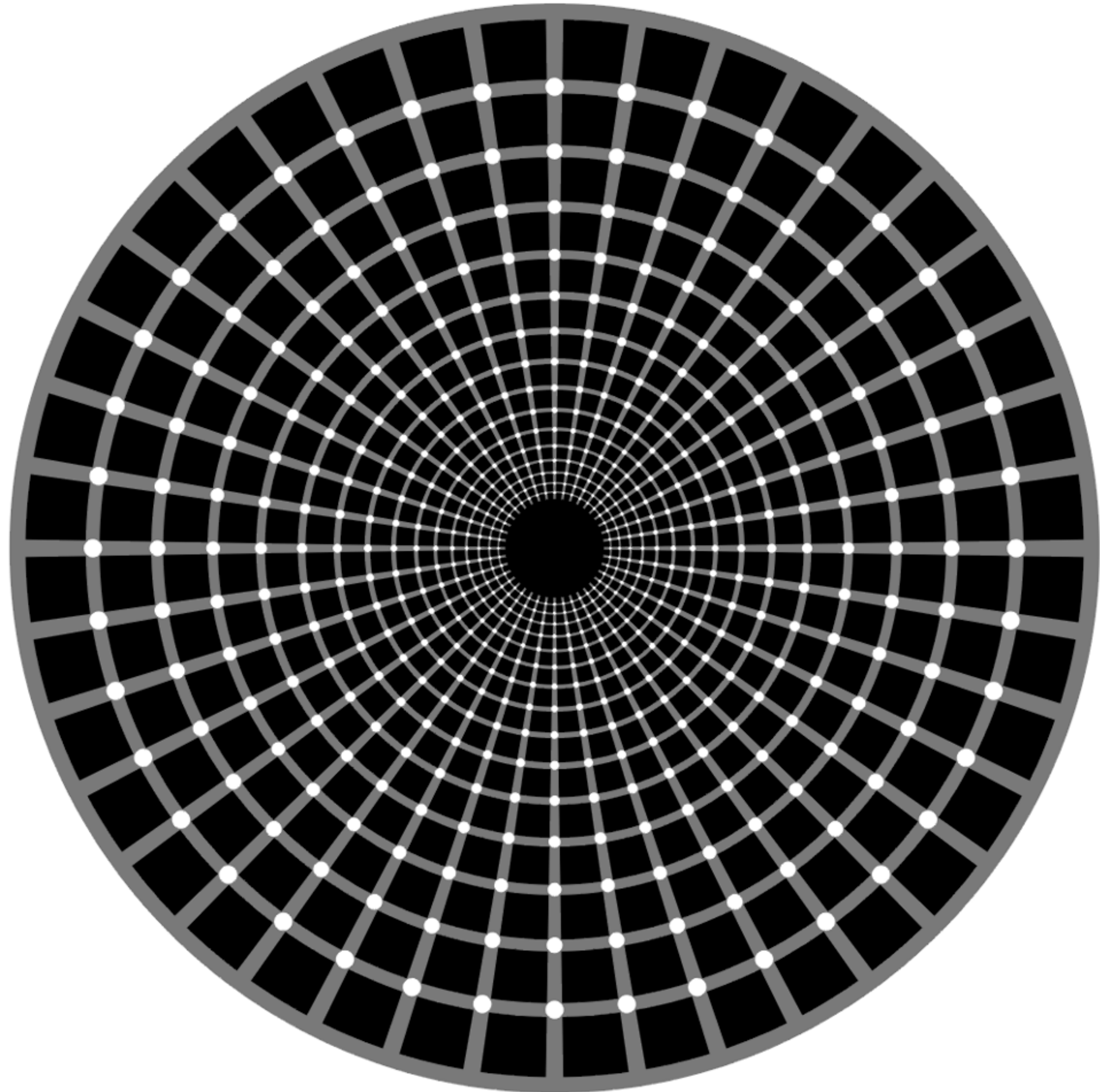


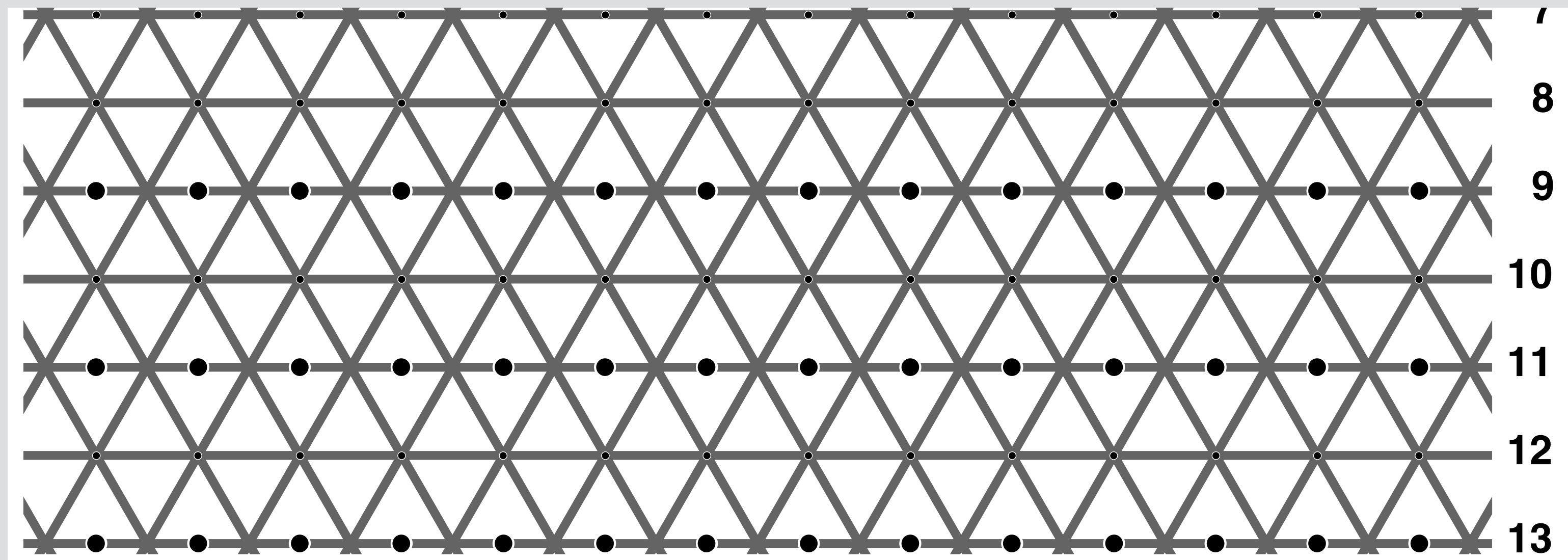
Hermann Grid



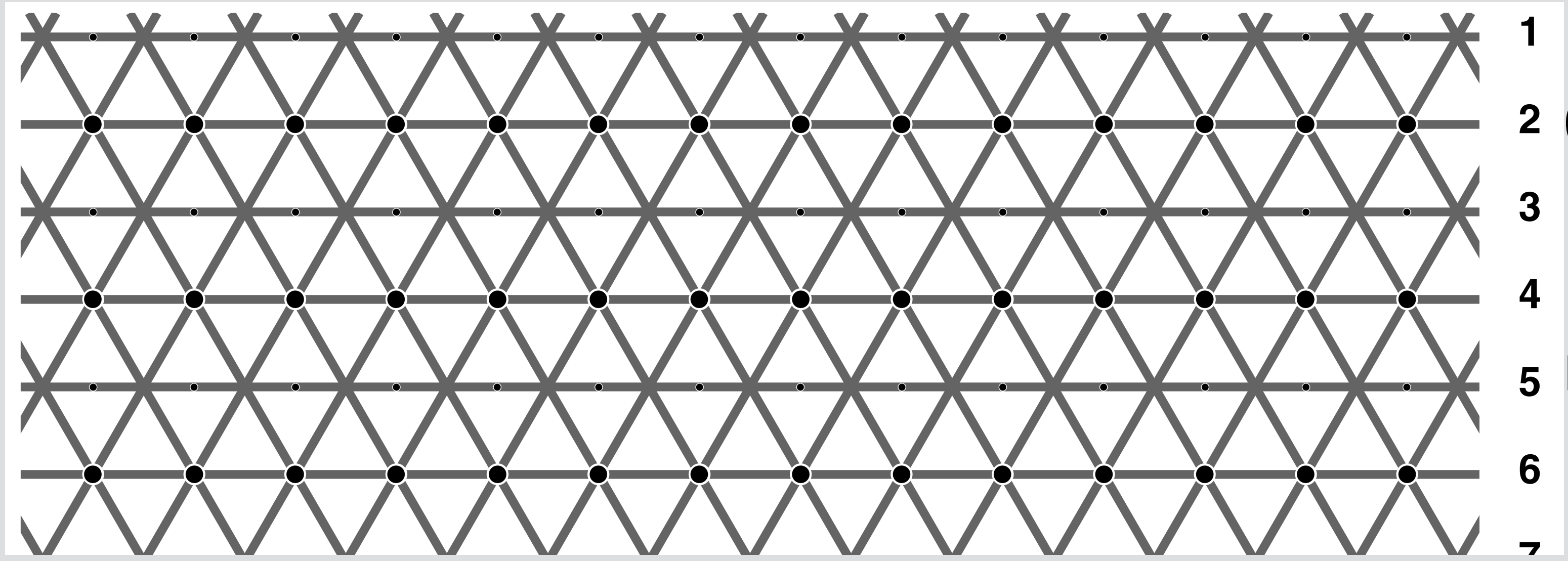
Enhanced Hermann Grid



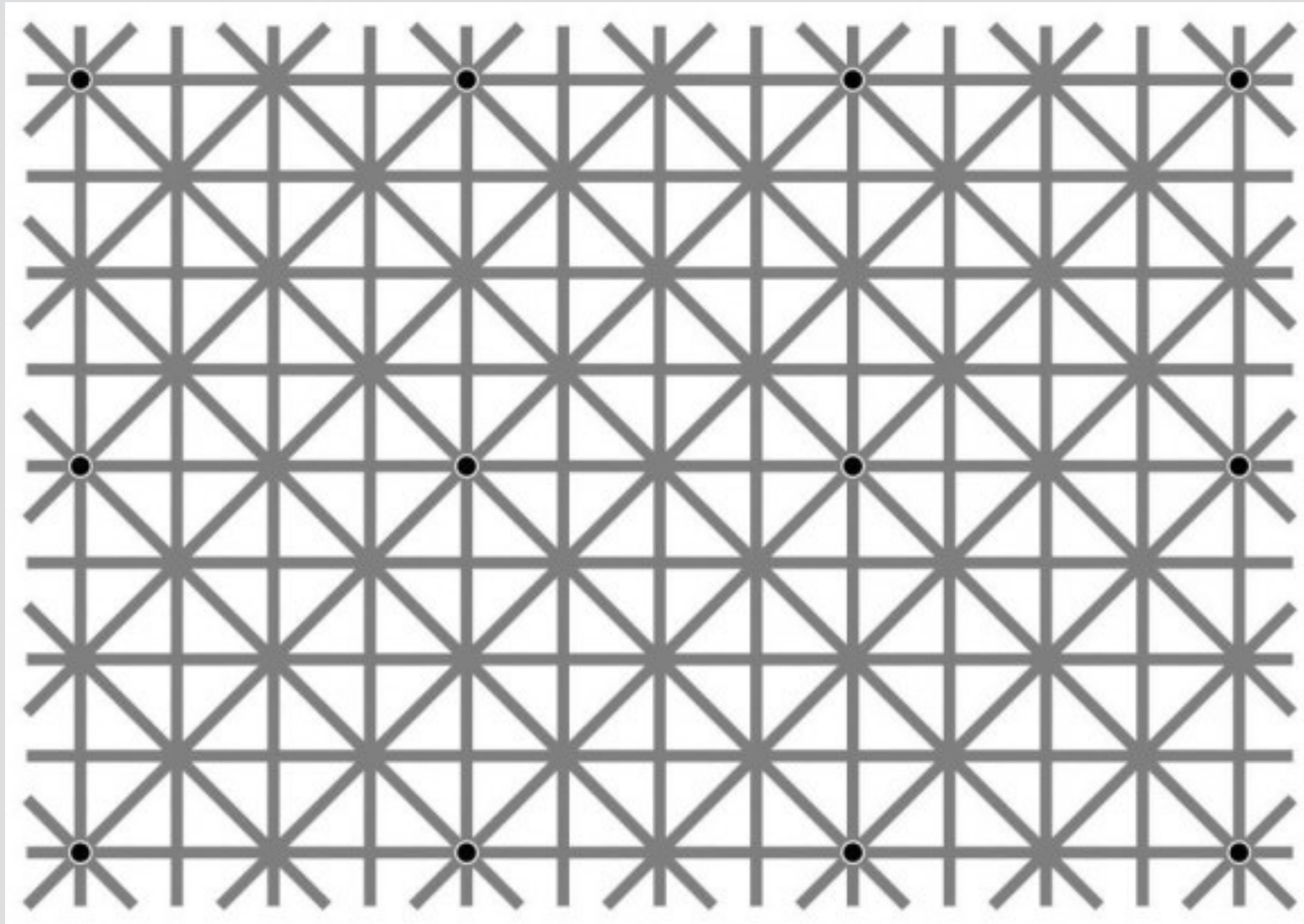




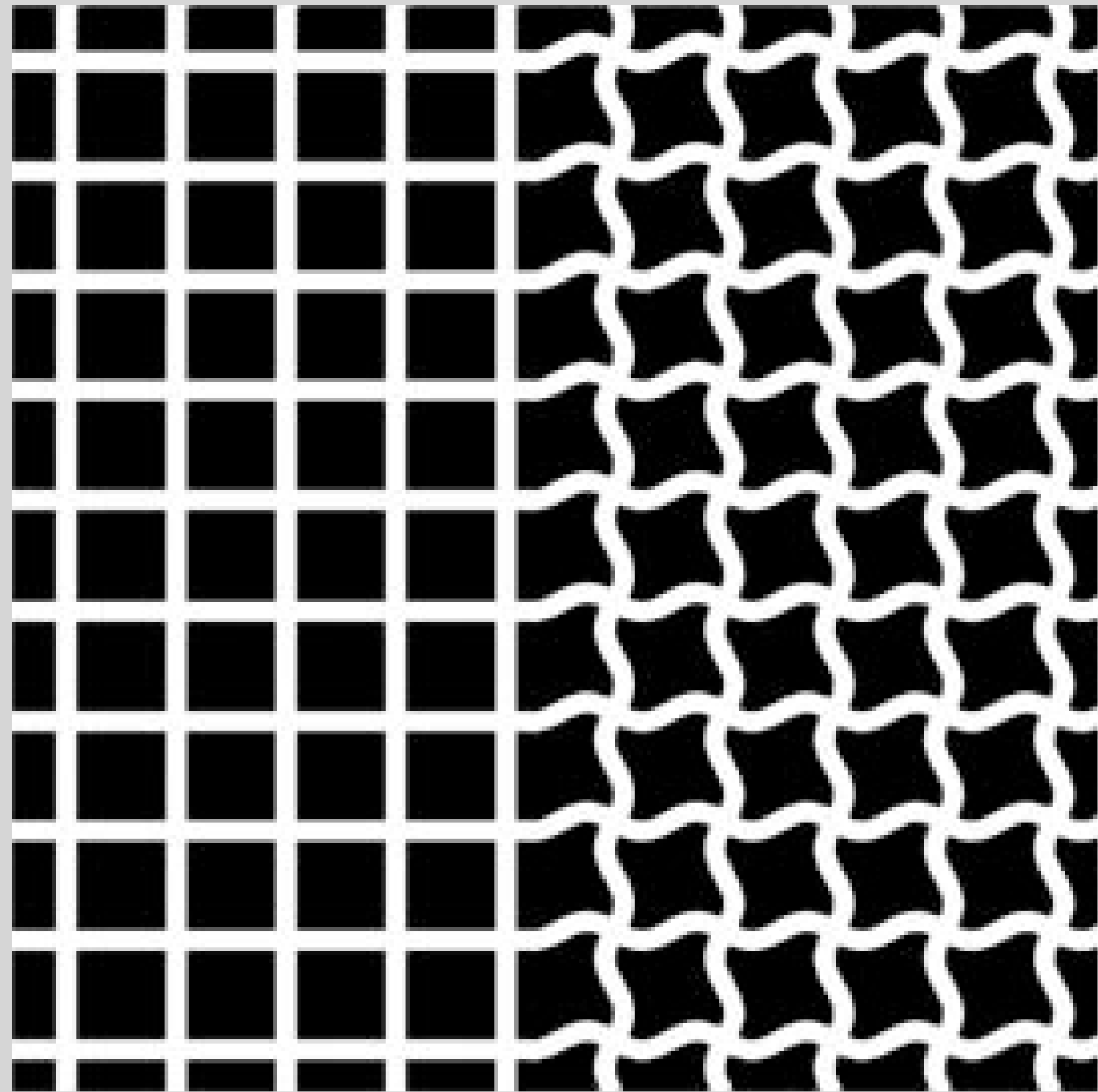
Count the
black dots on
odd-numbered
rows

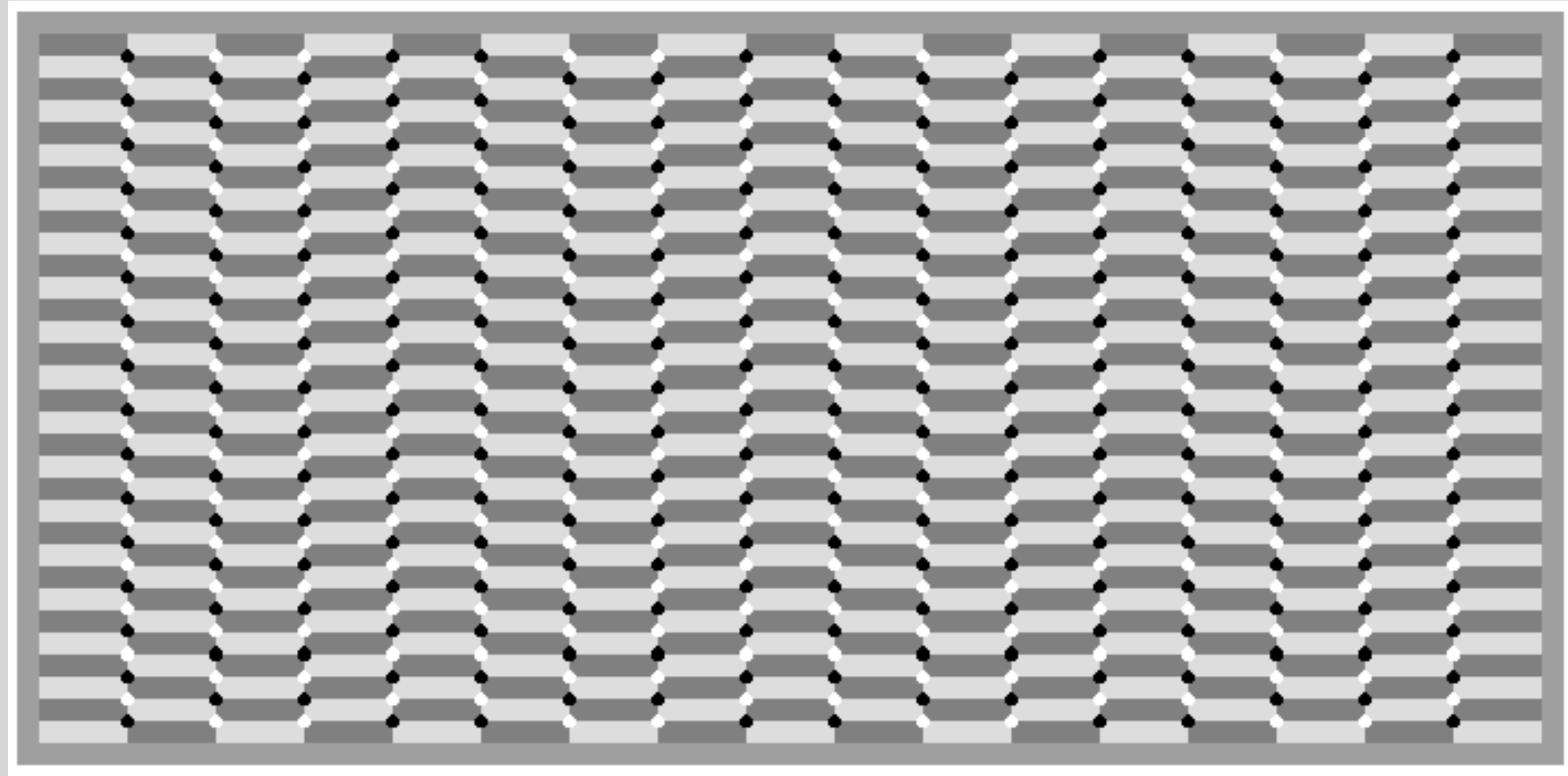


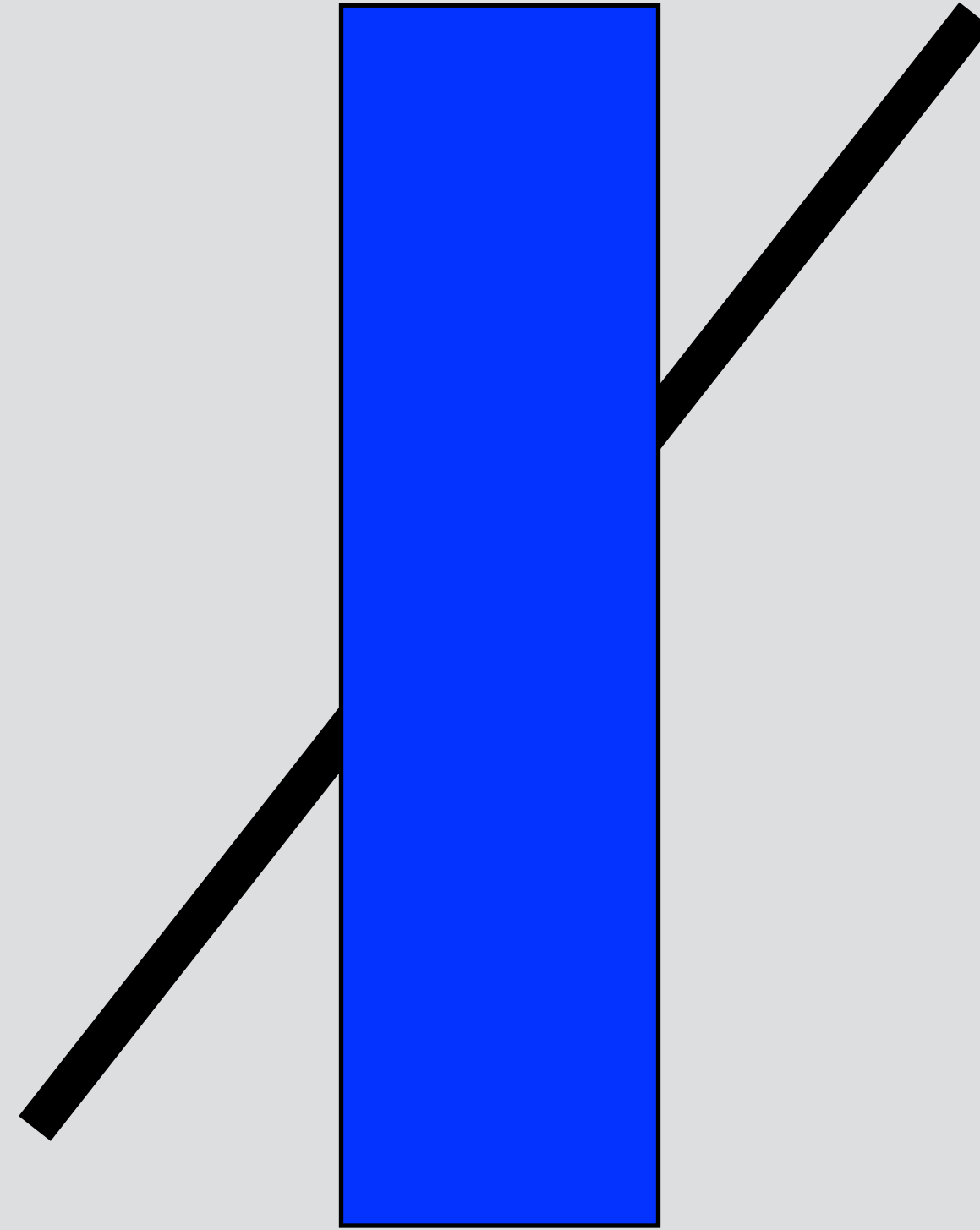
1
2 Count the
3 black dots on
4 even-numbered
5 rows
6
7

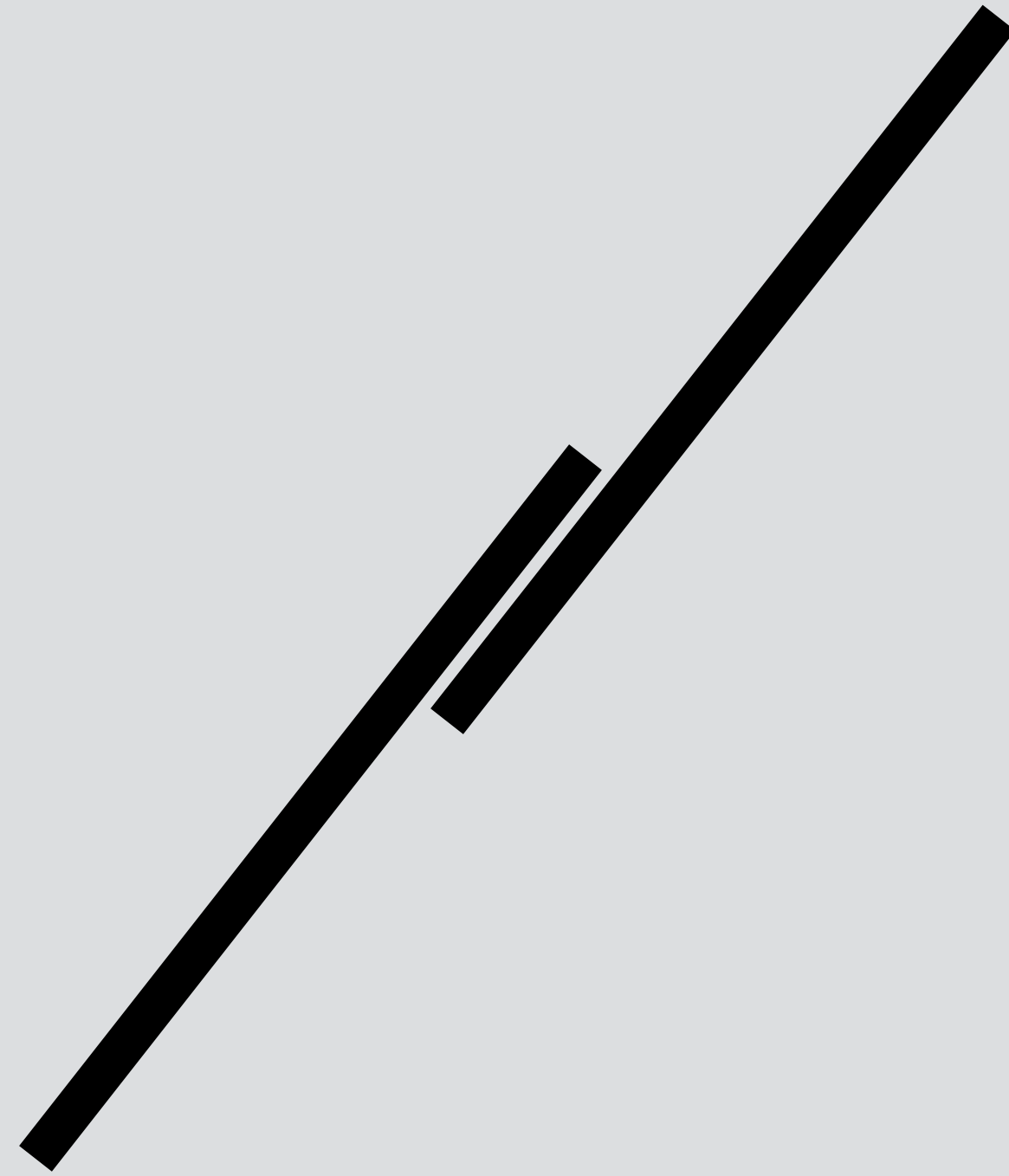


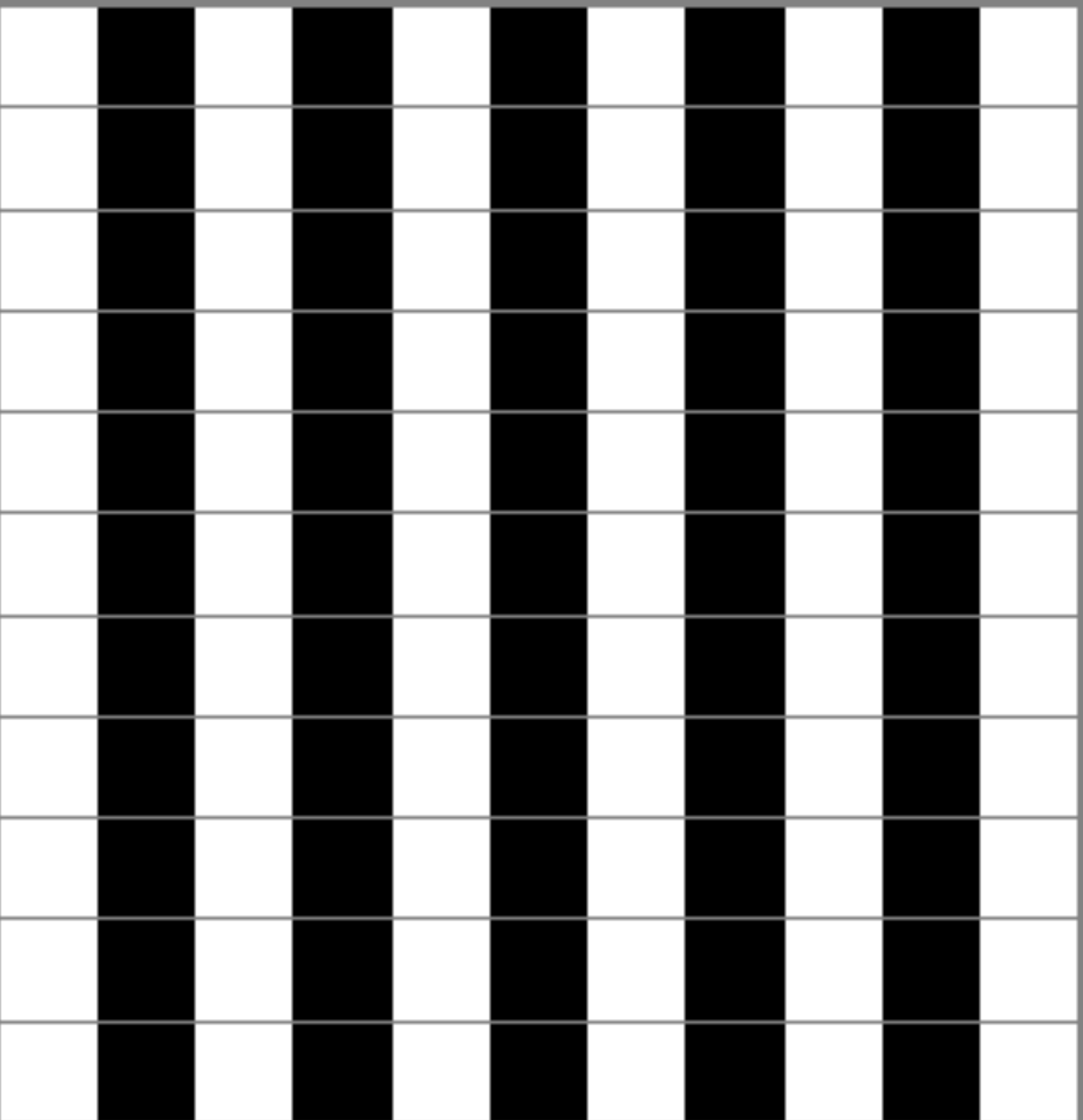
Ninio, J., & Stevens, K. A. (2000). Variations on the Hermann Grid: An Extinction Illusion. *Perception*, 29(10), 1209-1217. doi: 10.1068/p2985







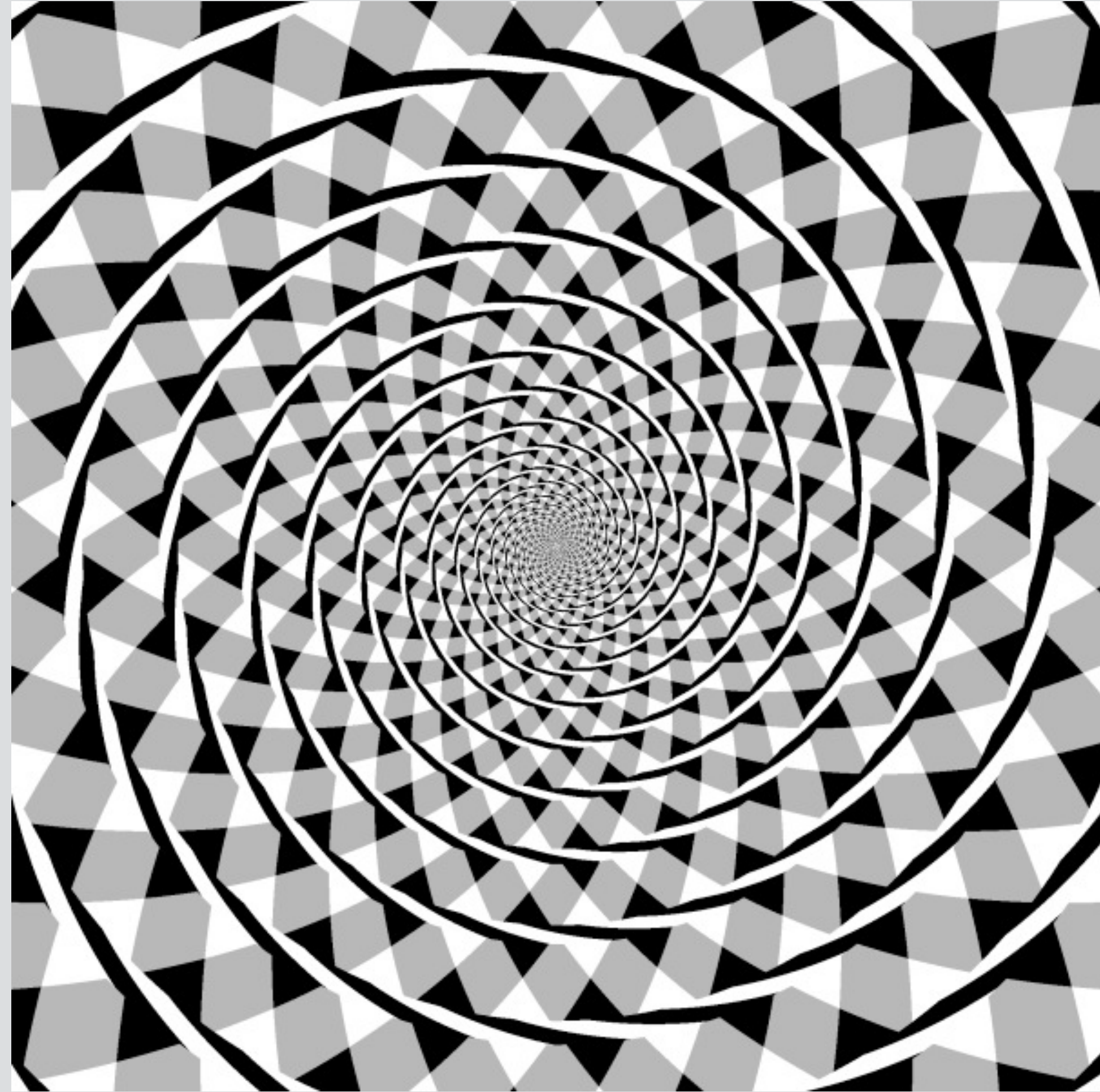




1

θ : 0.00 deg

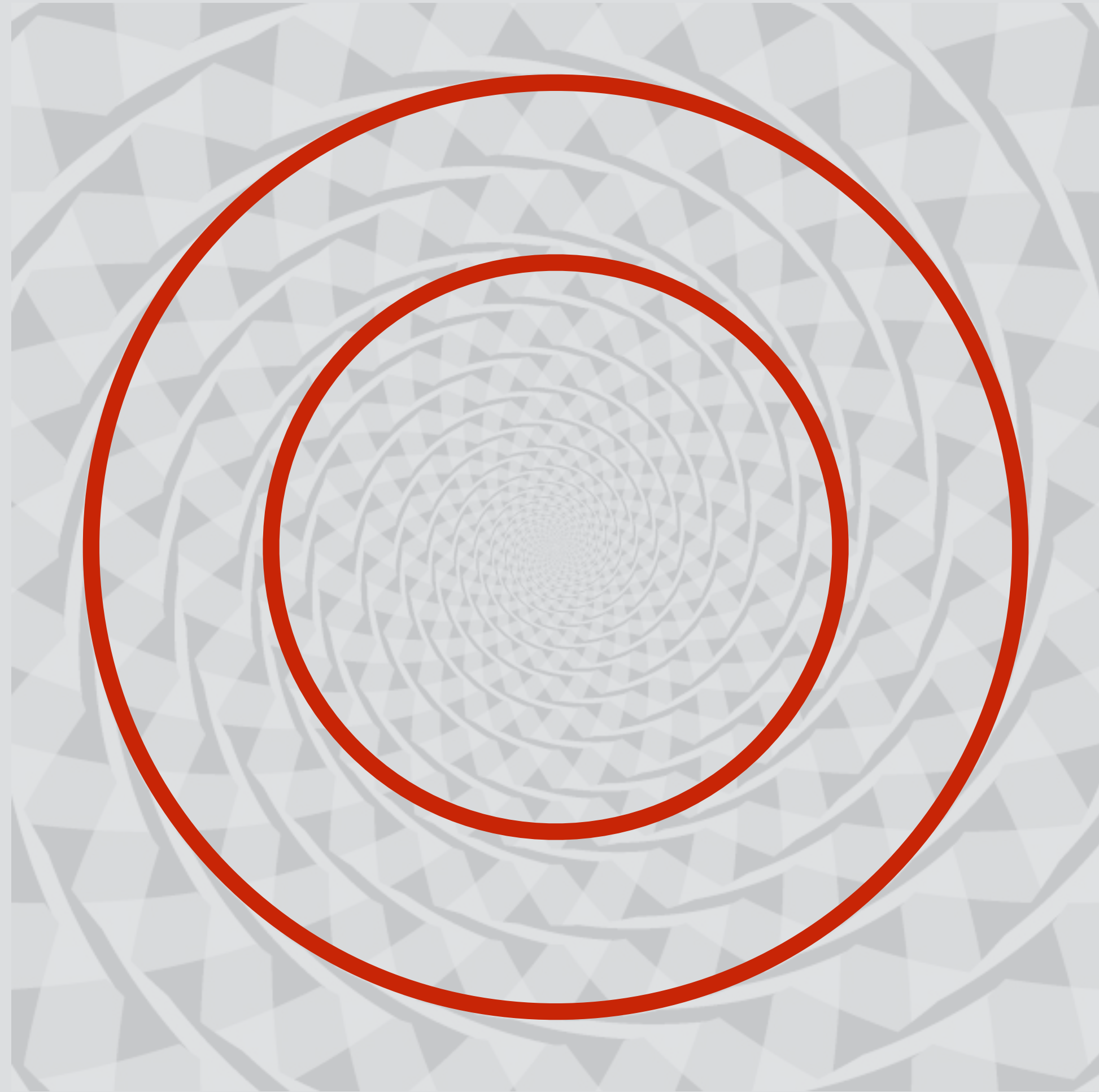
ϕ : 0.00



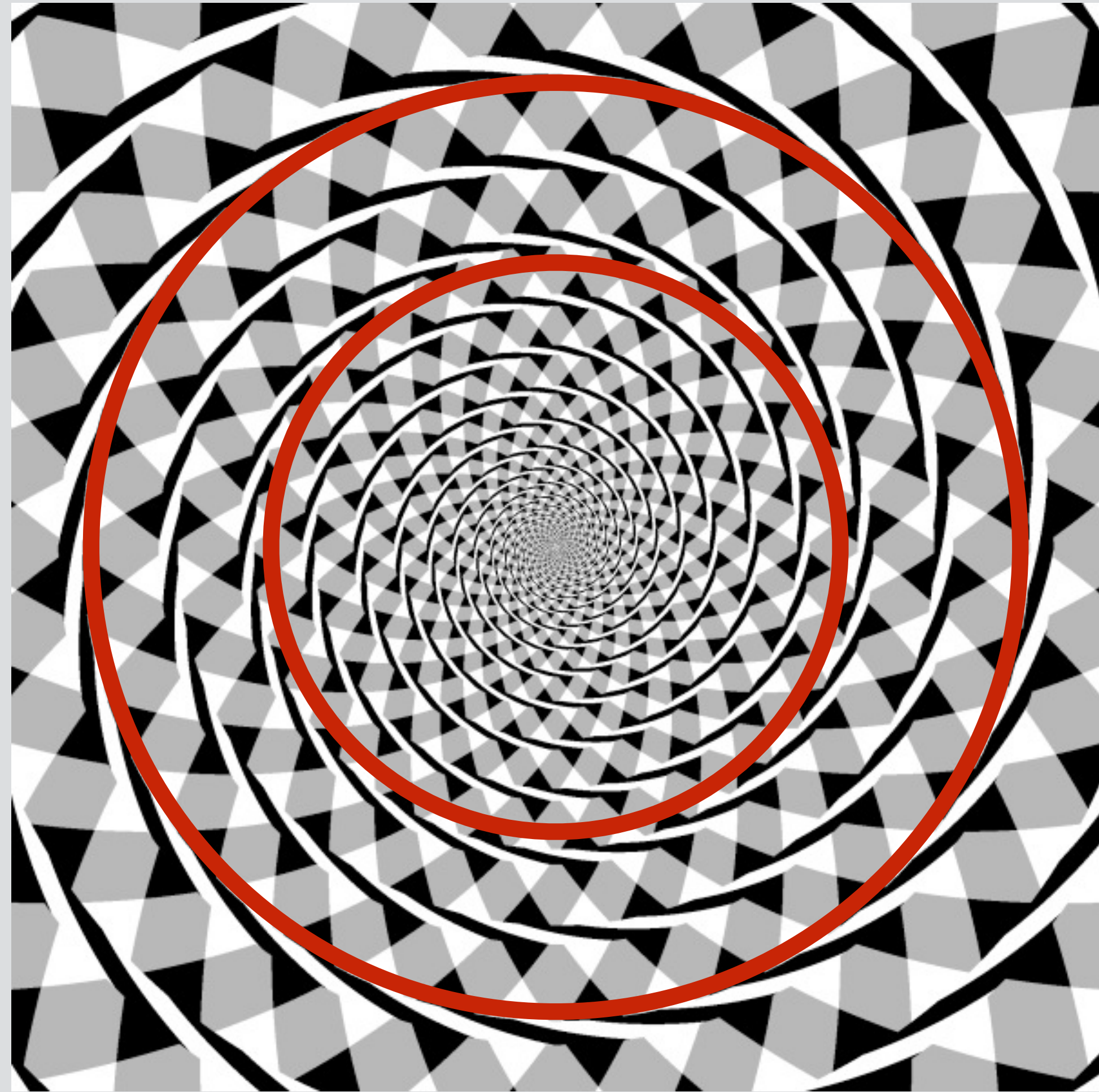
Fraser, J. (1908). A new visual illusion of direction. *British Journal of Psychology*, 2, 307–320.



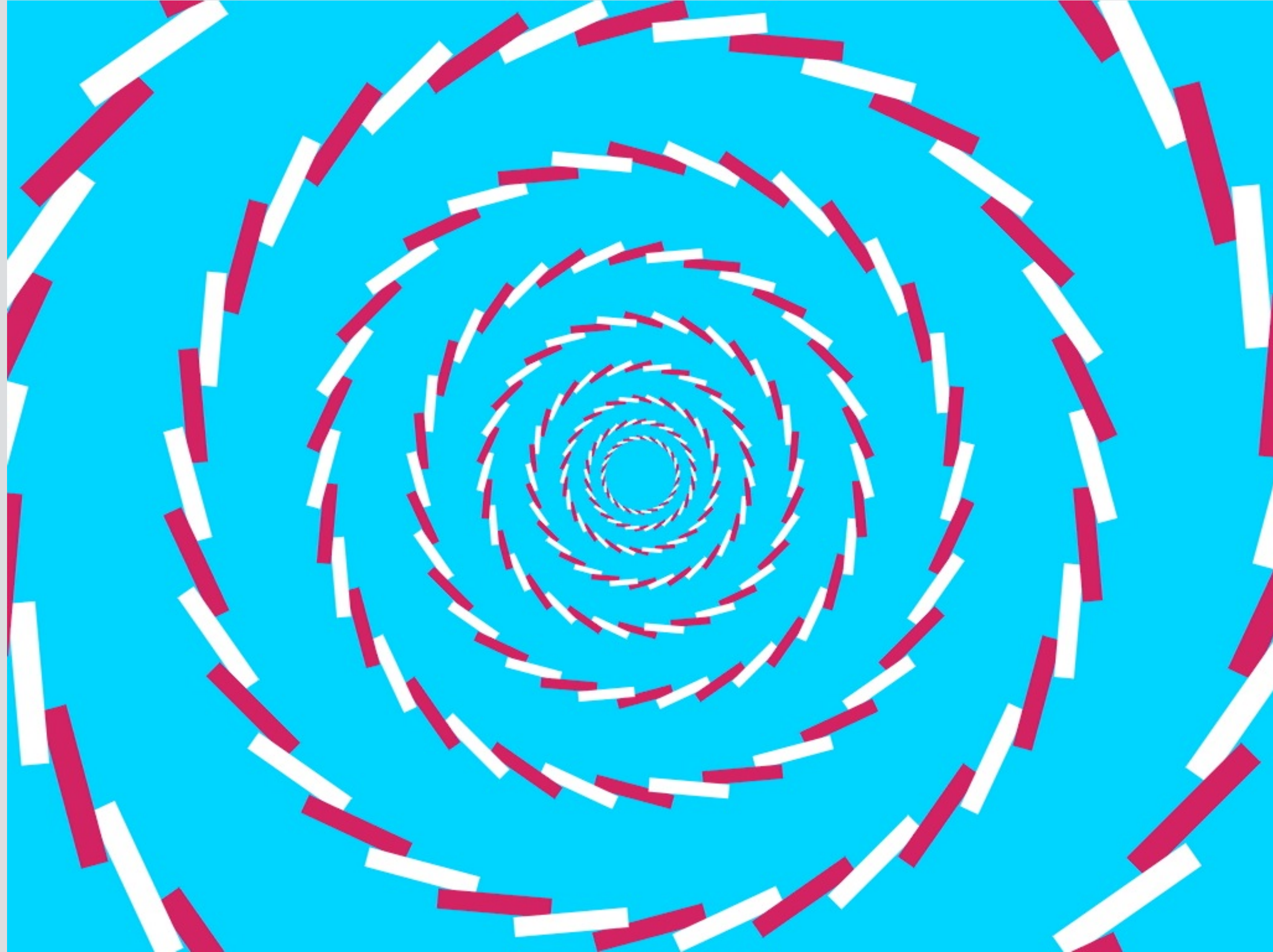
Fraser, J. (1908). A new visual illusion of direction. *British Journal of Psychology*, 2, 307–320.



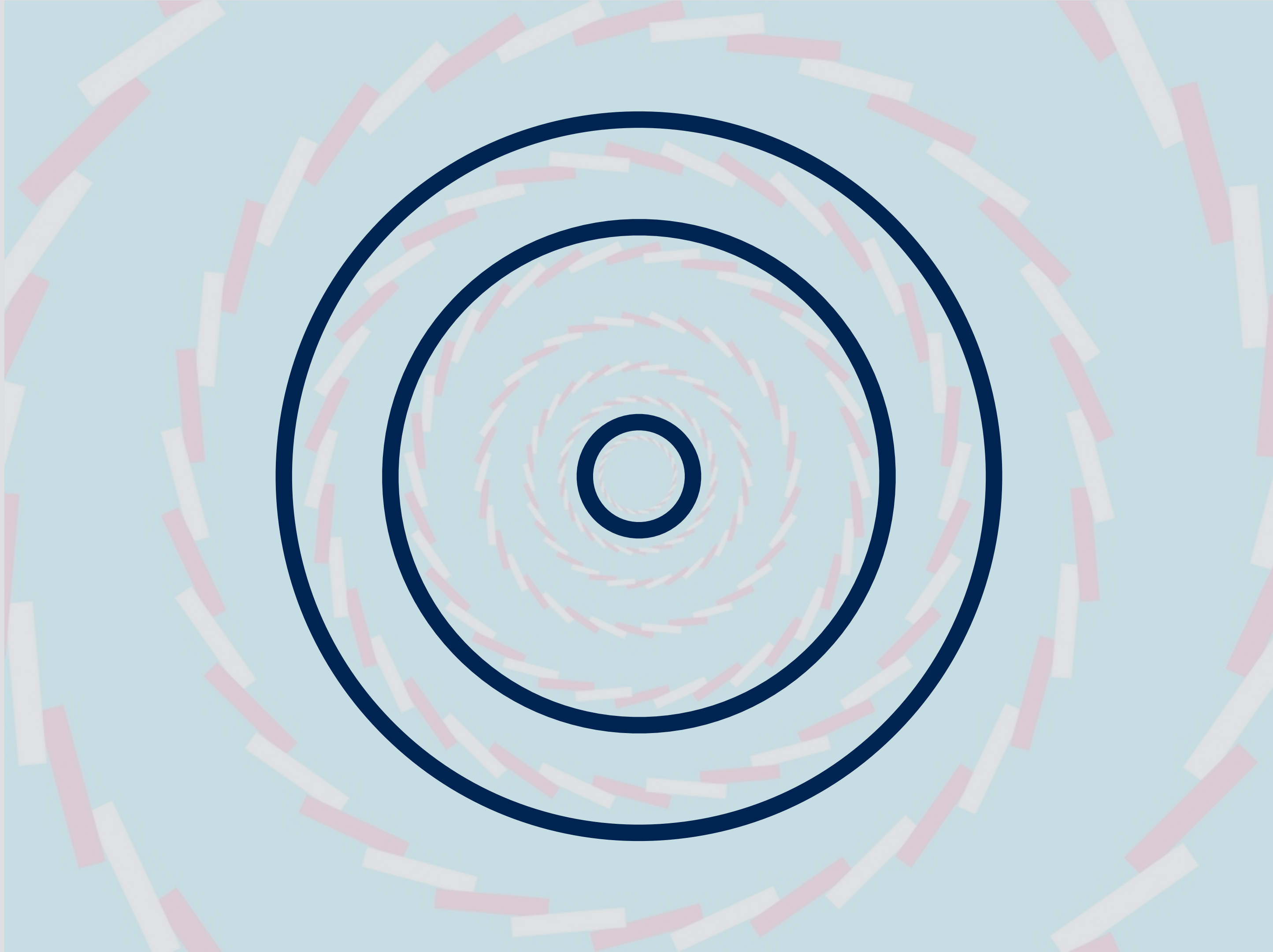
Fraser, J. (1908). A new visual illusion of direction. *British Journal of Psychology*, 2, 307–320.



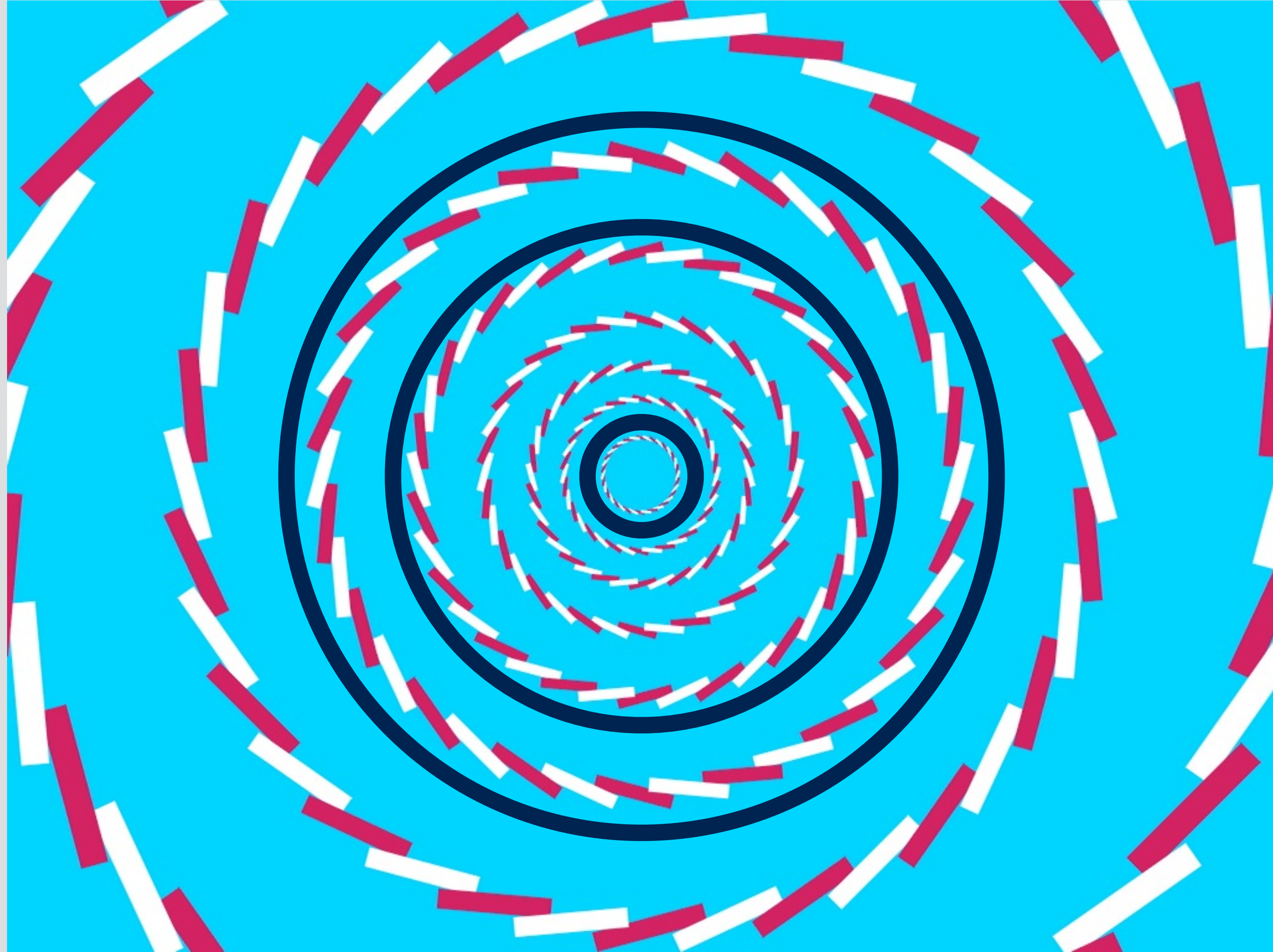
Fraser, J. (1908). A new visual illusion of direction. *British Journal of Psychology*, 2, 307–320.



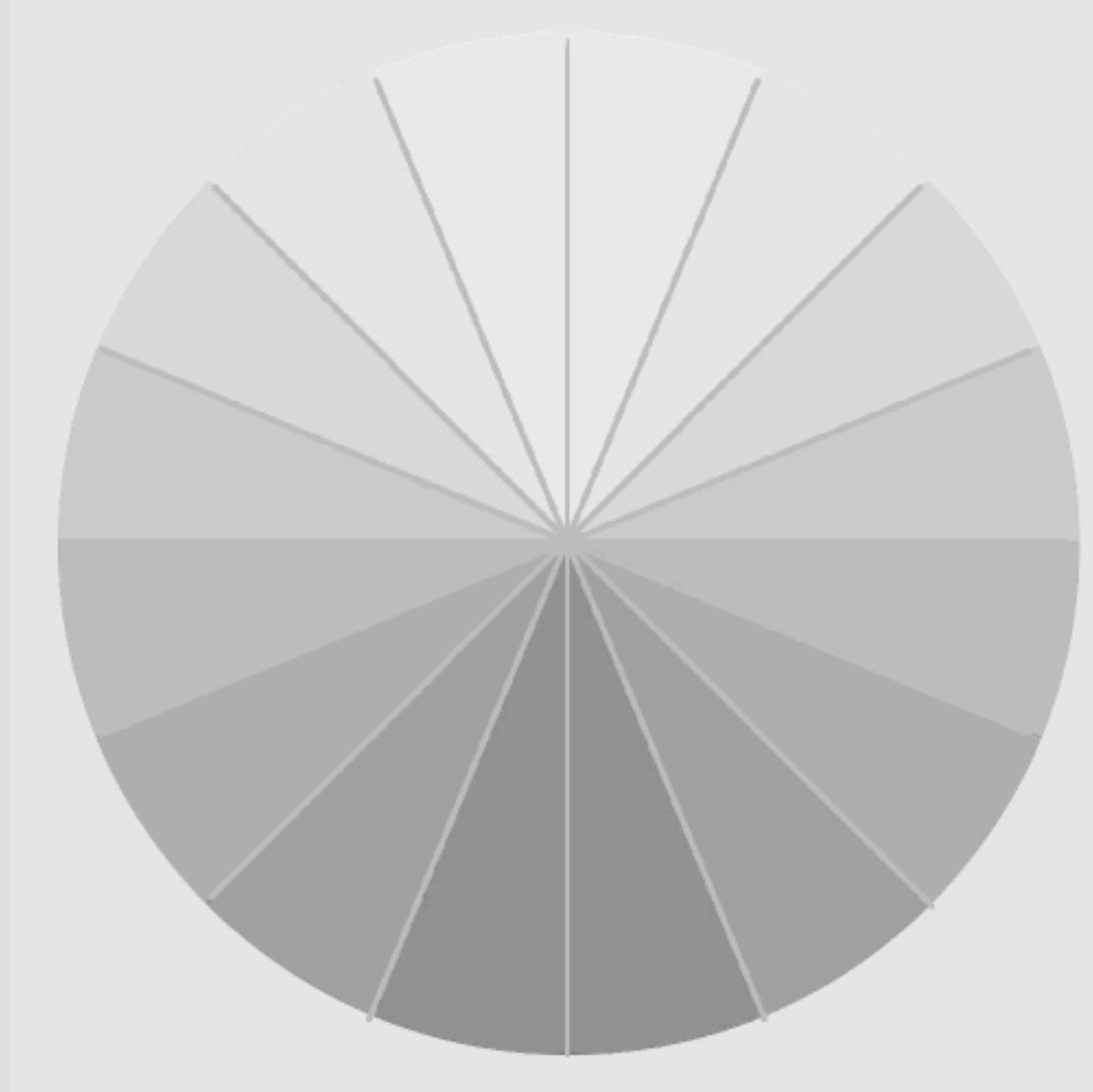
Akiyoshi Kitaoka



Akiyoshi Kitaoka

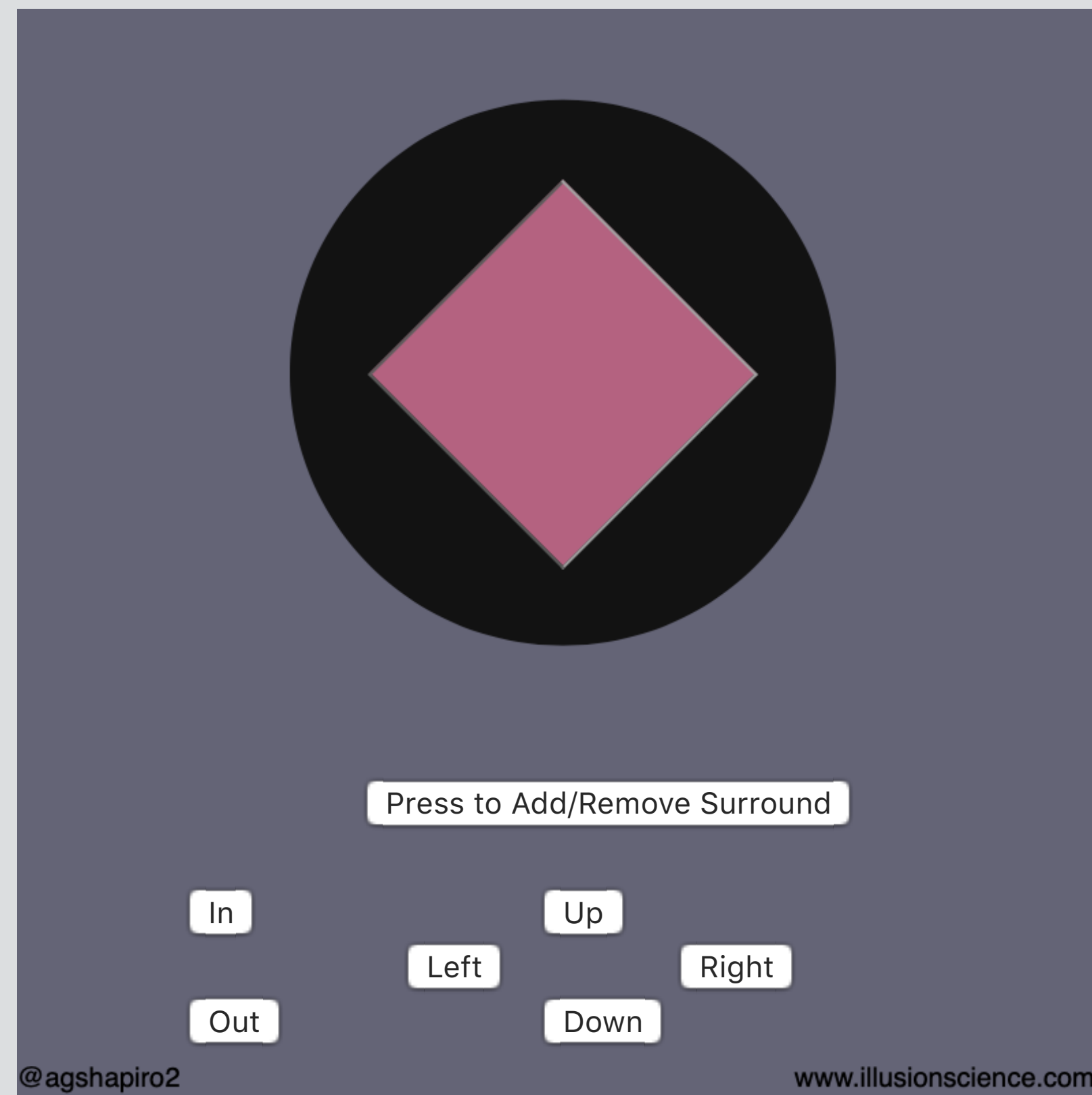


Akiyoshi Kitaoka

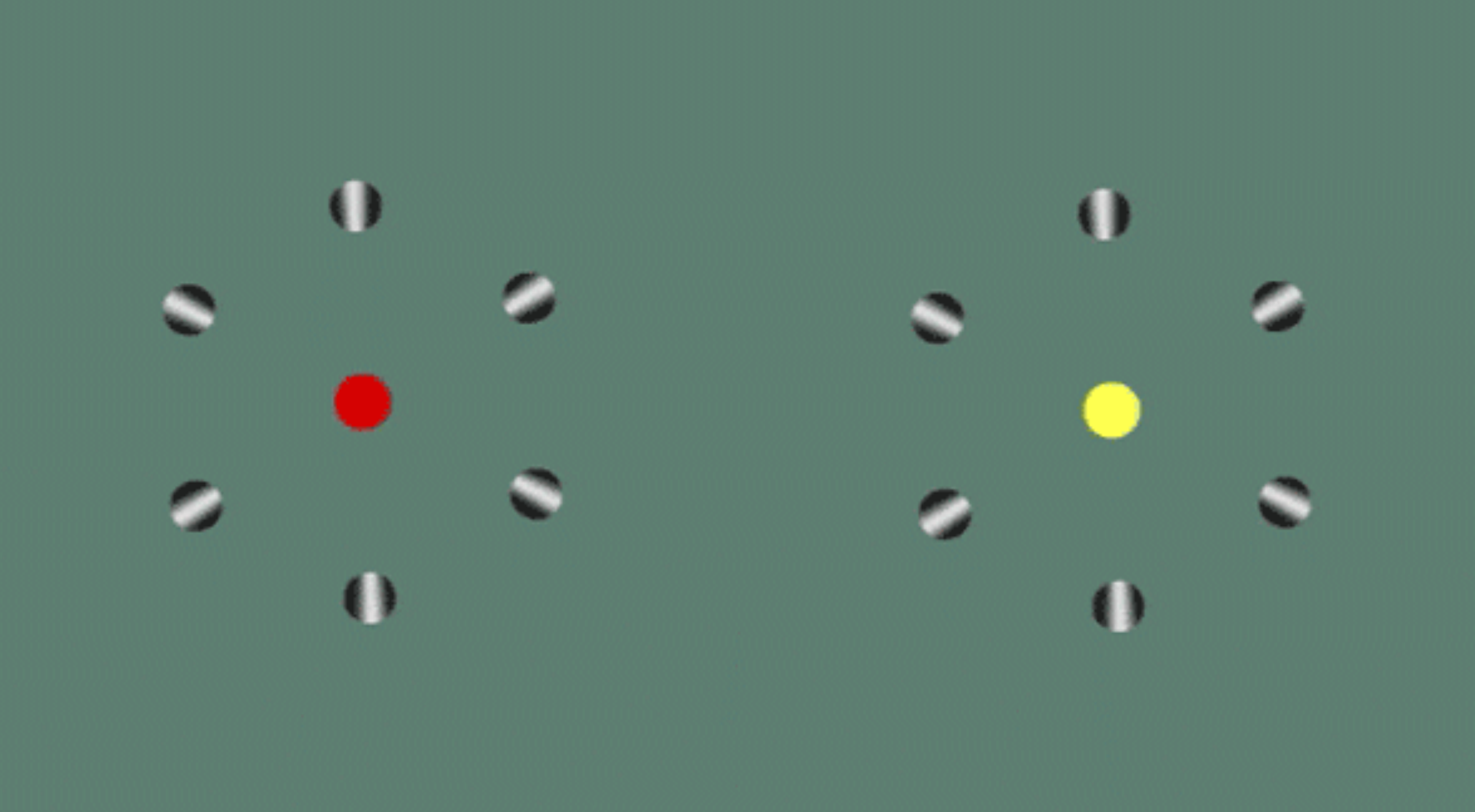


Anstis, S., & Rogers, B. (2011). Illusory rotation of a spoked wheel. *2*(7), 720-723.

The Perpetual Diamond



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



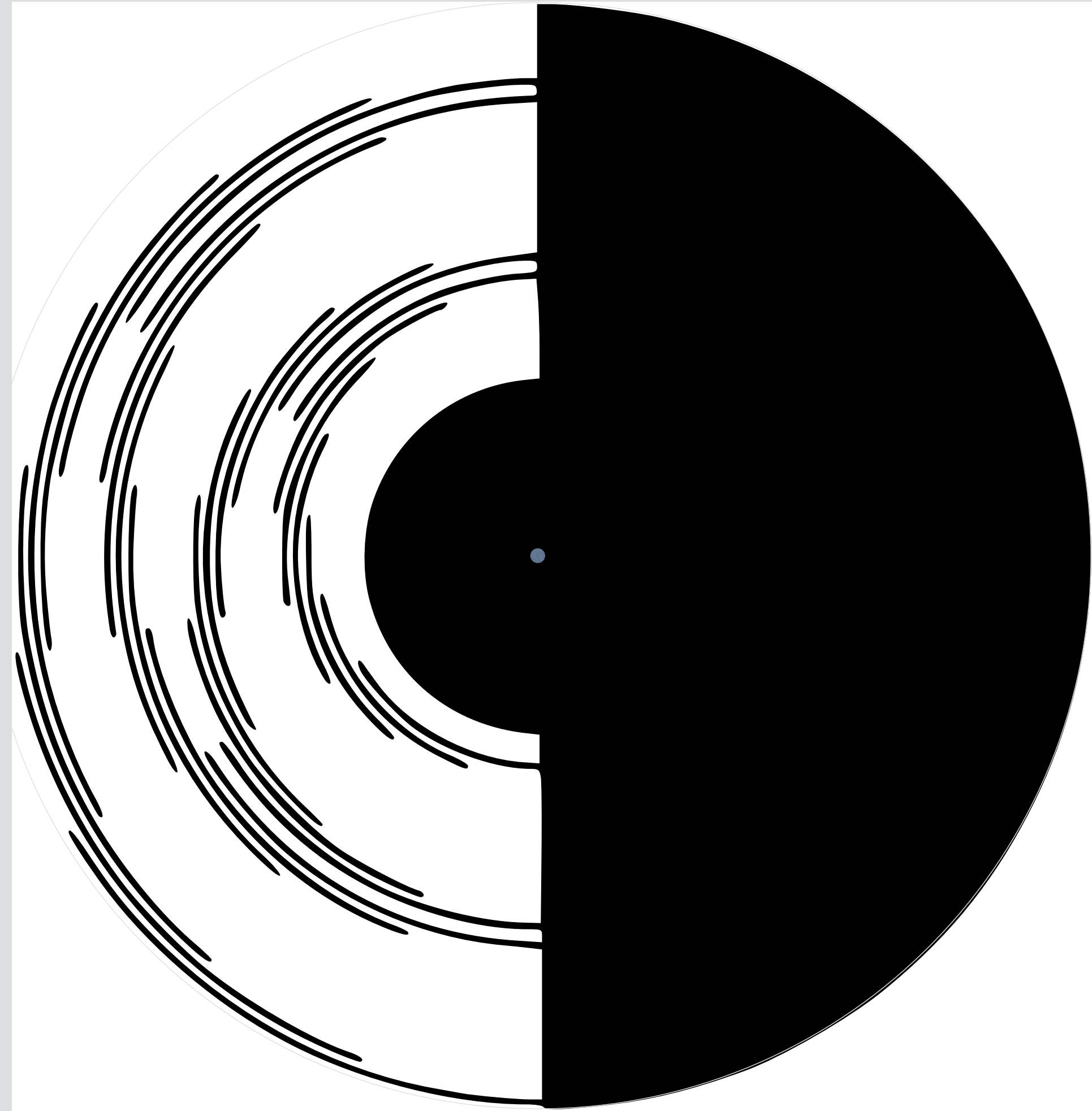
Now Let's Talk About Color

*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

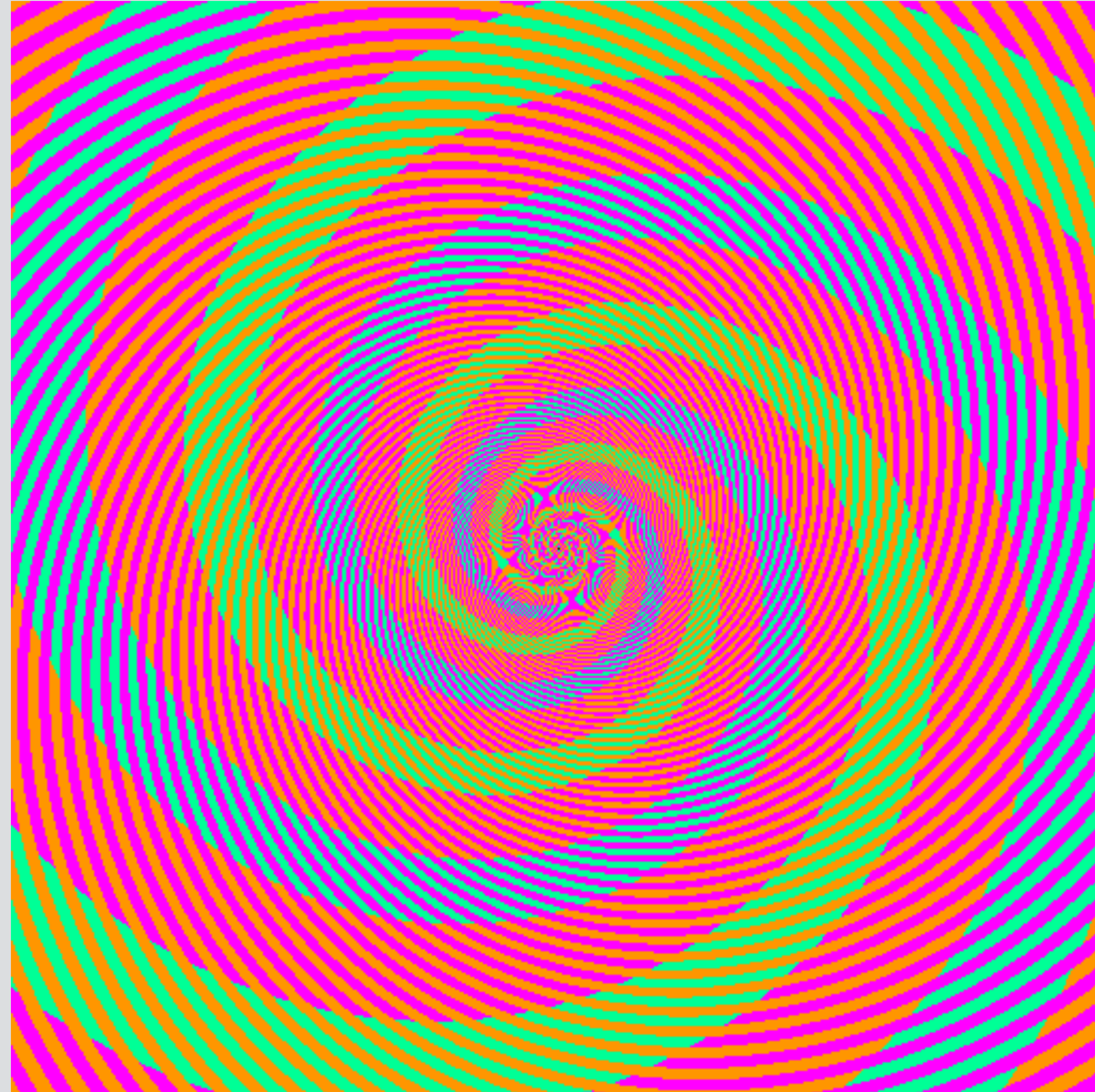
Benham's Disk



Charles E. Benham 1894



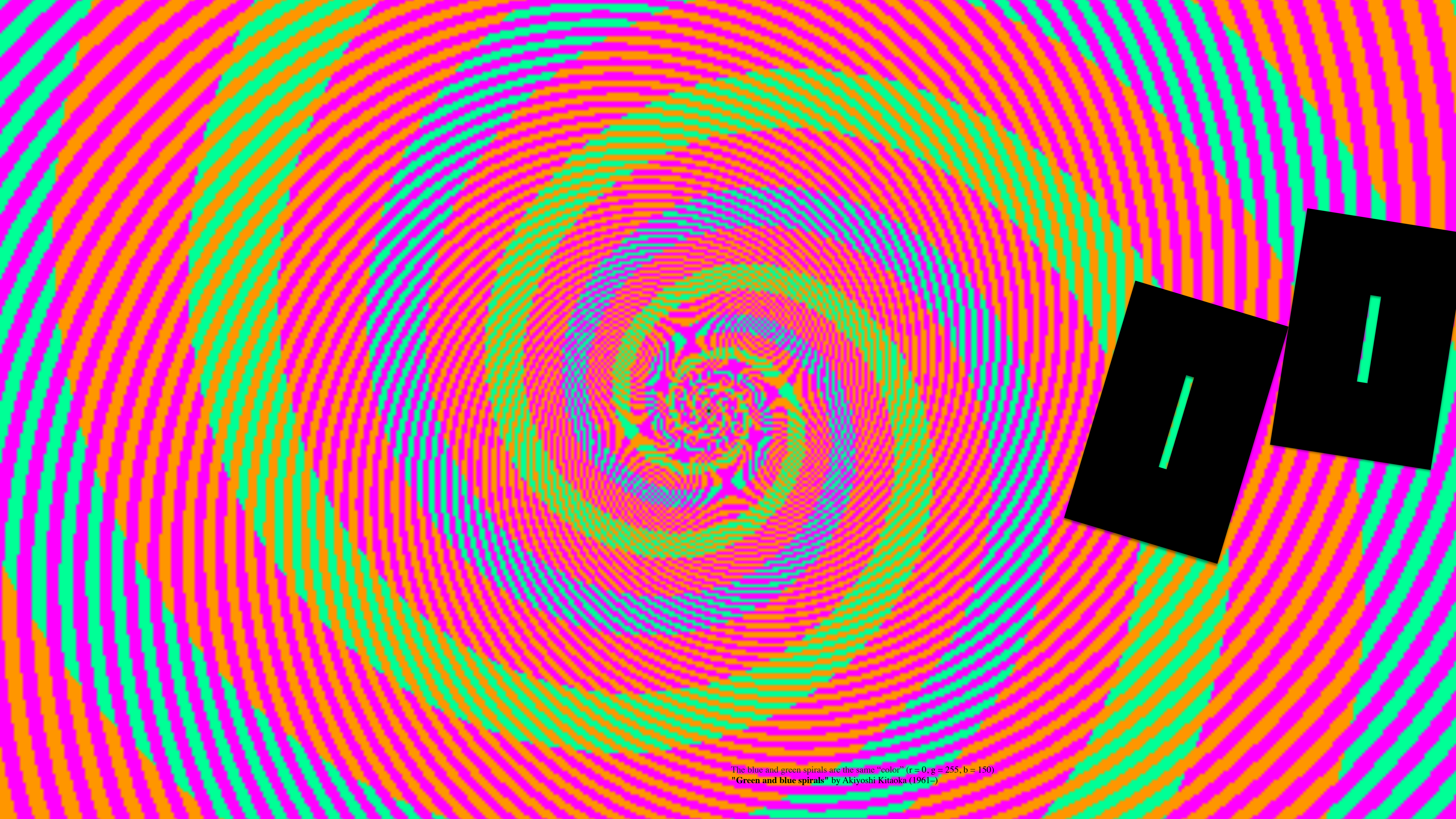
Demo



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

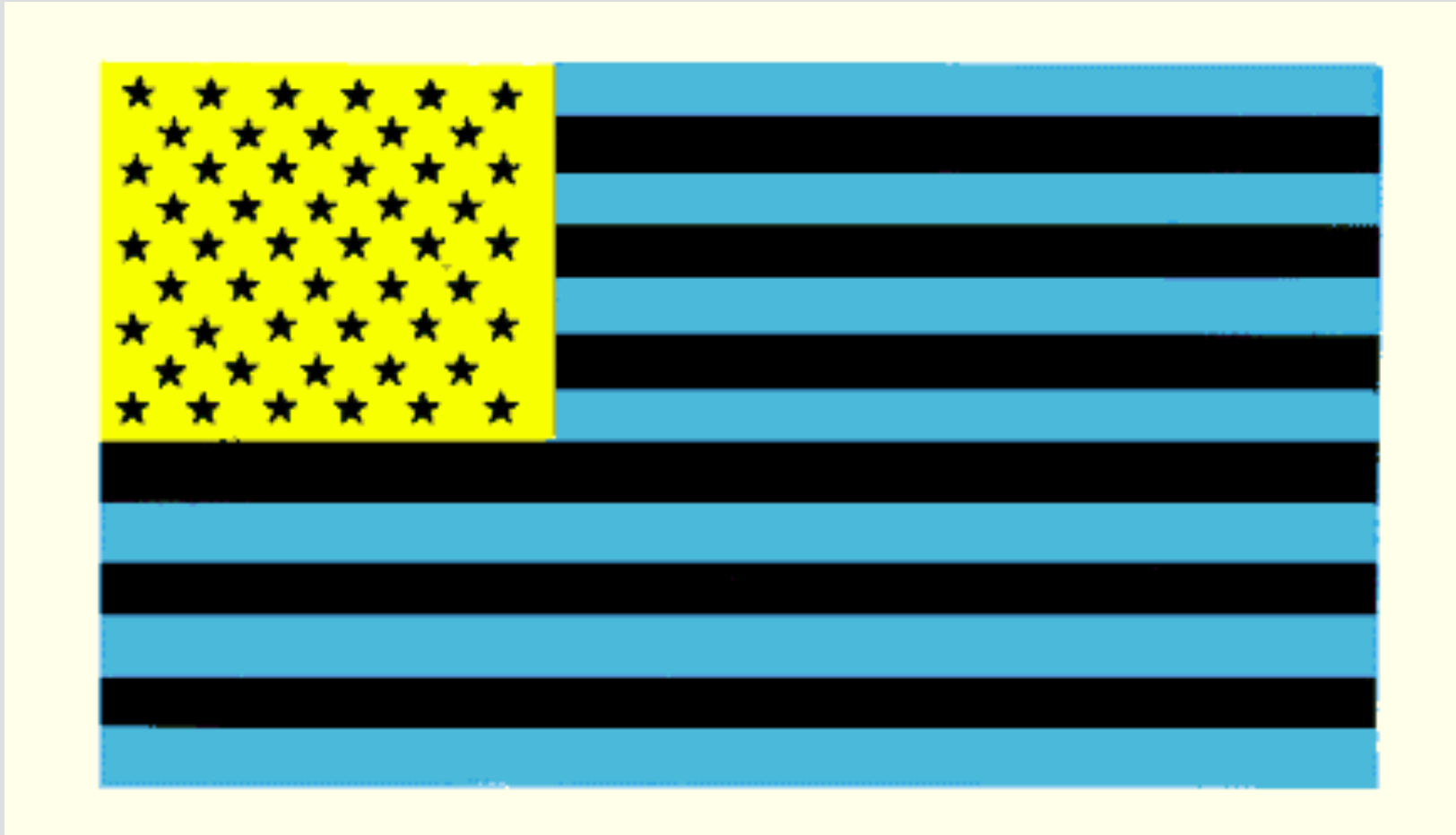


The blue and green spirals are the same "color" ($r = 0, g = 255, b = 150$)
"Green and blue spirals" by Akiyoshi Kitaoka (1961-)

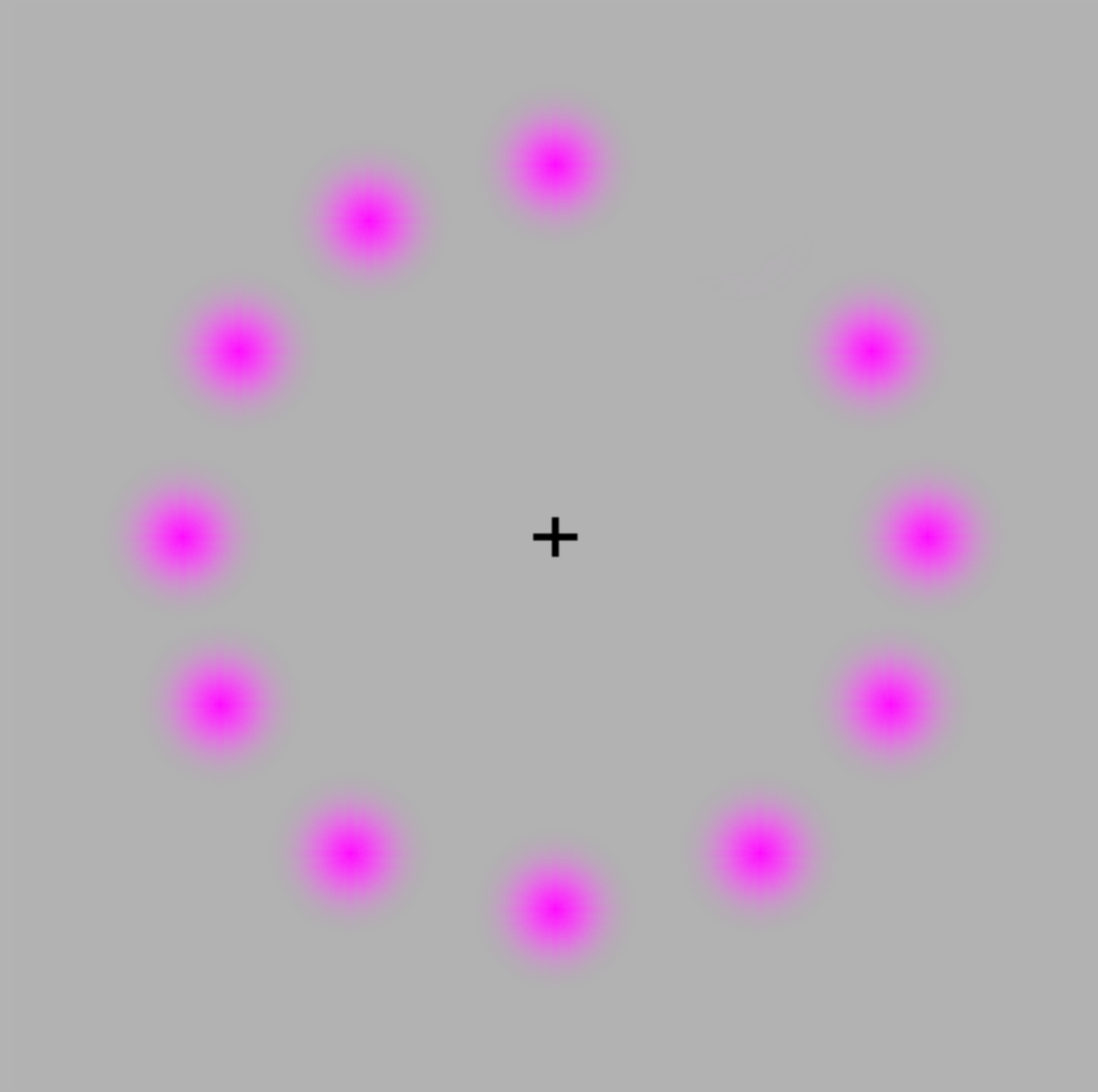


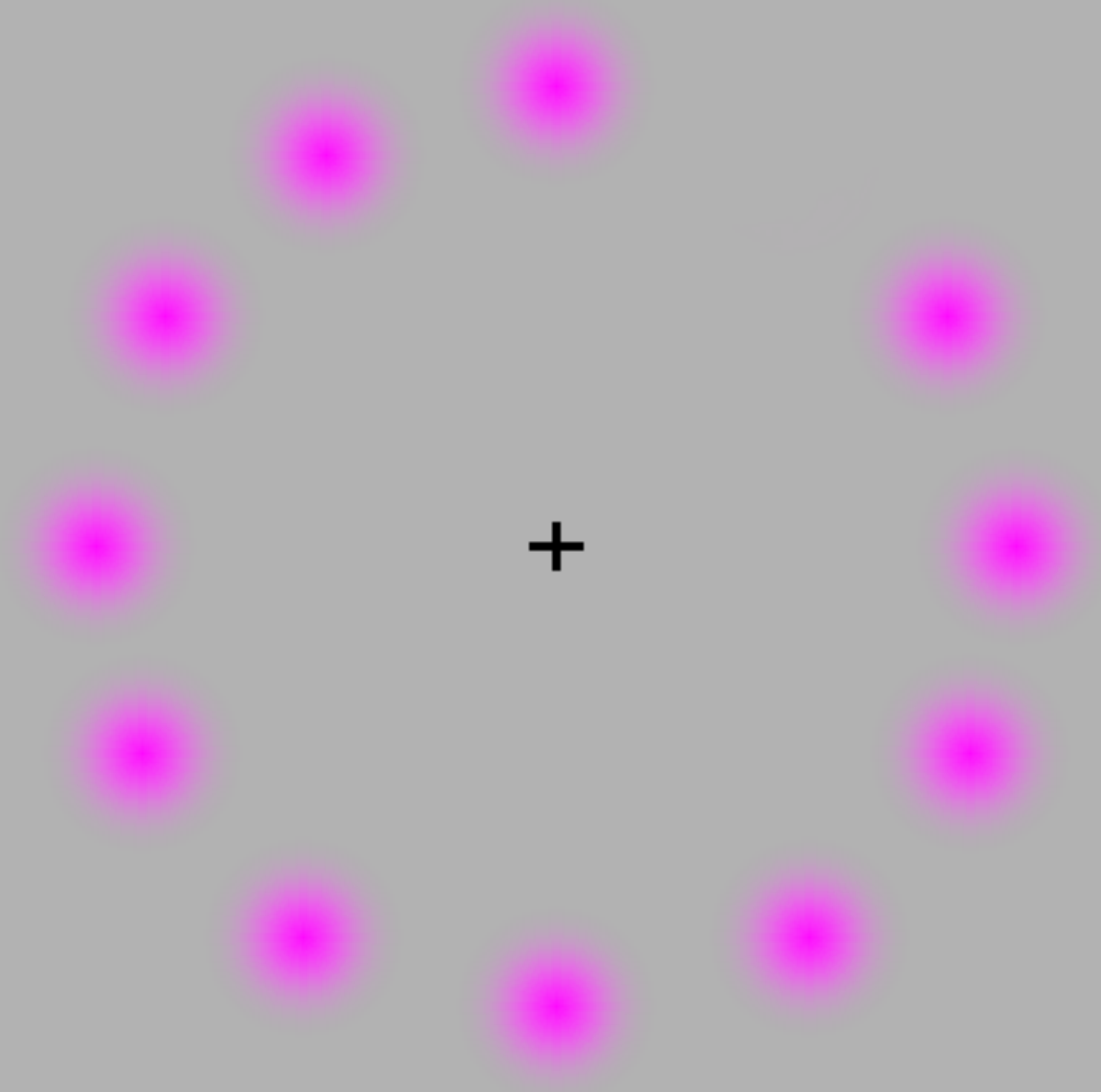
The blue and green spirals are the same "color" ($r = 0, g = 255, b = 150$)
"Green and blue spirals" by Akiyoshi Kitaoka (1961-)

Complimentary Afterimages









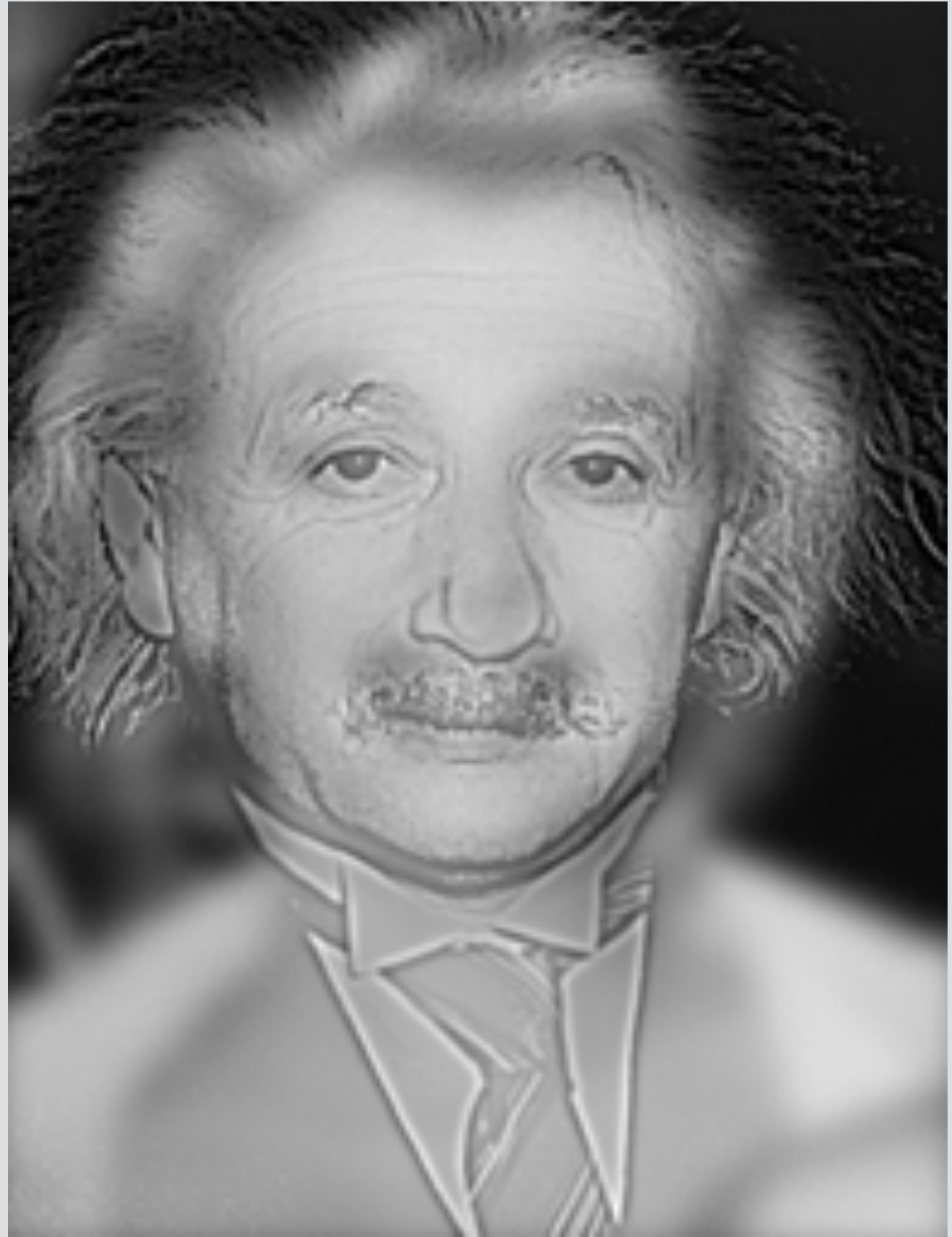
John Sadowski







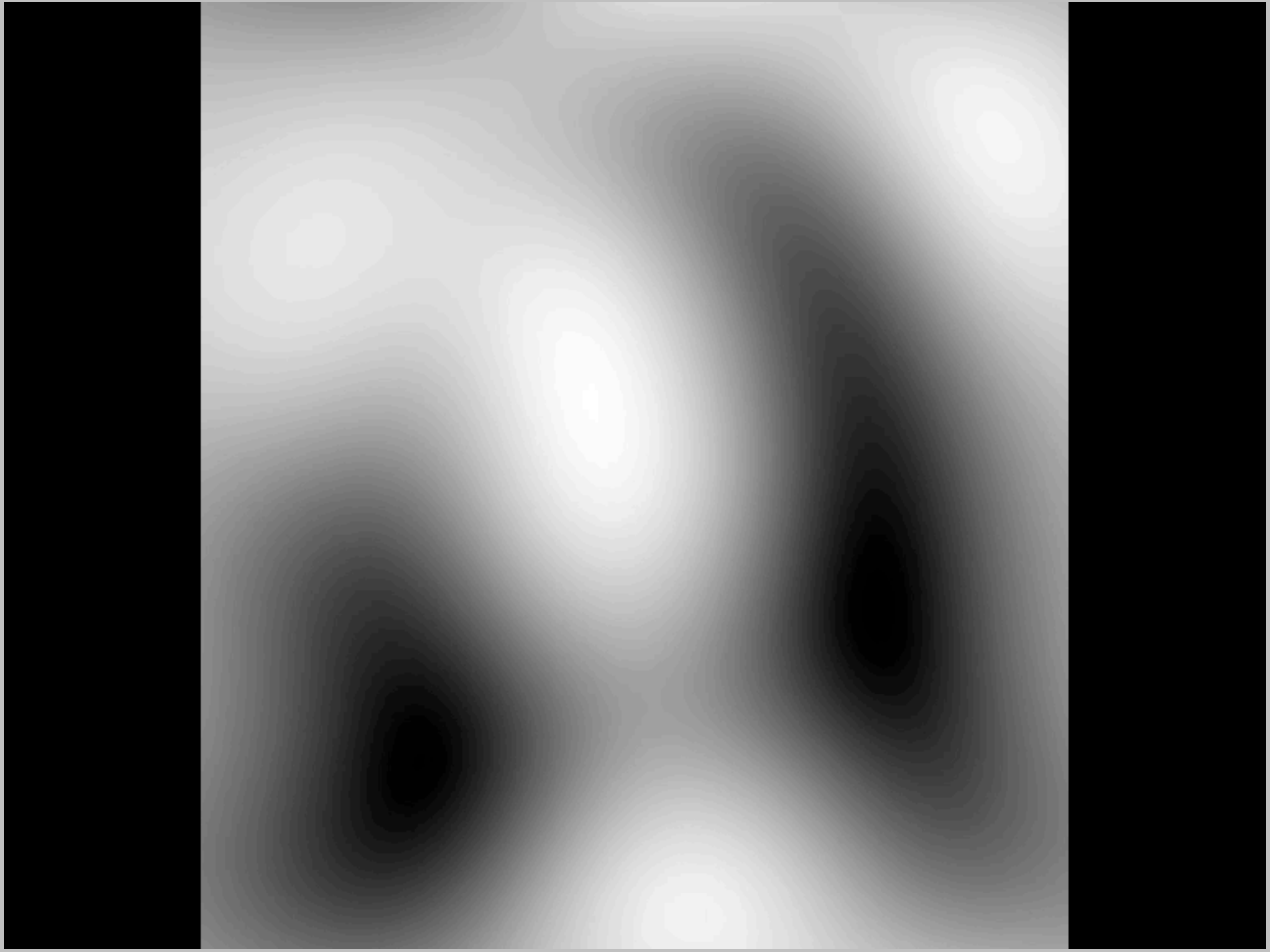
Separate streams for different
sizes

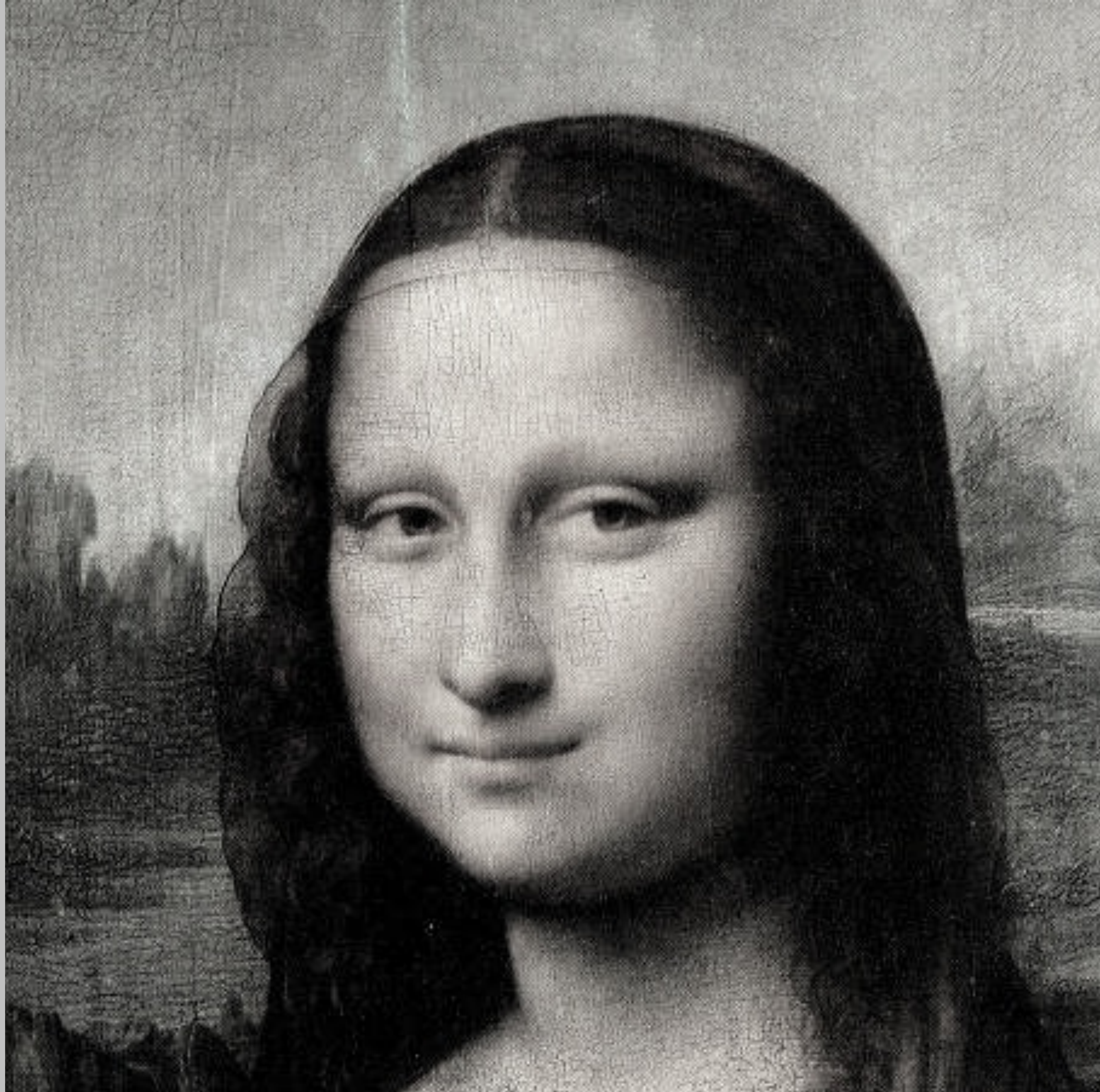












Faces are special

96%



91%



85%



90%



Mean Percent Correct

82%



86%



84%



86

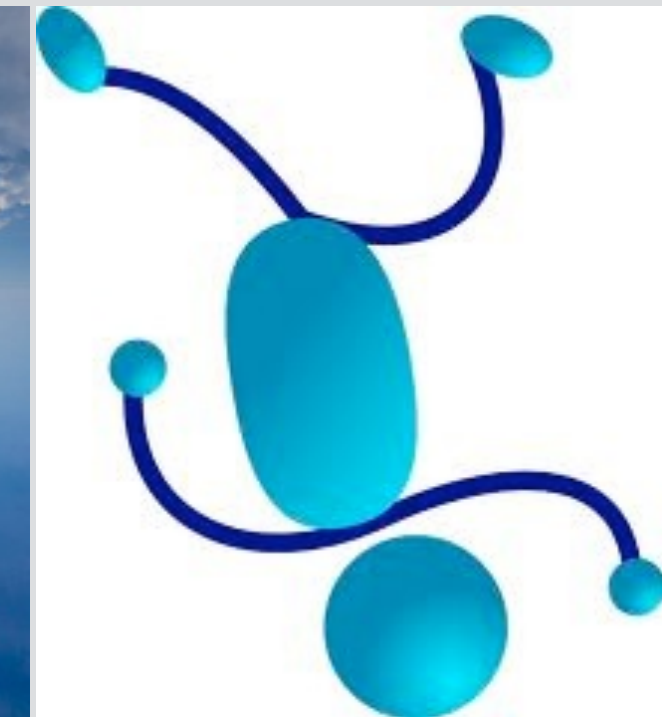




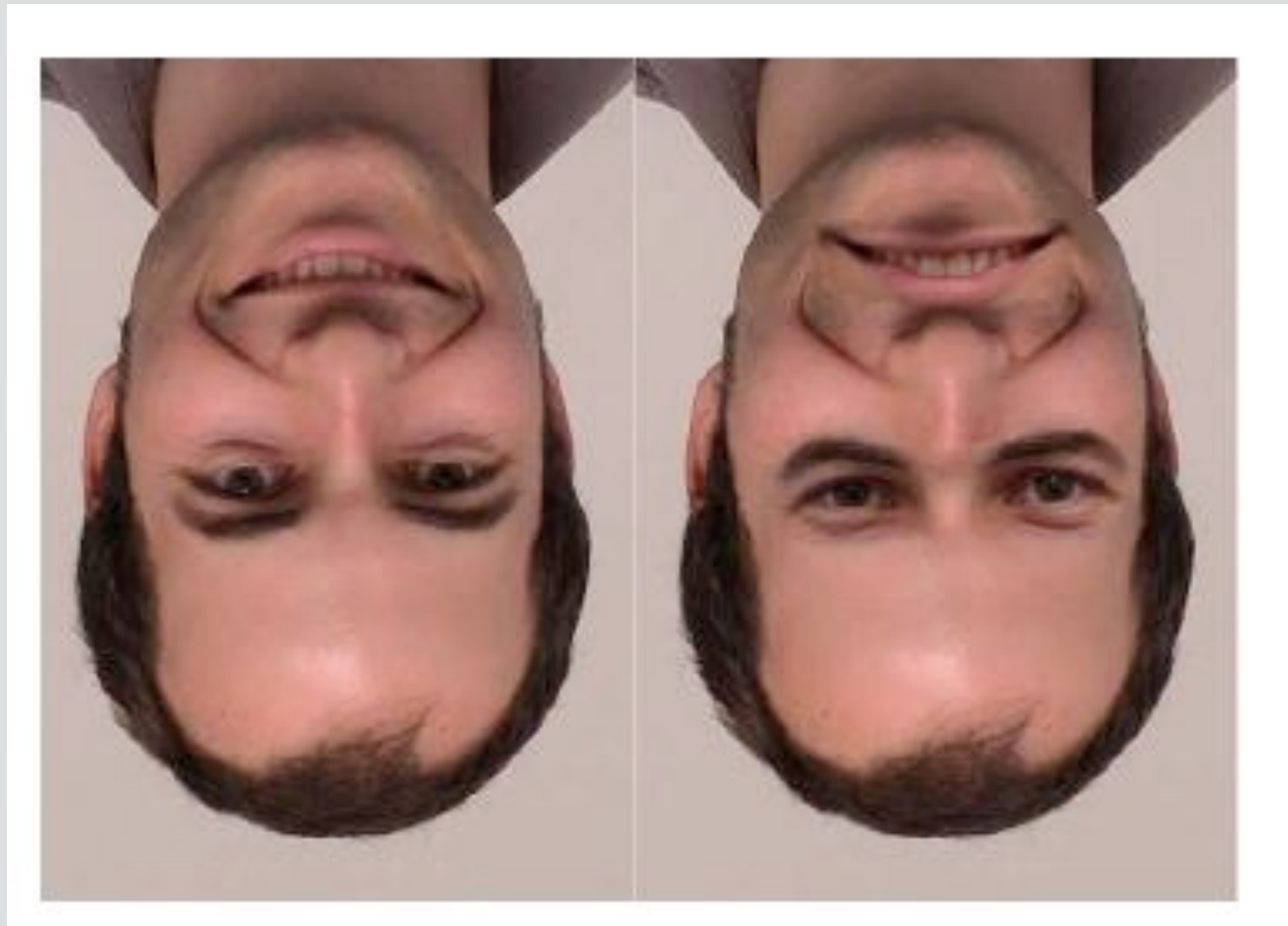
Figure 1.

Figure 2.

Figure 1.



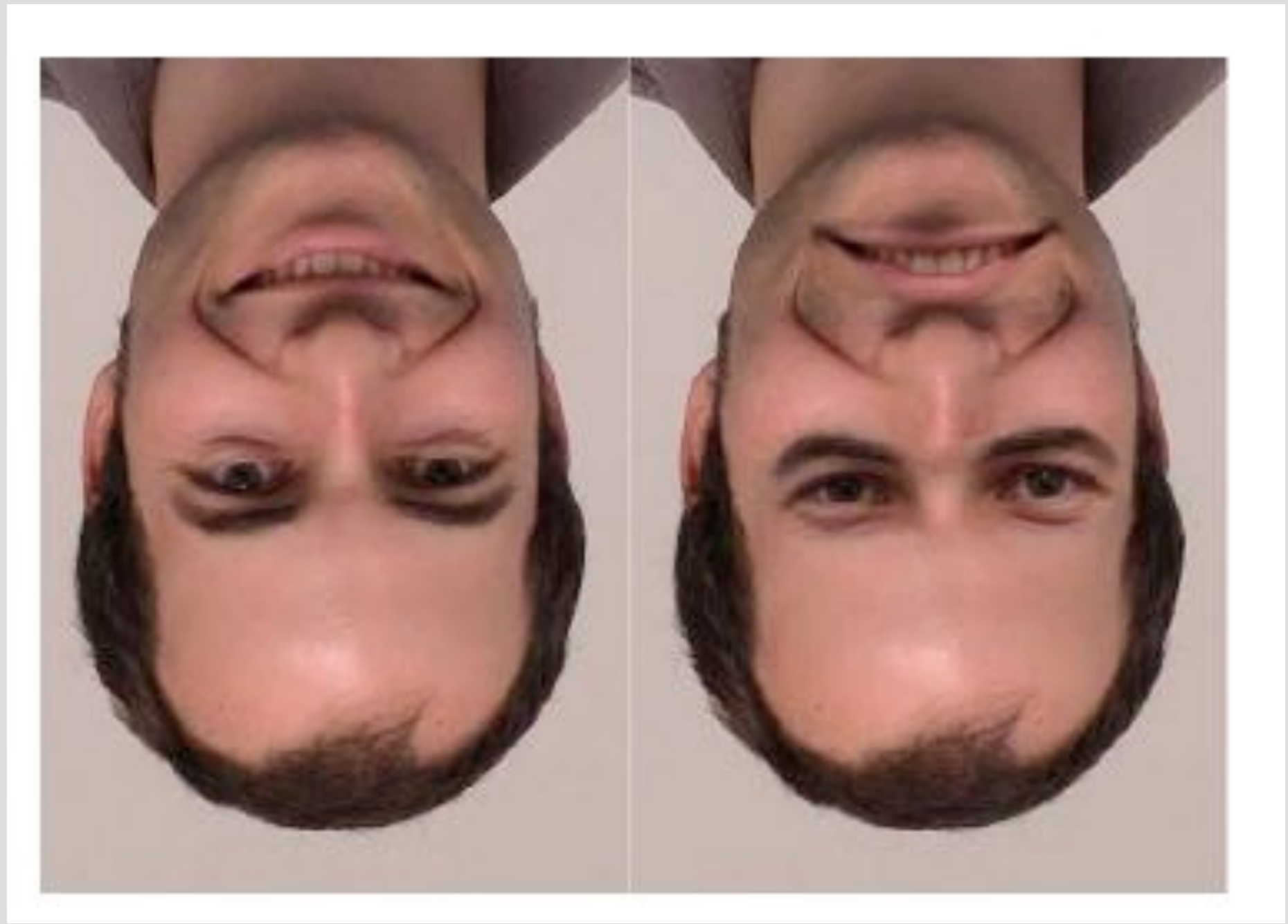
Figure 2.



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









TTTTTWO



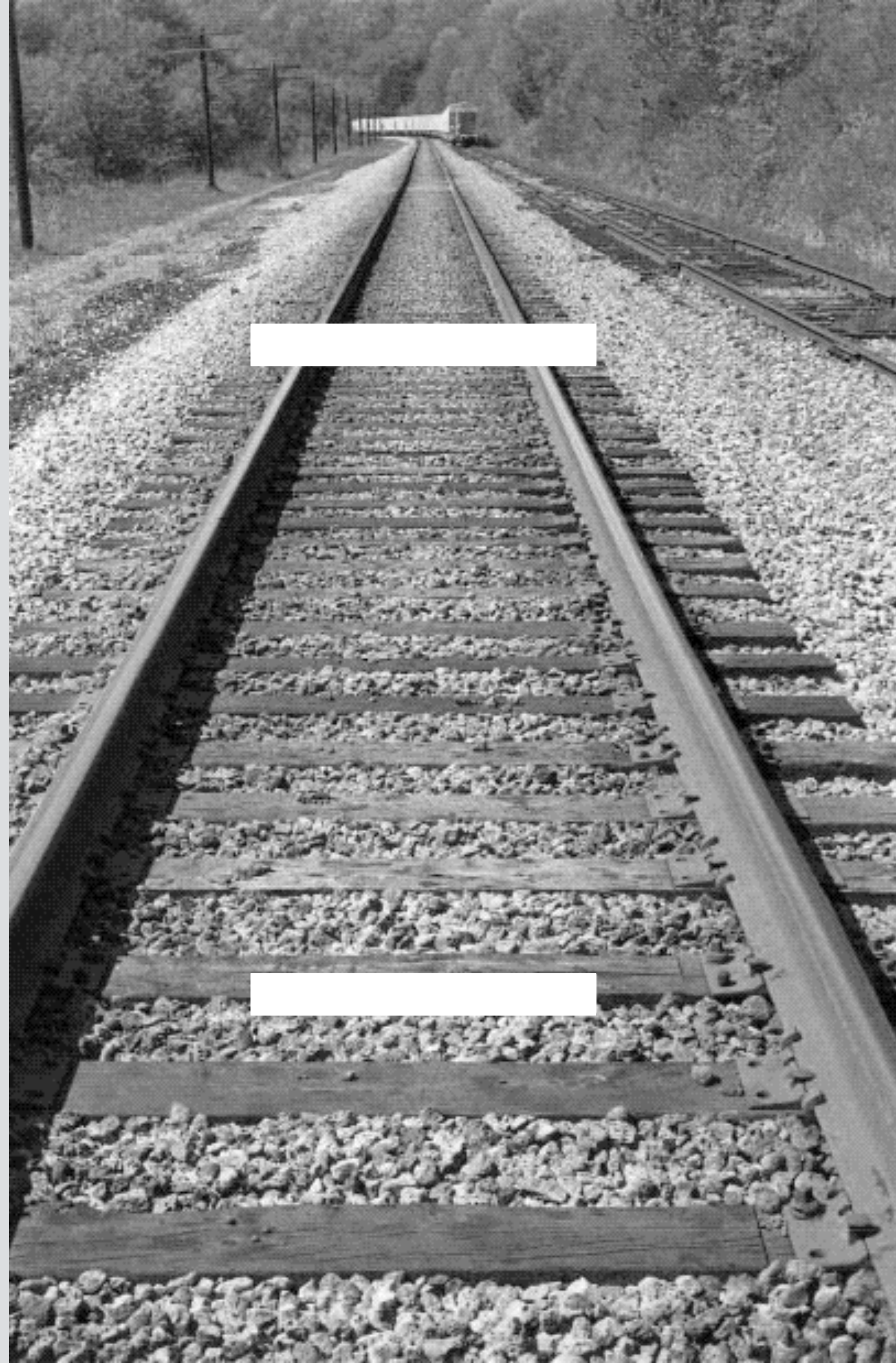
*The Likelihood Principle or
“Keep it Simple, if you can”*



Crazy Circle by brusspup

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

Size and Distance Information

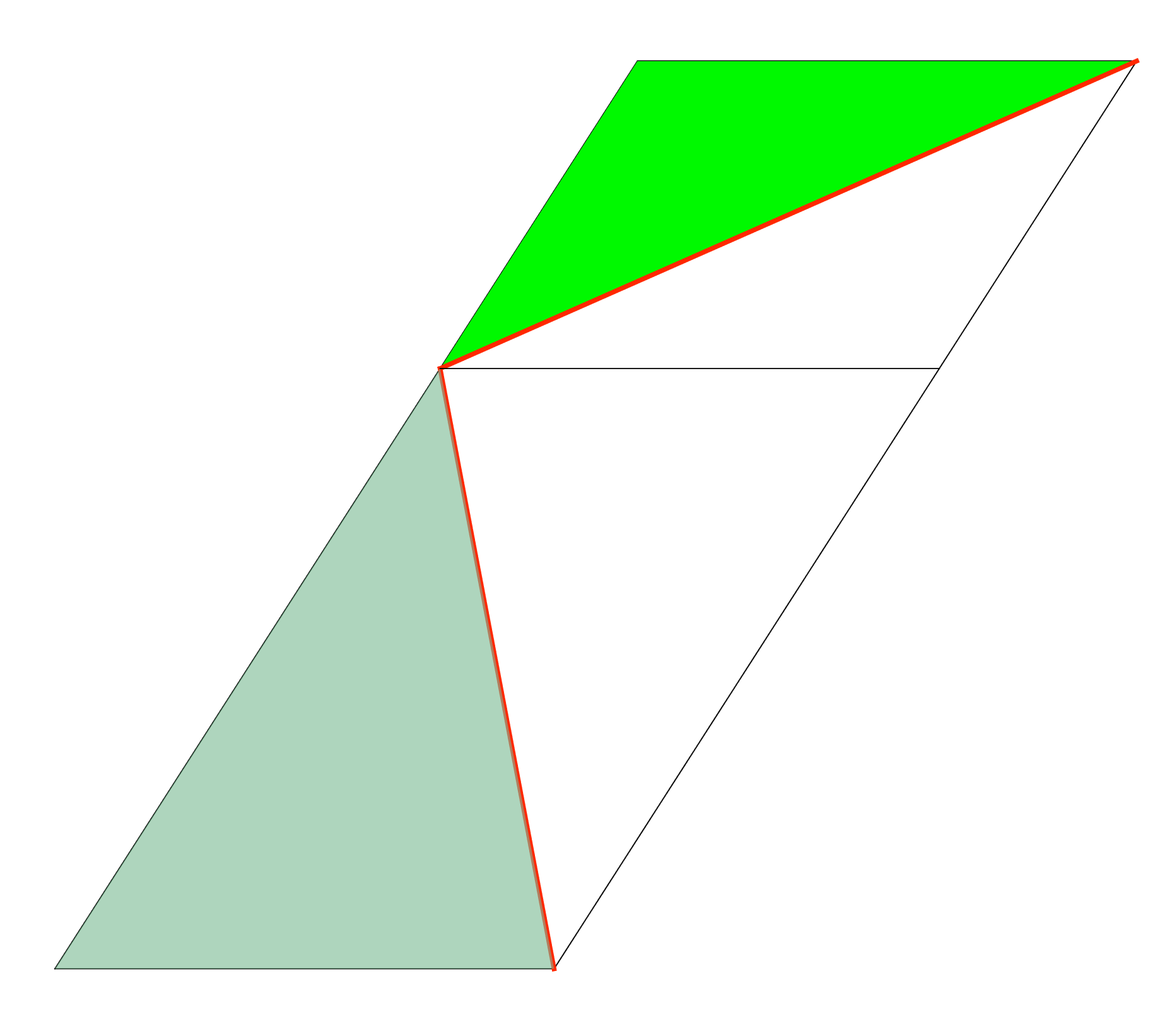


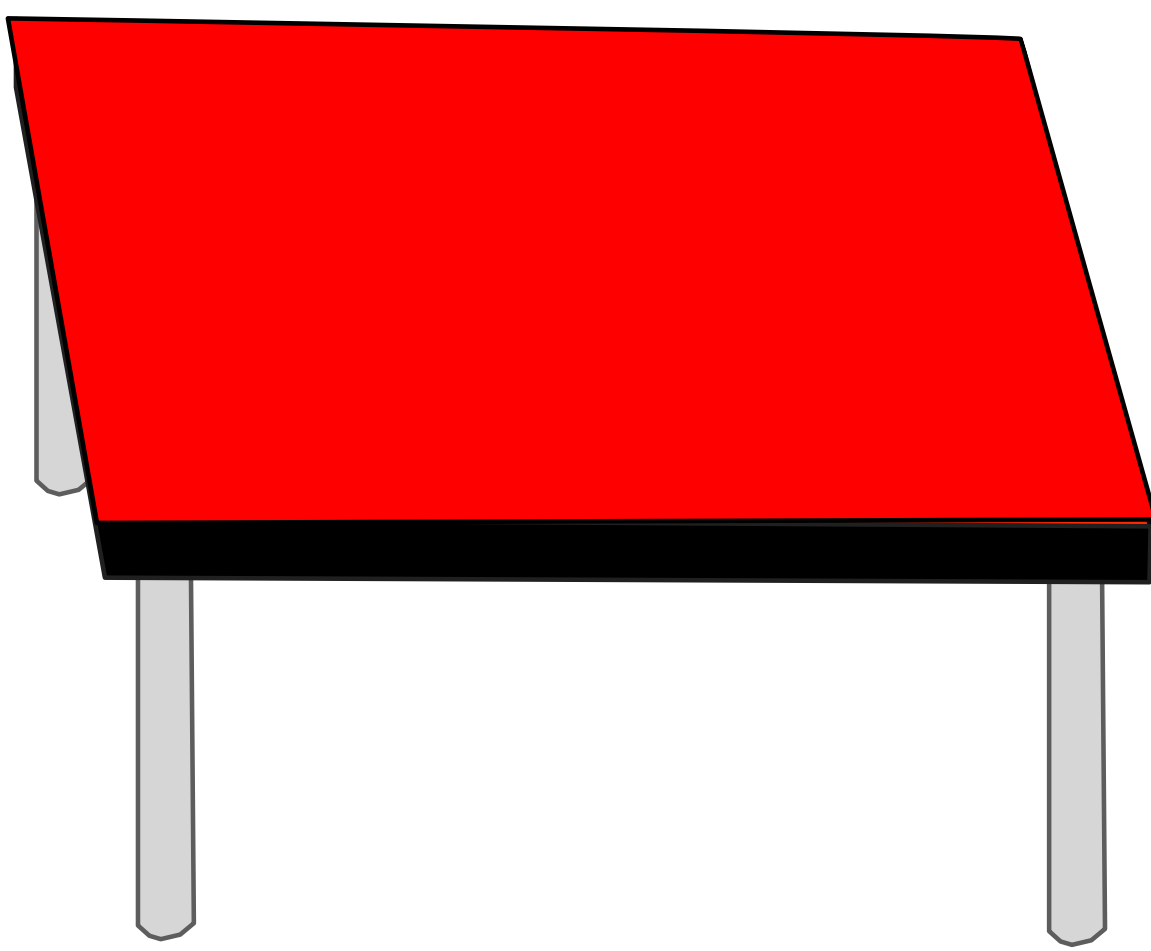
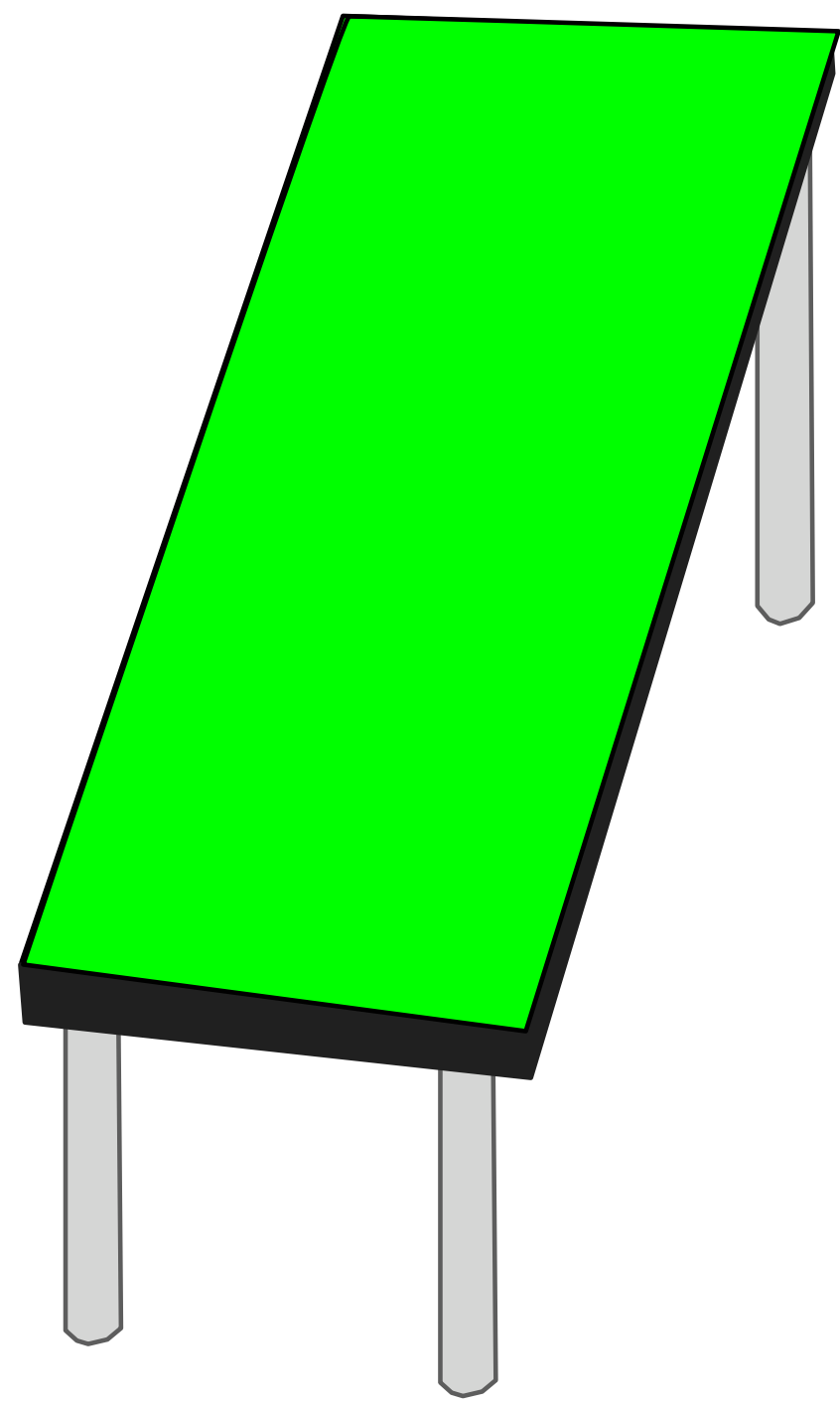


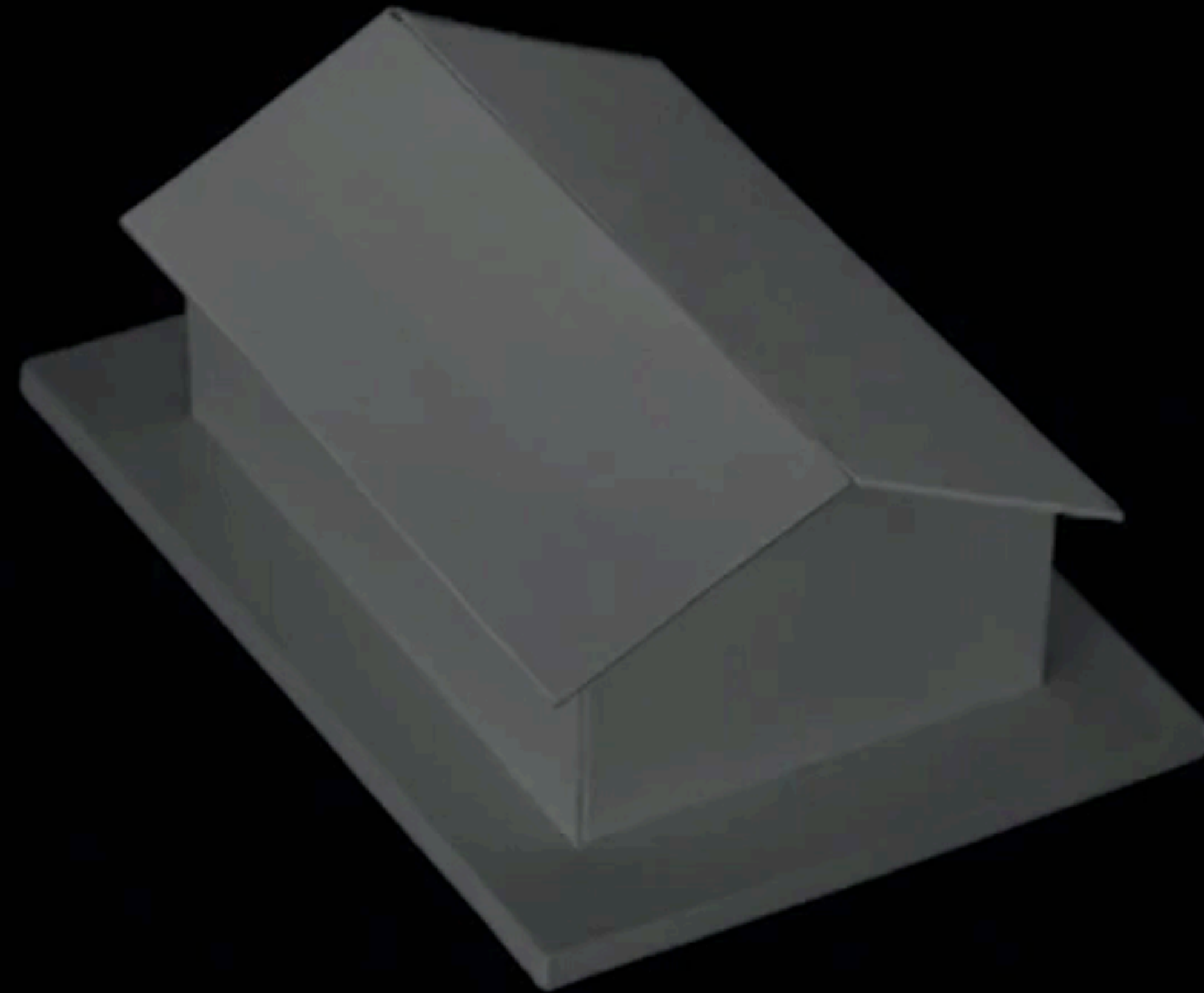












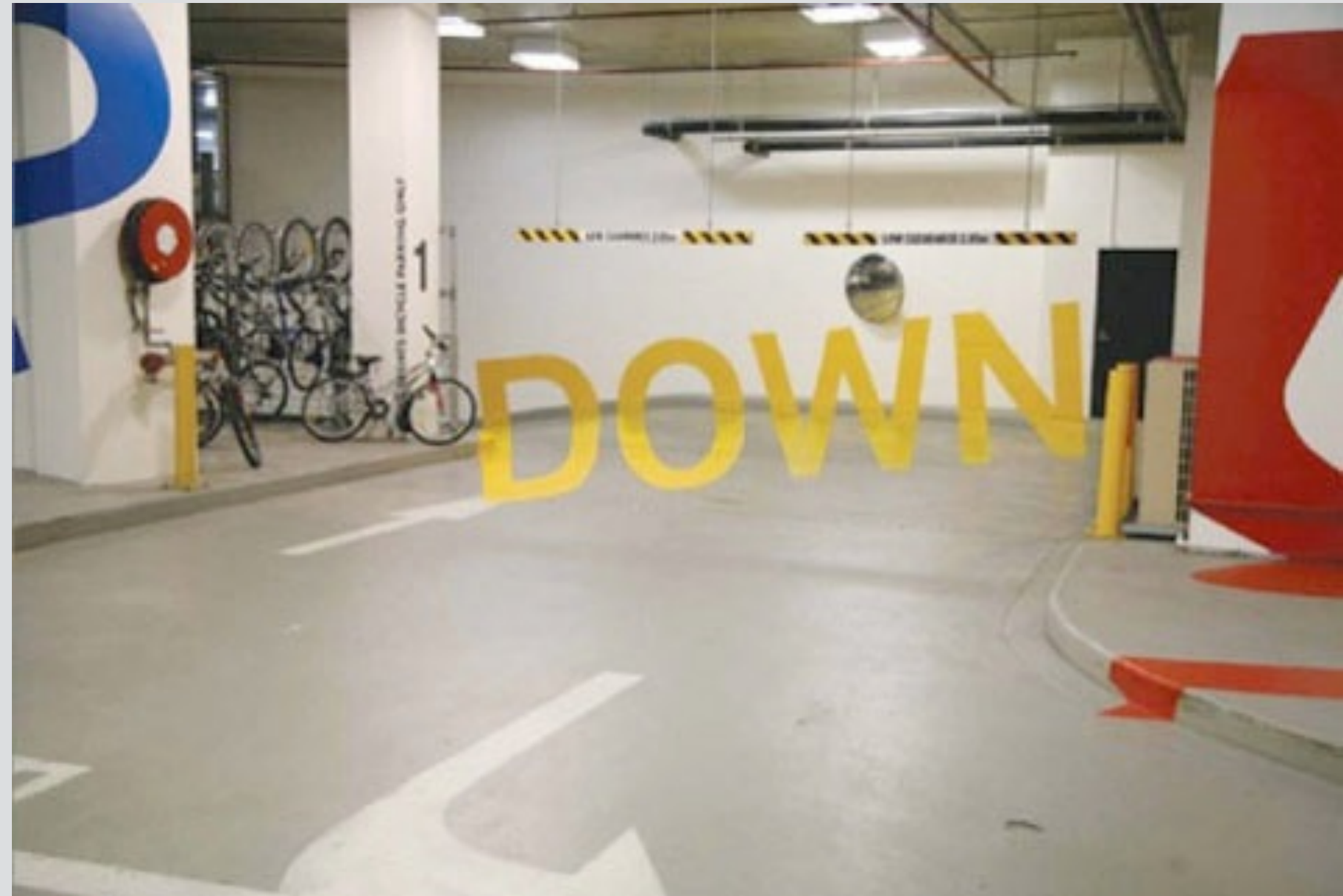
Kokichi Sugihara

















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



Daniel J. Simons
University of Illinois

Focus of Attention

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



Daniel J. Simons
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



Daniel J. Simons
University of Illinois

Focus of Attention

- Perception can be incomplete and inaccurate



Daniel J. Simons
University of Illinois

One More Time

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



Daniel J. Simons
University of Illinois

One More Time



(c) 2010 Daniel J. Simons

- 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



(c) 2010 Daniel J. Simons





Summary

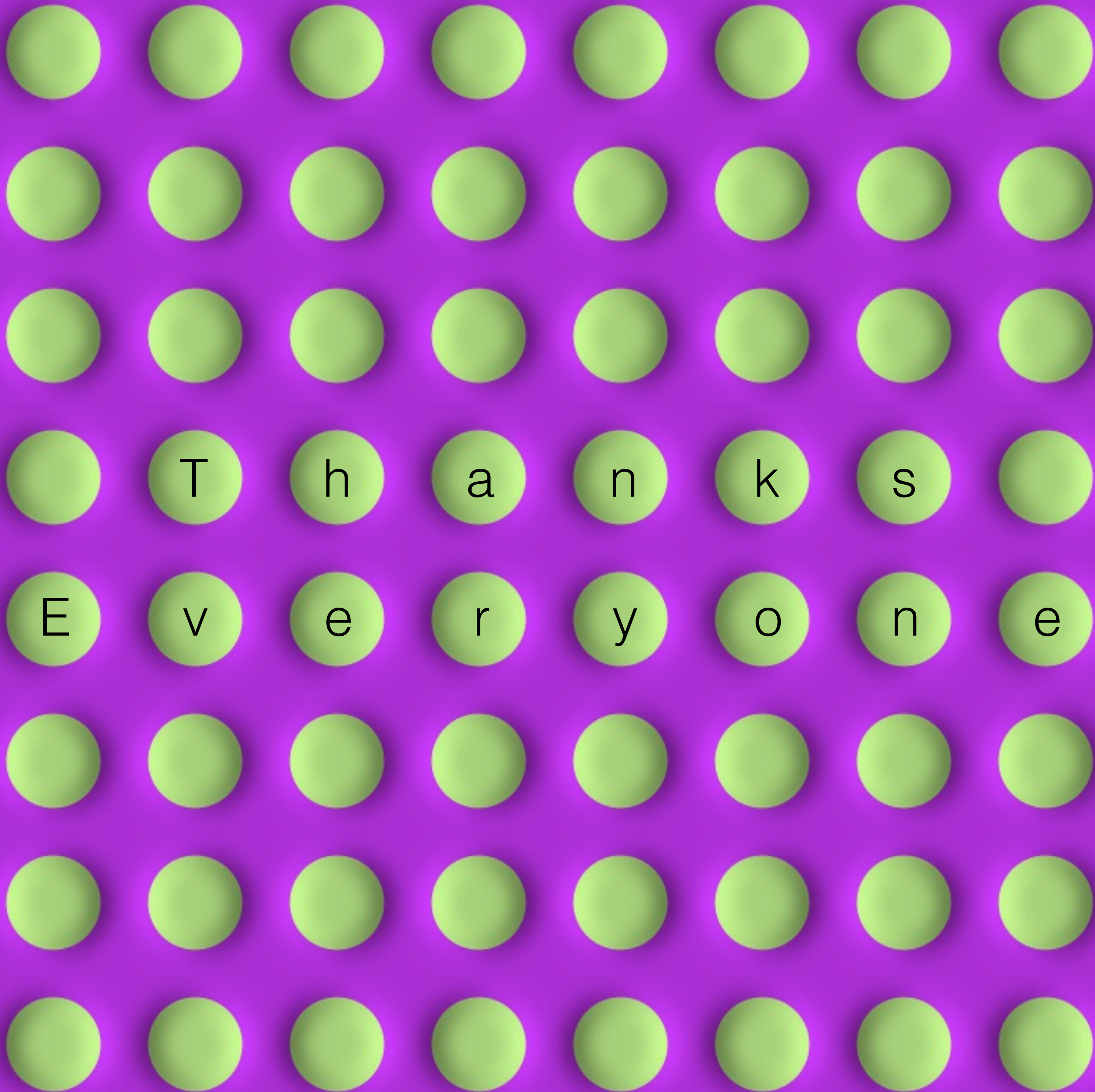
- We see with our brain, not with our eyes
- **What** is out there and **where** is it?
- The brain creates our perception of reality from multiple streams of information
- Sometimes perceptions are “wrong” (Illusions)



Science:



The Unfolding of Knowledge



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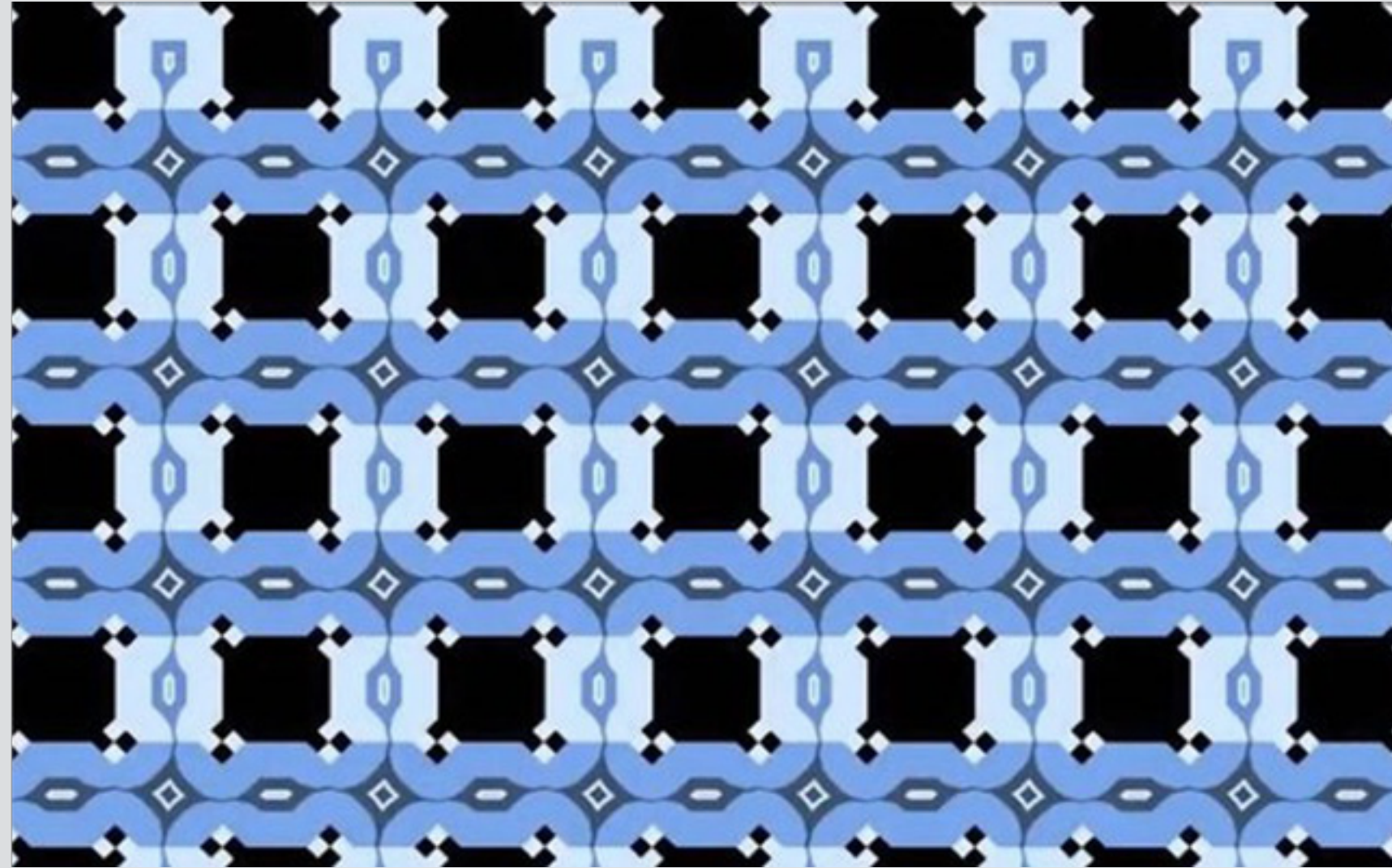
CU Wizards WEBINAR

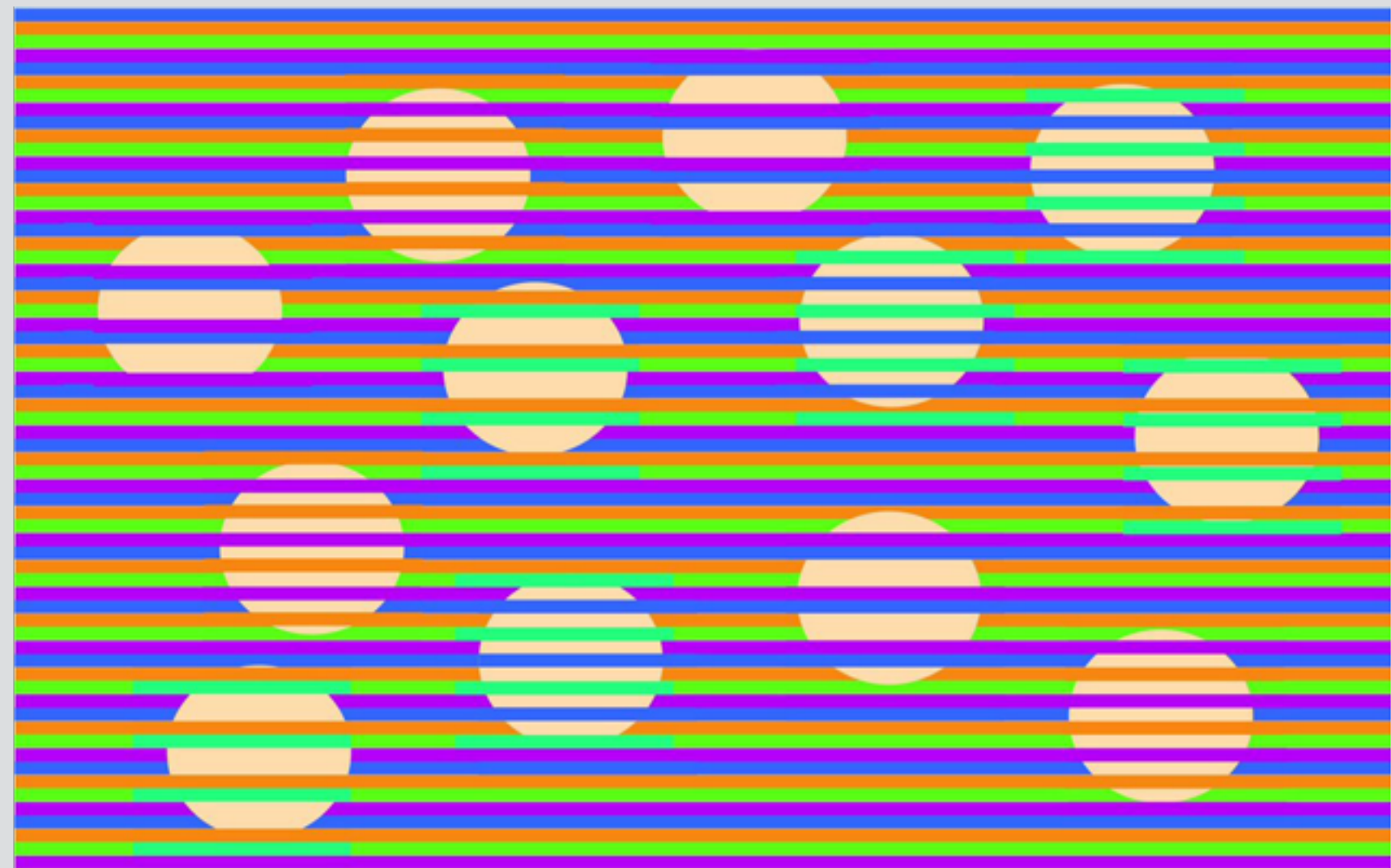
Saturday

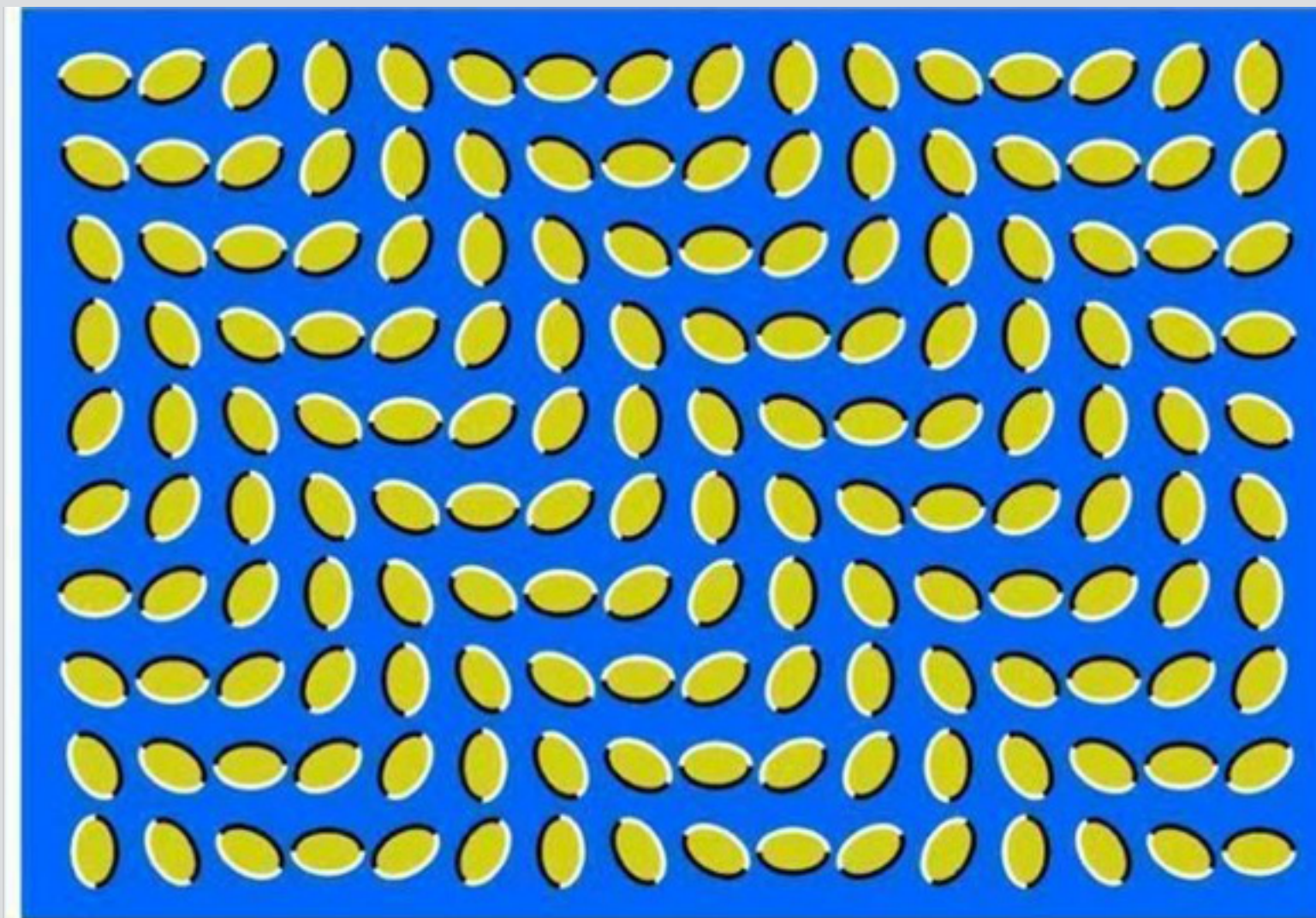
November 14

9:30-10:30 am

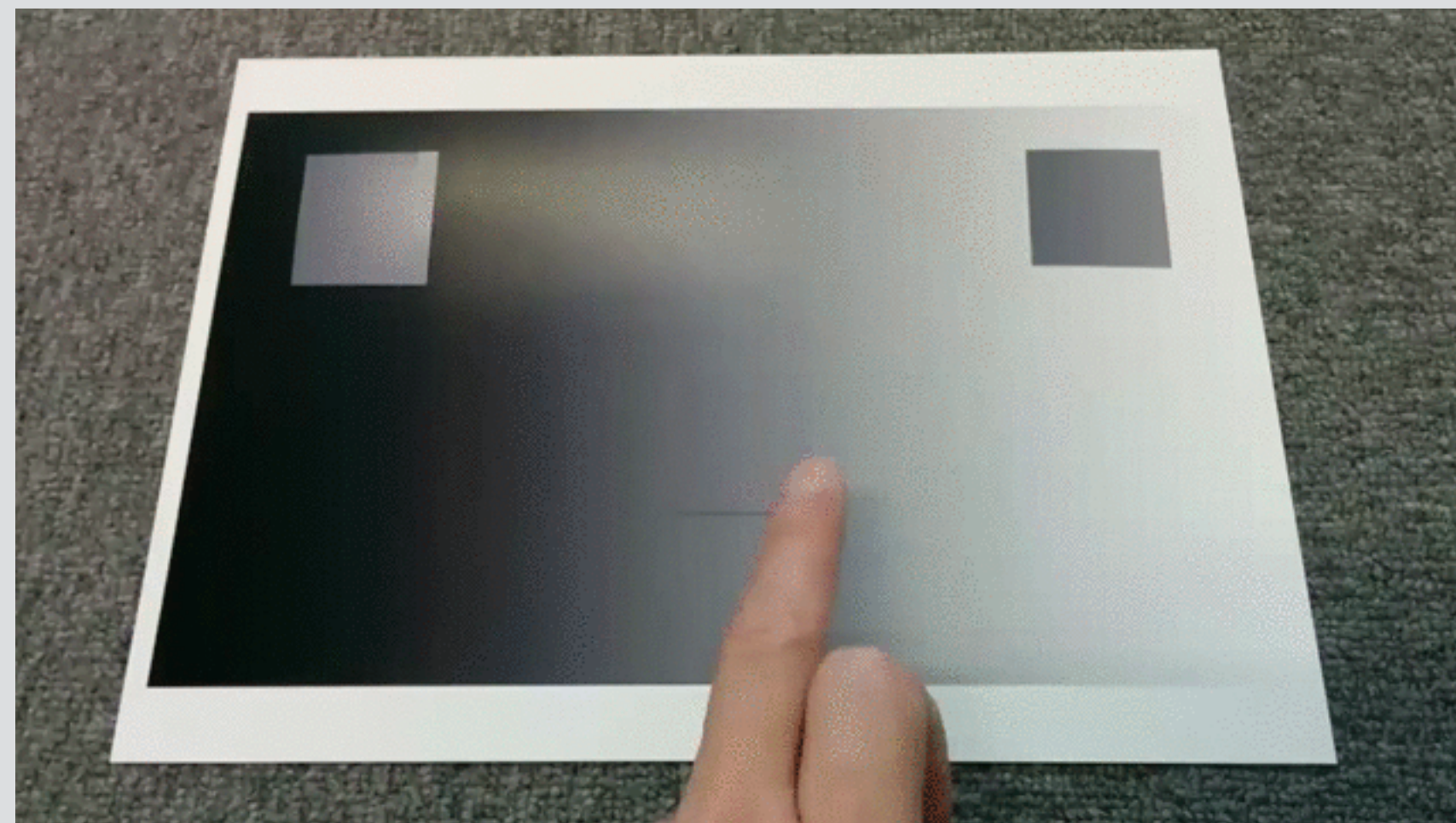
WWW.COLORADO.EDU/CUWIZARDS









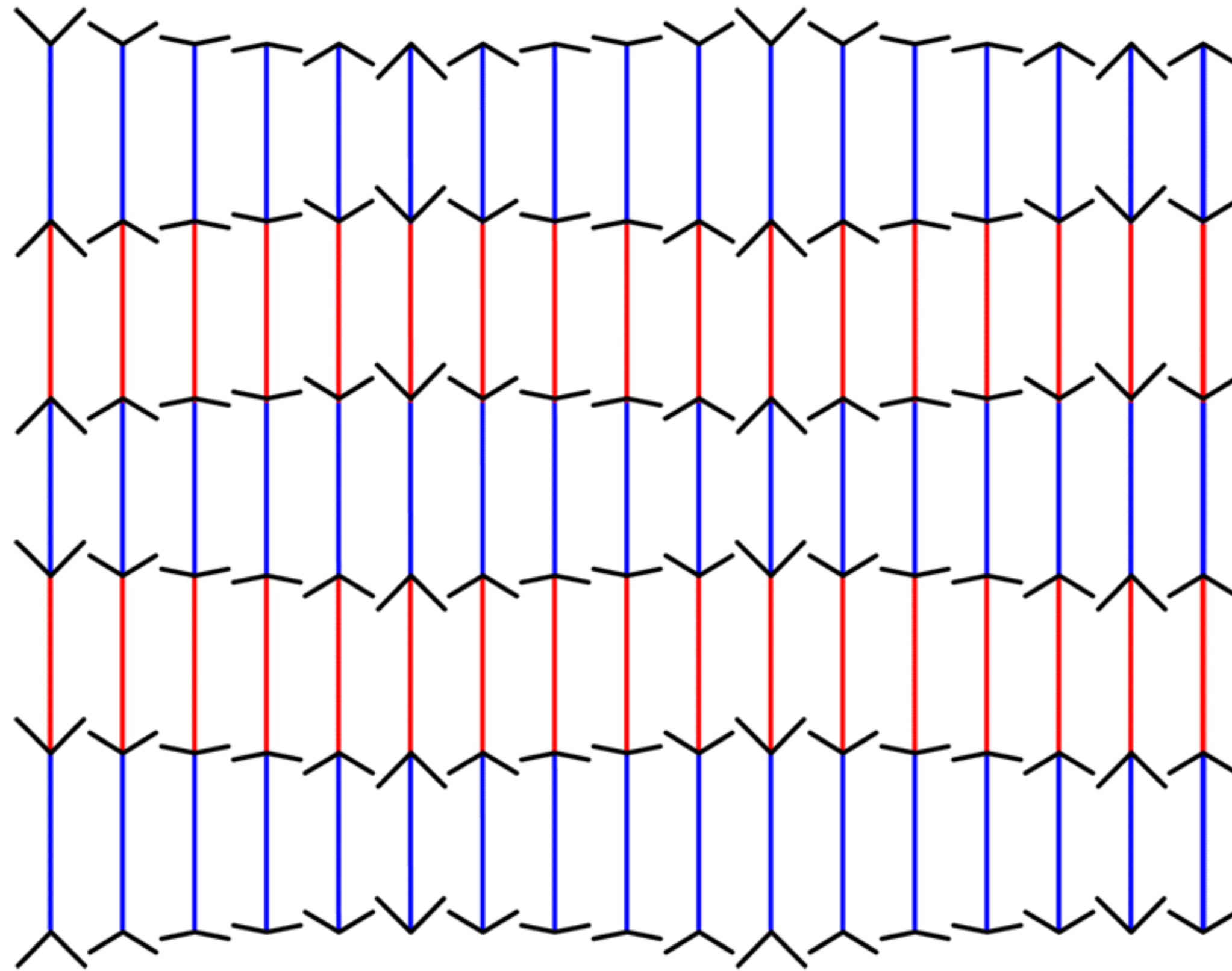




Müller-Lyer Sinusoidal Waves

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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