

Bulging Checkerboard

One of the great creators of optical illusions is Akiyoshi Kitaoka and the bulging checkerboard illusion is by his hand. The checkerboard gives a strong sensation of “bulging out the screen”. Of course, it's just a regular checkerboard. All that is needed for the illusion to work are the little dots.

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How does the illusion work?

The reason for the effect is unclear but I think it has to do with the fact that we tend to see lines in everything. If we consider, for example, the squares in the top-right part of the checkerboard, the pattern looks like figure (a)

(a) We tend to interpret the margin around the small white spots as lines

(b) and because these perceived lines are not perfectly aligned, we perceive a slight tilt.

(c). By cleverly positioning the small dots differently in different quadrants of the checkerboard, the whole checkerboard appears to be bulging!



a. The layout of the tiles and the spots in the figure

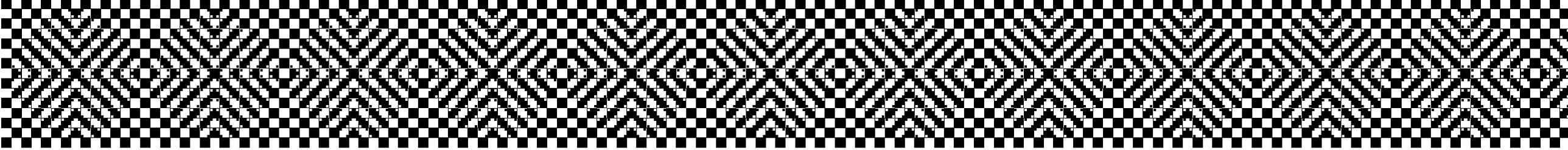
b. There is a small margin around the spots, which we interpret as lines (the orange lines).

c. Because the perceived lines are not perfectly aligned (see above figure) we perceive them as being slightly tilted. In each quadrant of the square the perceived tilt is different, and therefore we perceive a "Bulge".

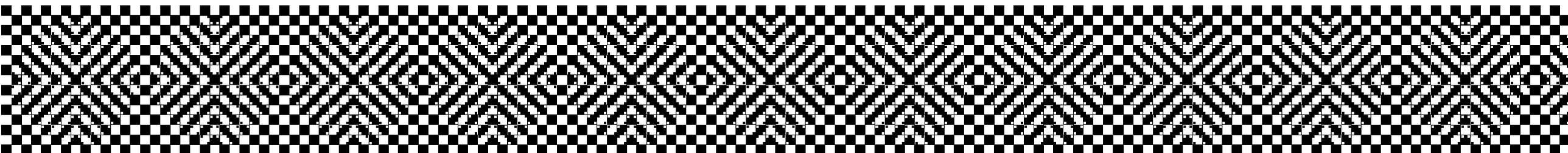
Sources-

<https://michaelbach.de/ot/ang-KitaokaBulge/>

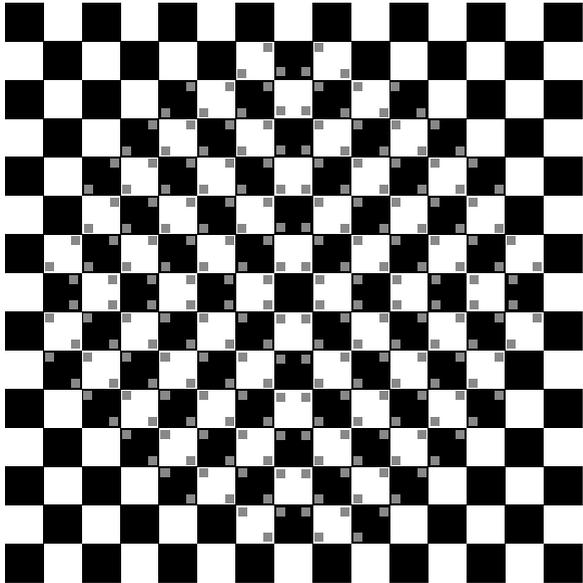
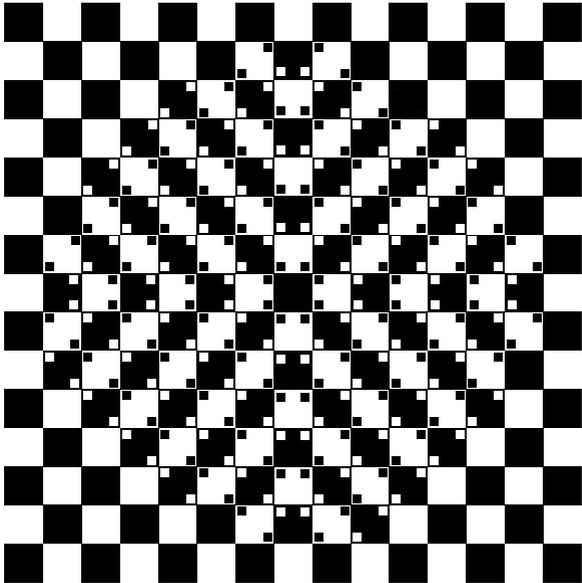
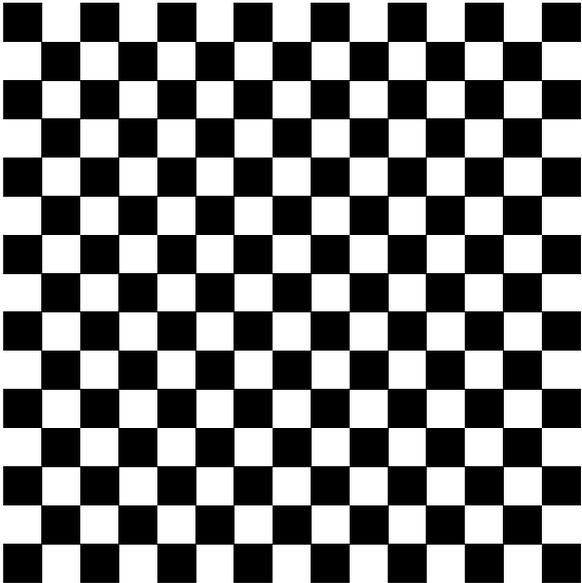
<https://www.cogsci.nl/blog/bulging-checkerboard>



EXPLORATIONS

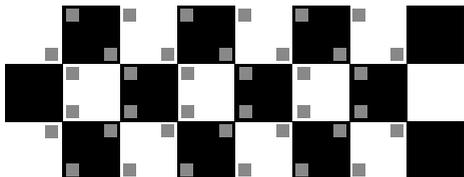
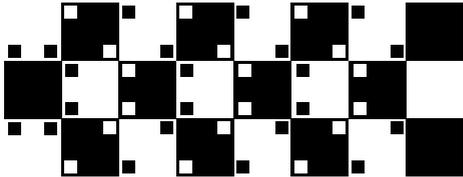


Effect of small boxes contrast



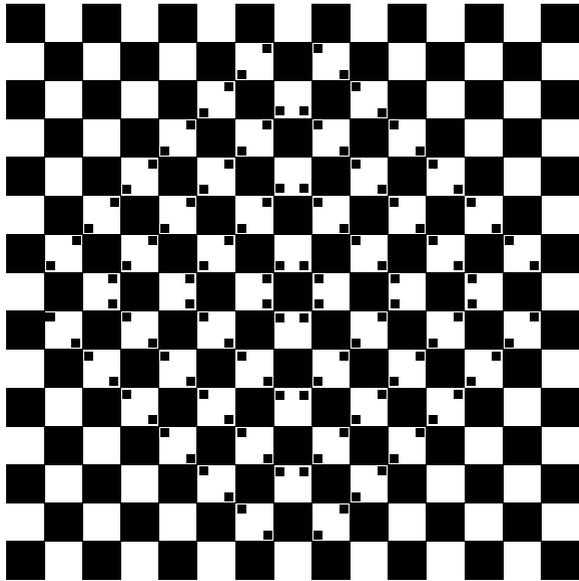
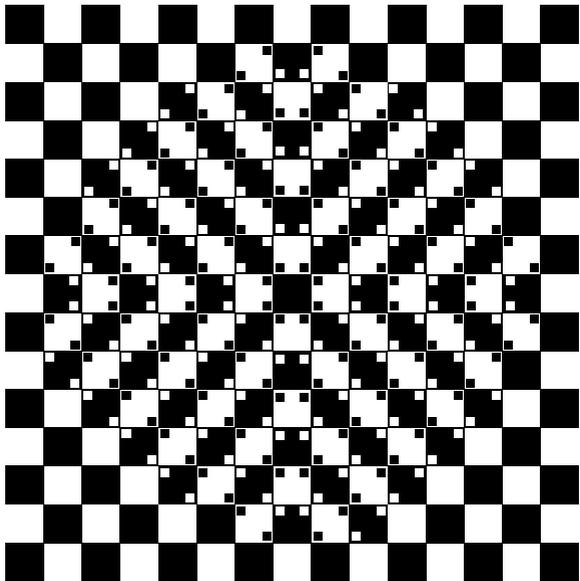
We can see a Bulge the moment the small squares are added.
Notice the positions of the small boxes, which makes the effect. Lateral inhibition at the edges can be one of the reasons why the squares are perceived as distorted.

On reducing the contrast, i.e. making all the boxes Grey, the bulge effect loses its intensity. Even though we still see the effect, the bulge height seems to be reduced.

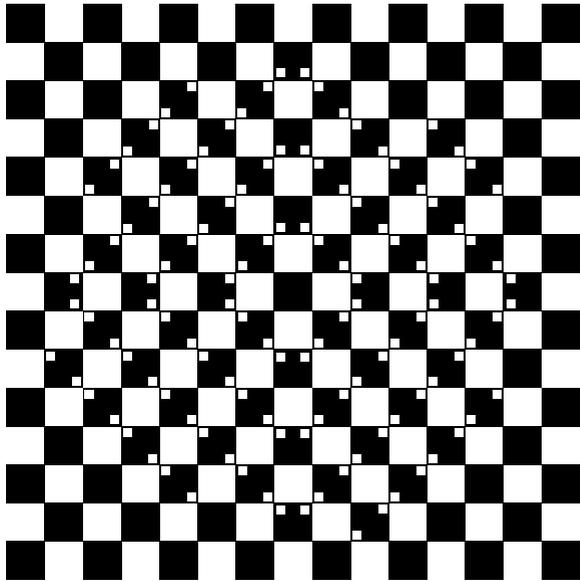


On reducing the contrast, the effect reduces.

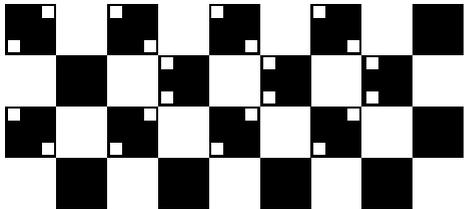
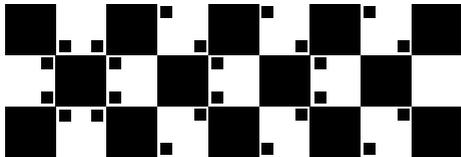
Impact of just one color small boxes



Removing the white small boxes reduces the bulge effect, though it is still present.

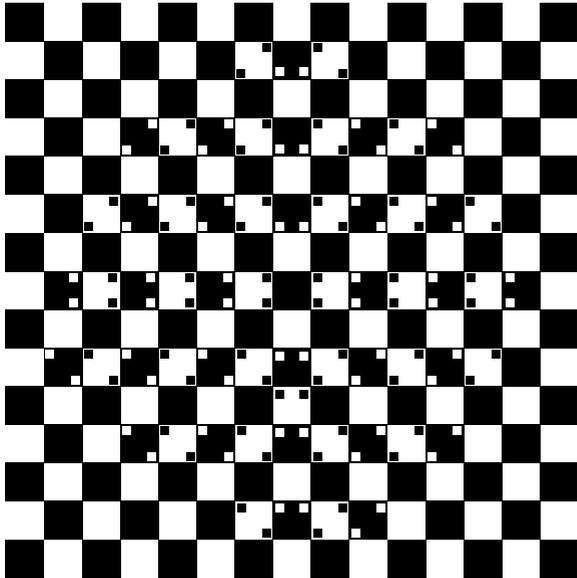
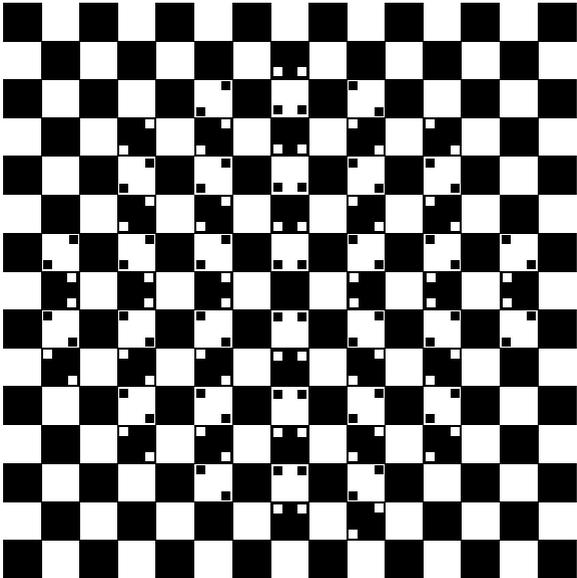
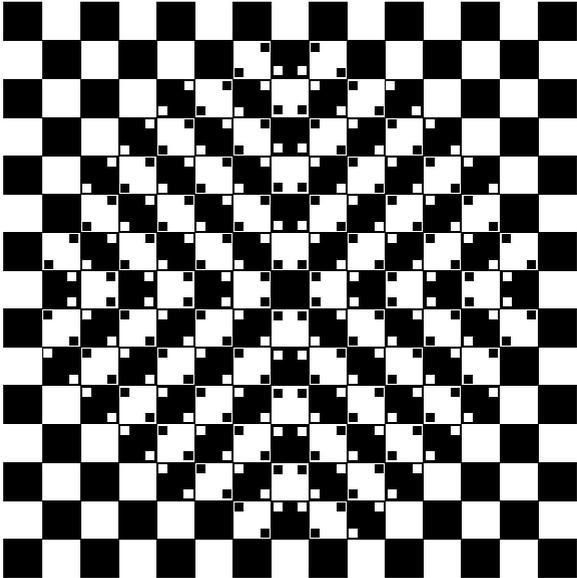


Removing the black small boxes reduces the bulge effect, though it is comparatively more from the left figure.



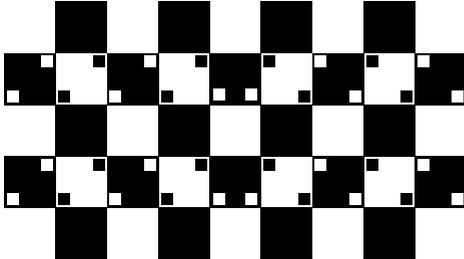
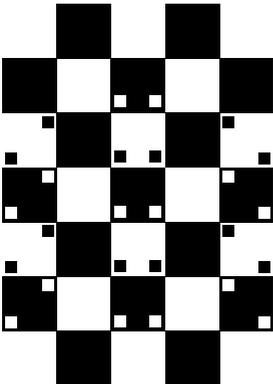
Impact of small white boxes is more compared to the black small boxes, and it can be seen in the above figures.

Removing small boxes horizontally/ vertically.



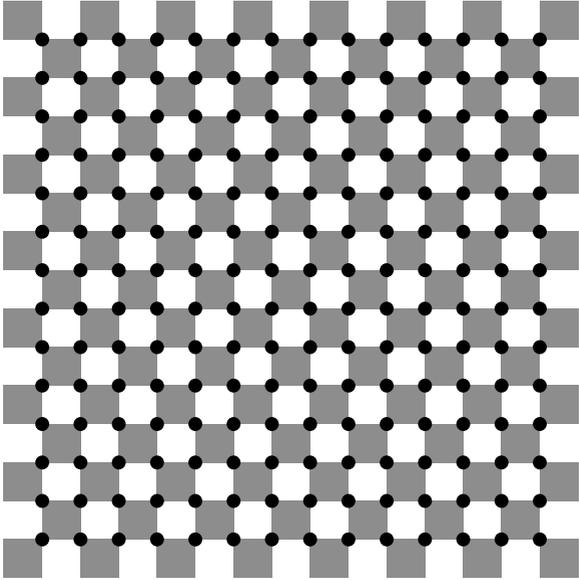
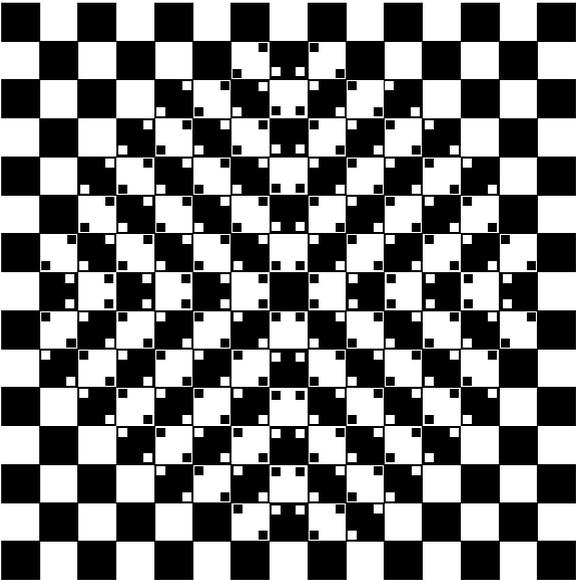
On removing the boxes vertically we see vertical bulge.

On removing the boxes horizontally we see a horizontal bulge.

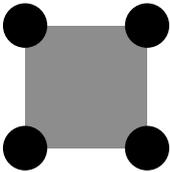


With the placement of the small squares we can control the direction of bulge.

Putting circles at the intersection

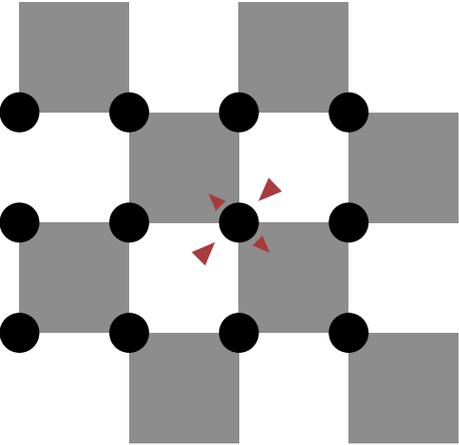


The circle placed at the intersections are perceived as distorted and oval in shape.



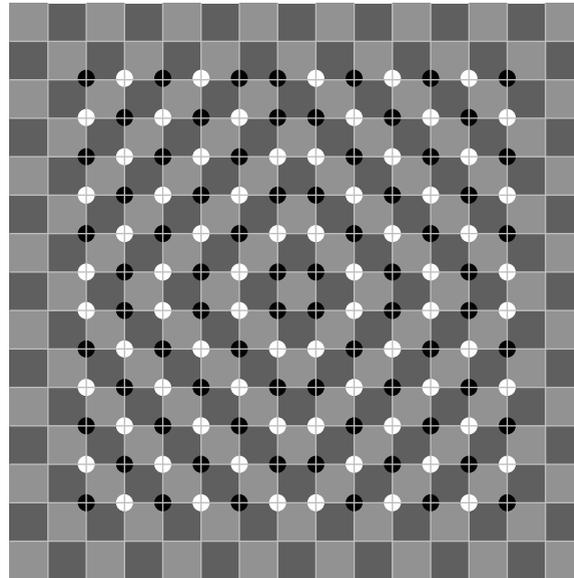
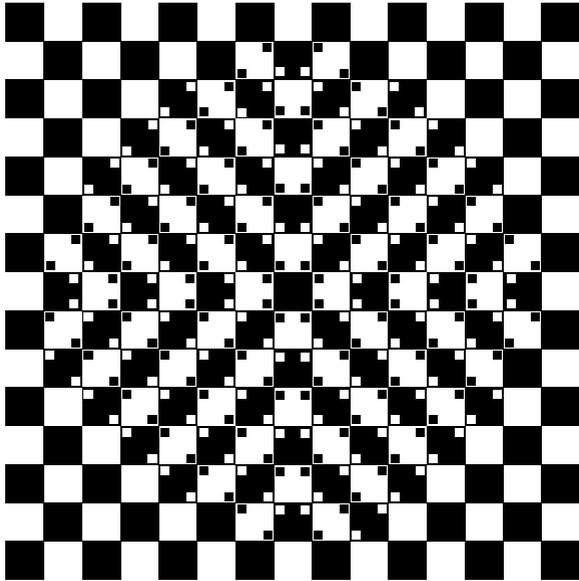
In isolation we perceive circles as circles with less distortion at the intersection with the square.

• The circle being used.



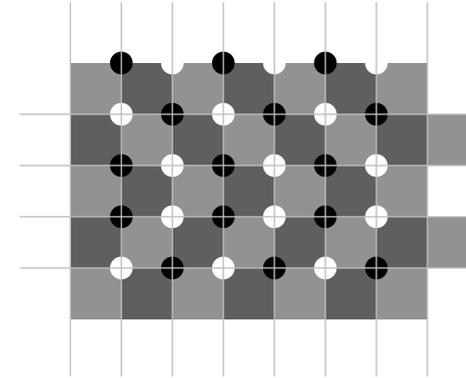
Notice the impact the white and grey squares have on the circle. The white overpowers black and black spreads on grey, hence an oval shape is perceived. Lateral inhibition can be one of the possible reason.

Trying budge effect with circle at the center of the intersection.

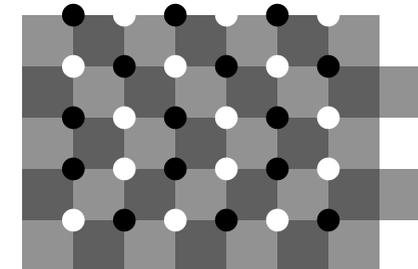


With the circle being placed at the intersection and a line dividing it into four quadrants we can observe a slant bulge though not as impactful as the image in the left.

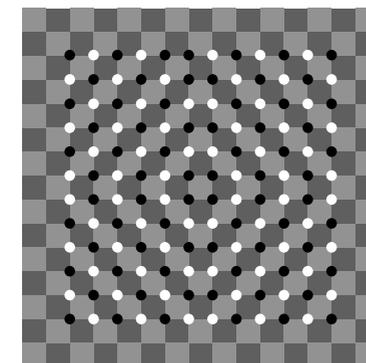
As seen in the previous exploration, we can still perceive the circles being distorted as ovals.



The white and black circles achieves a similar though not as strong bulge effect.

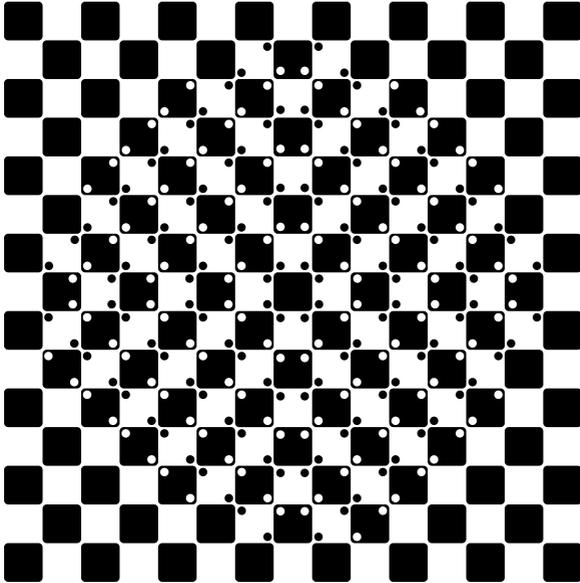
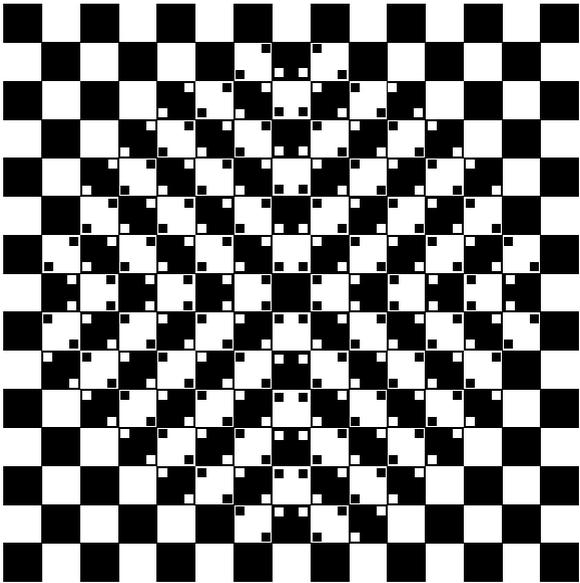


The lines intersecting the circle plays a major role in the bulge perception.

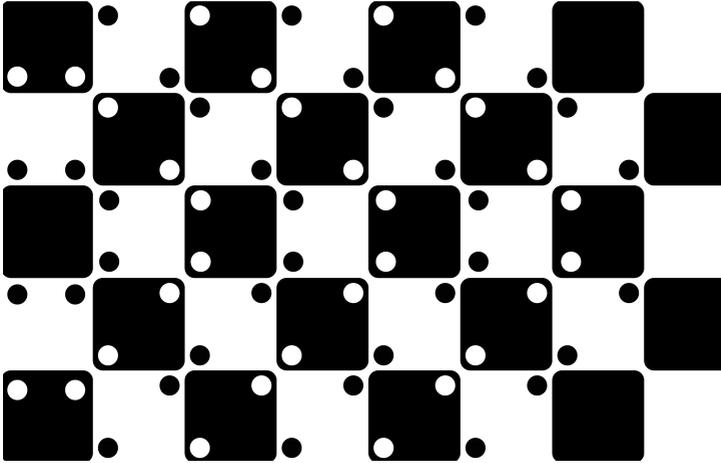


On removing the lines, we start seeing other forms and patterns. Here, I can see diamond forms.

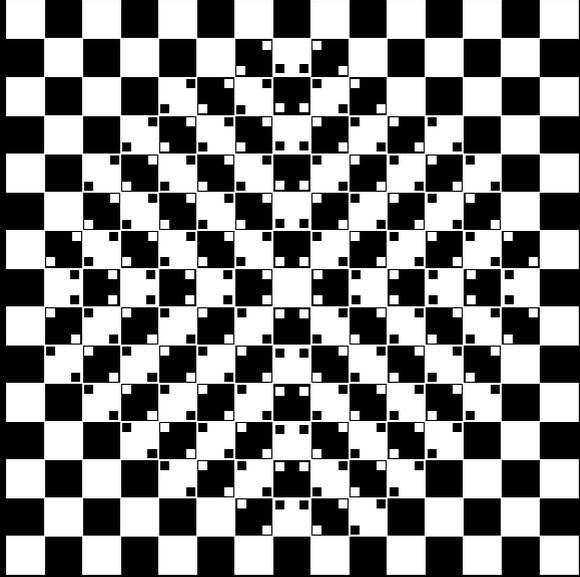
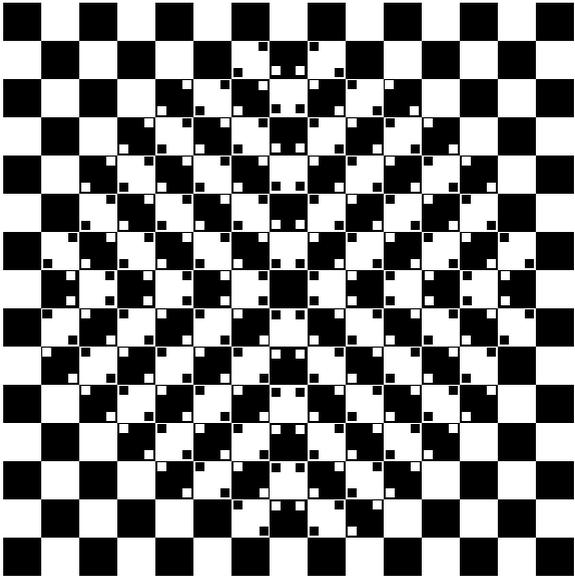
Changing the small square shapes to circles



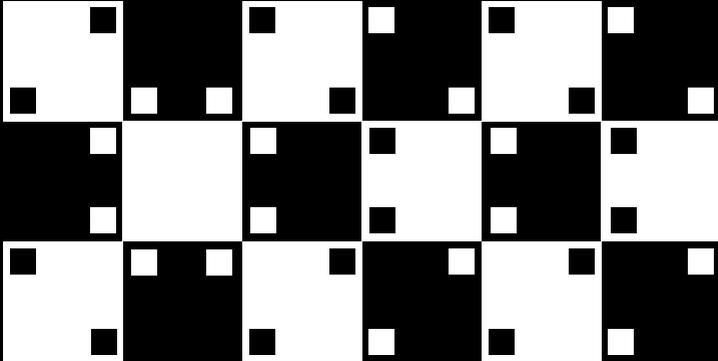
On changing the shape of the small squares to circles the impact reduces, though the bulge can still be perceived.



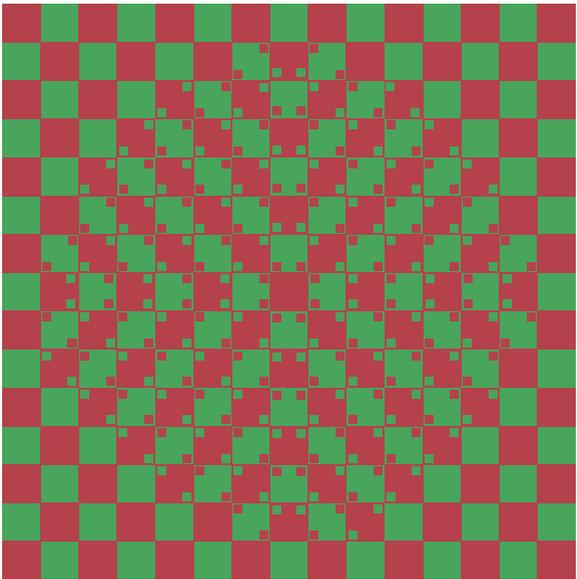
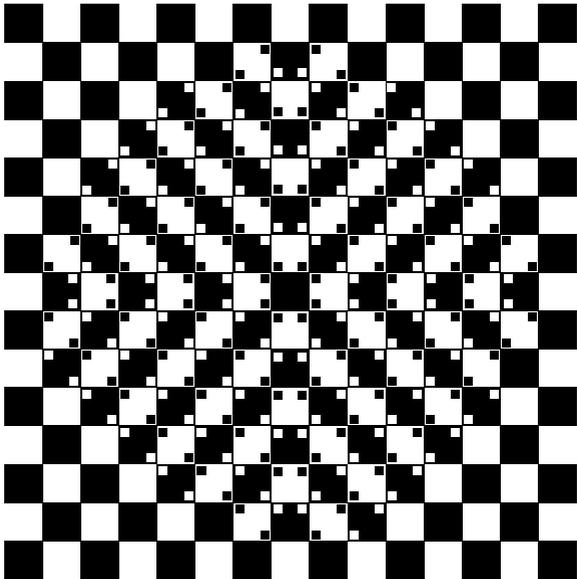
Effect of background



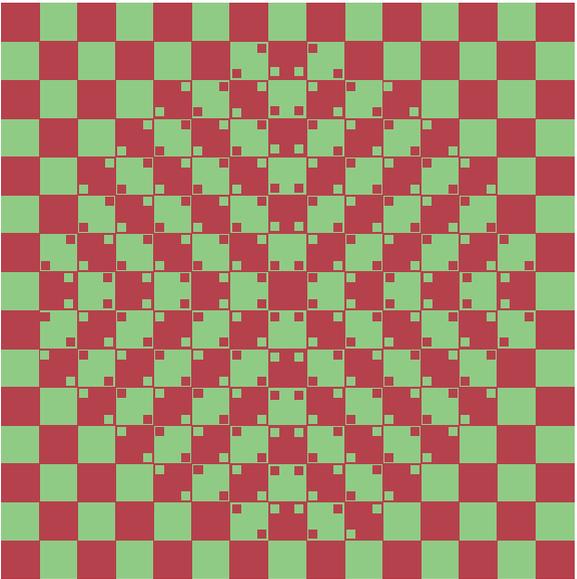
Changing the background does not effect much on the bulge until we follow the same concept as the image in the left.



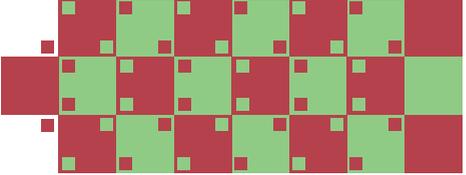
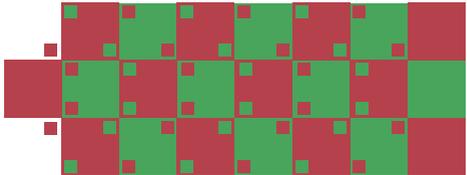
Color contrast



On using the contemporary colors, where both the colors the dominant, the bulge effect reduces.

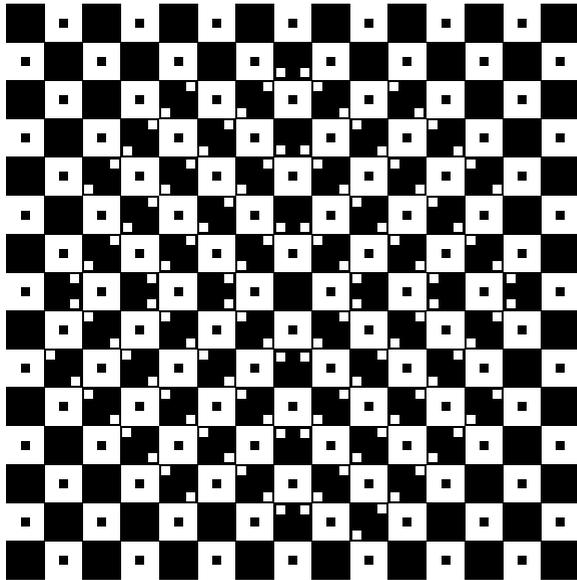
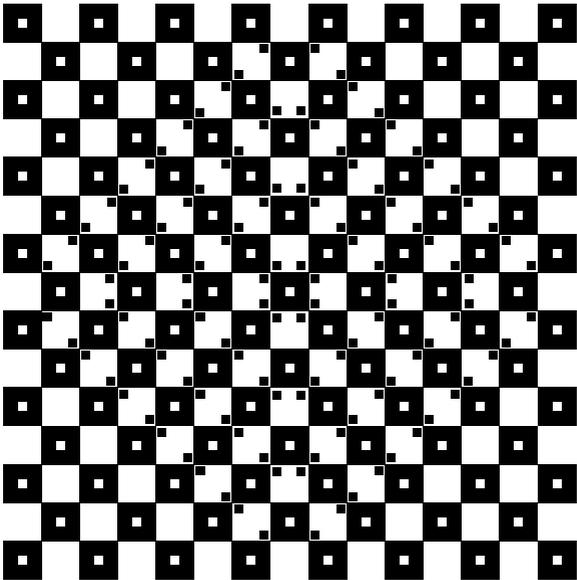
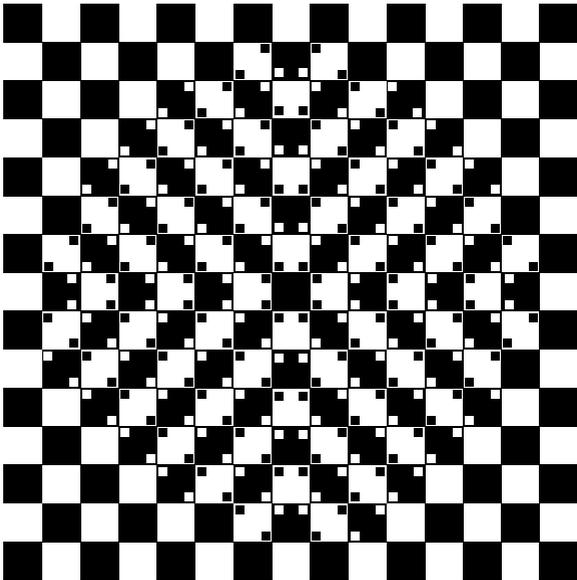


On making one of the colors more dominant and the other color subtle the bulge effect can be perceived.

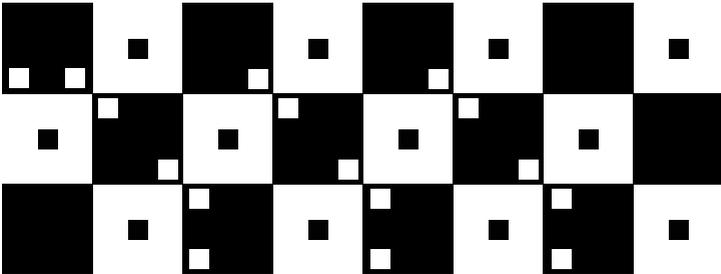


As seen in the starting example also, contrast plays an important role for this effect to work.

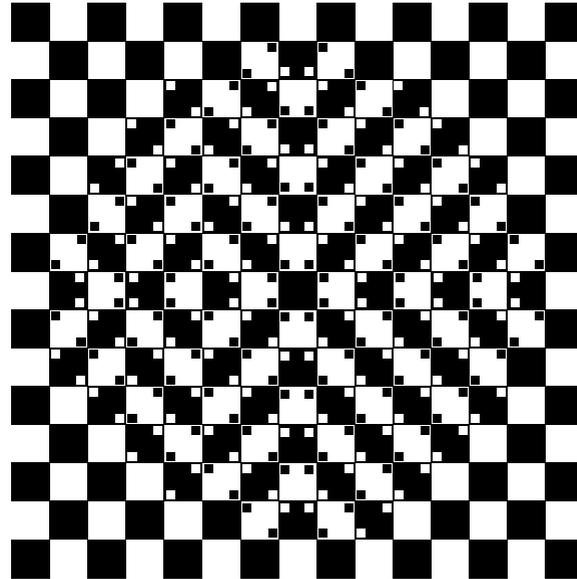
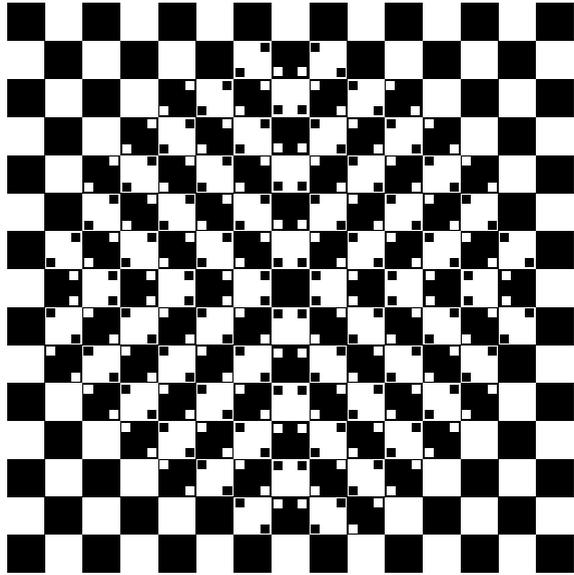
Trying to reduce the bulge effect with placement of square dots.



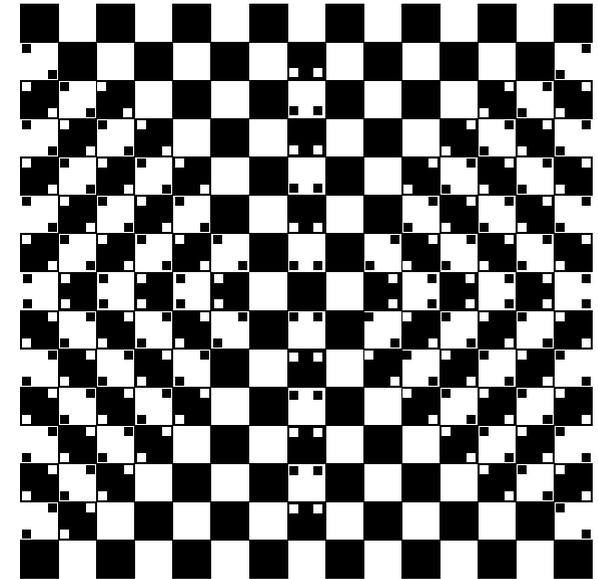
On placing one small square at the center of the black squares the bulge effect reduces. Same effect can be seen on the right image.



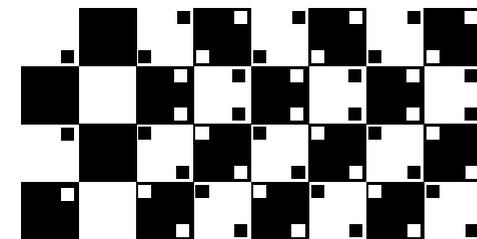
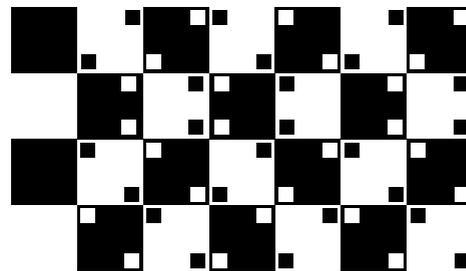
Trying pitch effect by changing the placement of the small squares.



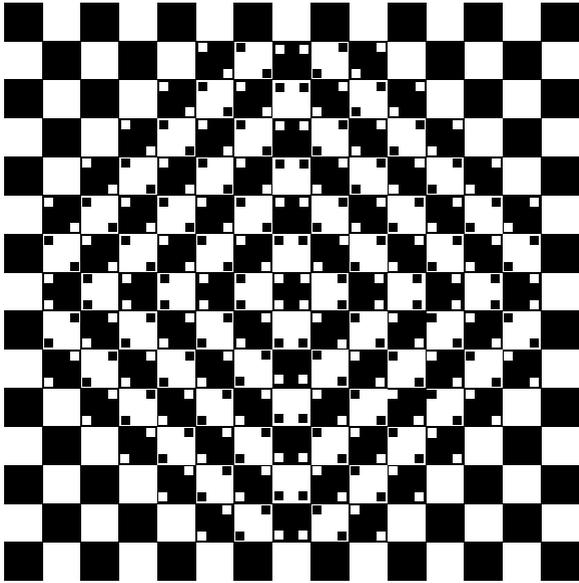
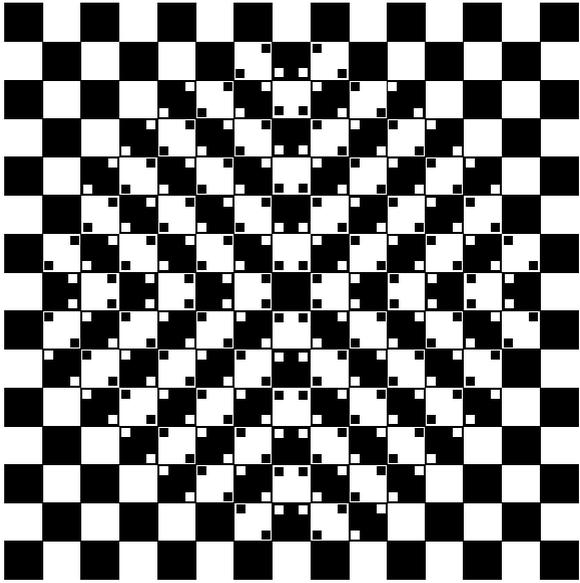
On the left side of the image we can perceive a distortion from the bulge.



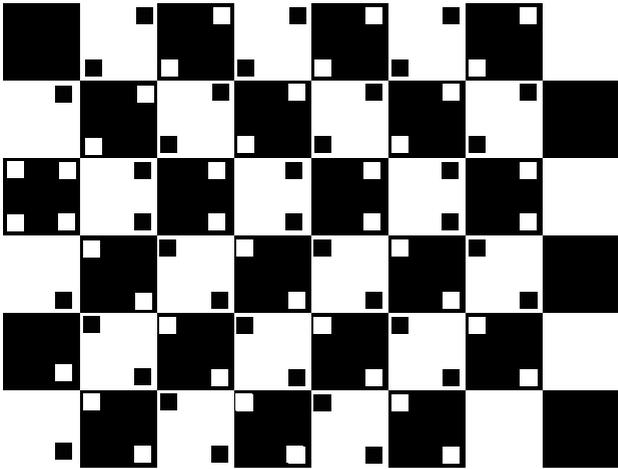
On placing the small squares we can manipulate the distortion on the grid.



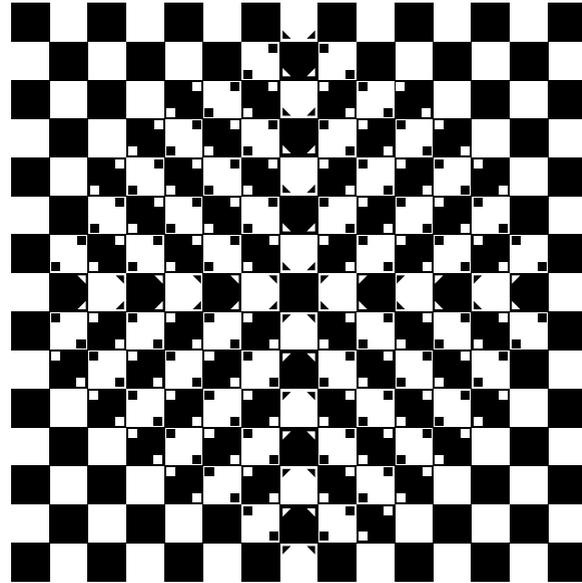
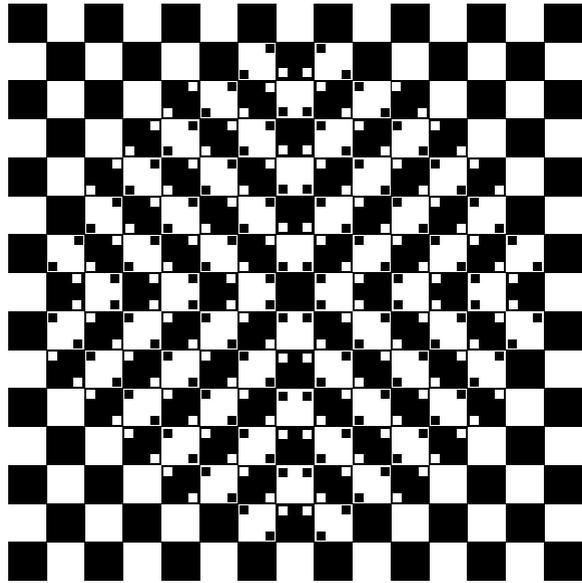
Trying pitch effect by changing the placement of the small squares.



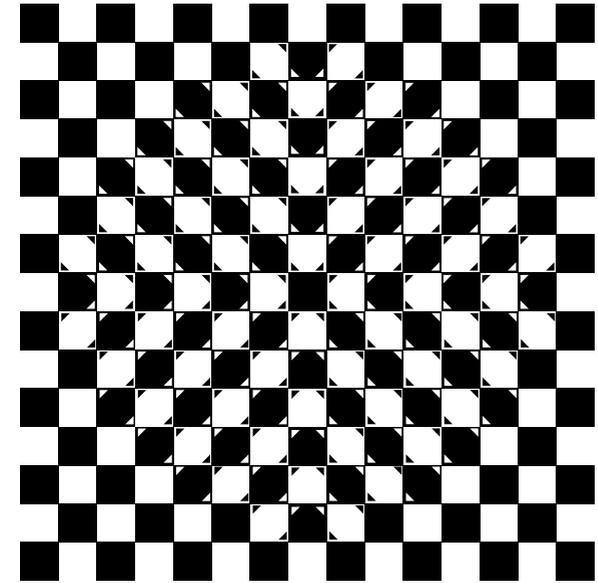
On flipping the positions of the small boxes in each square we can reverse the bulge effect to a "pitch" effect.



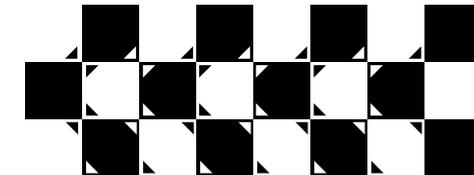
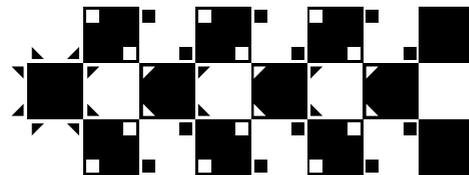
Changing the shape of the small square to triangles



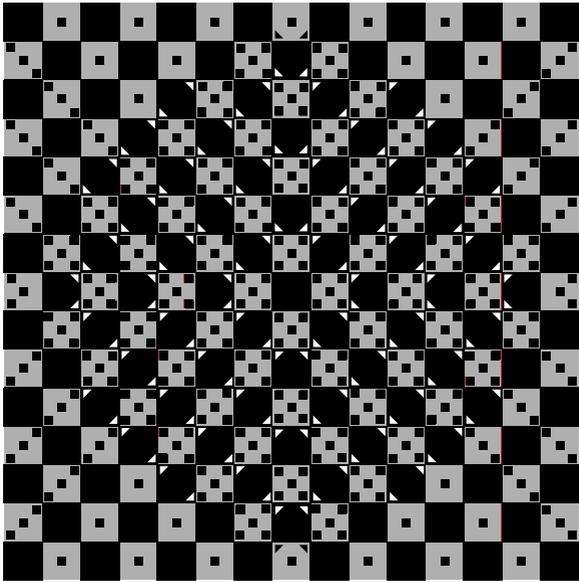
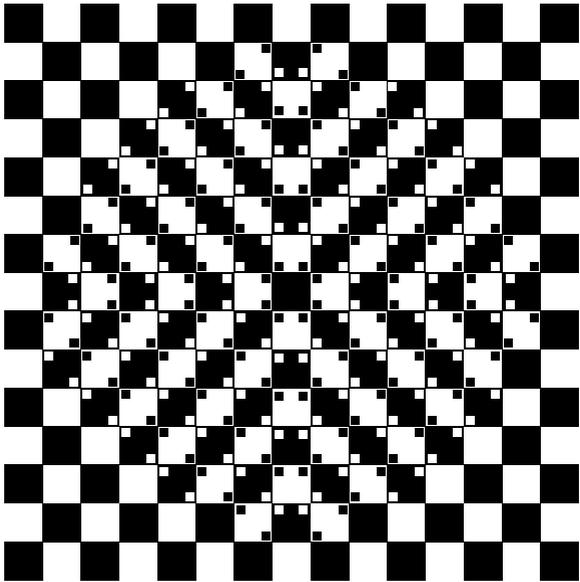
On changing just the vertical and horizontal small square shapes, the bulge effect sharpens.



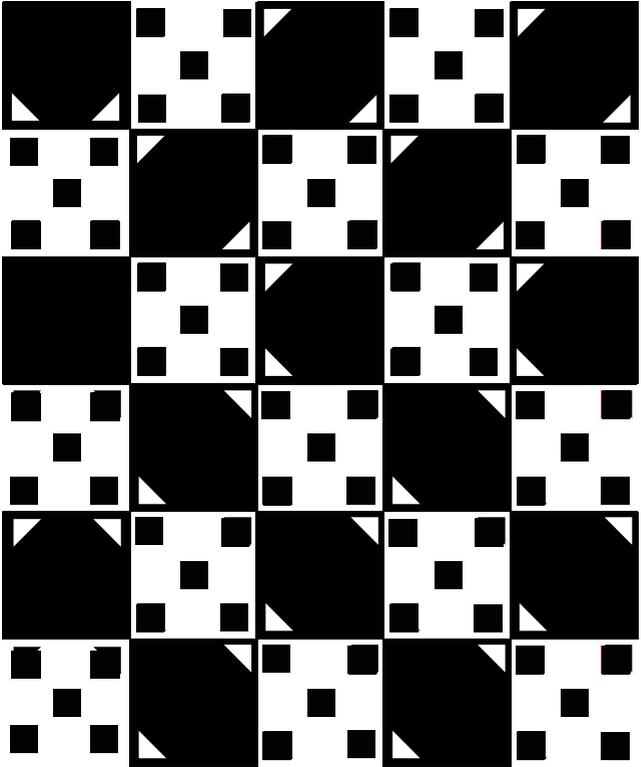
When all the small squares are changed into triangles, the bulge effect disappears as now we can now also perceive a 'X' shape forming which fights for attention with the "bulge effect". This can be explained by gestalt law of continuity where elements in a line seem more related to one another than those positioned randomly.



Trying multiple distractions to reduce bulge effect



We now see multiple forms which distract us from the bulge effect.



Conclusion

- The small squares when placed near the edge, leaving a small line, makes the box perceived a distorted when seen from far. (Lateral immersion)
- By strategically placing these small boxes amongst the checker- board we can exploit this perceived tilt to create bulge or pitch effect.
- The use of shape matters, as the impact reduces when used circle, and the effect reduces more when we use triangles and we then start perceiving another forms which overweights the bulge effect.
- The contrast matters to make the effect more effective. If the contrast between the two colors is less, the bulge effect reduces, and thus this effect works best on black and white as it has maximum contrast.
- On putting distracting elements, like putting squares at the center of some squares, the effect reduces.
- Gestalt common fate: According to the Gestalt law of shared fate, when two or more visual items move in the same direction or at the same pace, people interpret them as one pattern/ motion.
- Humans tend to see an image as a whole first than constituting it of individual elements. We interpret the dots in the image as part of adjacent squares adding certain curvature to the pattern. This curvature if consistent by positioning the dots in a pattern, gives rise to bulging effect with respect to our perception

