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Last but not least

A new set of illusions—the Dynamic Luminance-Gradient Illusion and the Breathing Light Illusion

Abstract. A novel set of illusions that break brightness constancy and size constancy at the same time is reported. The illusions occur when observers move towards or away from these patterns. Many variations of these phenomena and a possible explanation are discussed.

We introduce here a new set of illusions that show illusory variances in brightness and also in size of the stimuli. During the 2006 meeting of the Vision Sciences Society (VSS), Alan Stubbs showed his illusions, created in Maine, USA, in the 'Best Visual Illusion of the Year Contest', hosted by the Neural Correlate Society, while Simone Gori showed his illusions, created in Germany, during the VSS 'Demo Night'. Although the patterns were different and Stubbs stressed more the illusory variance in luminance while Gori stressed more the illusory variance of the size, the two phenomena were actually very related to each other and they also have common origins. After this meeting the two authors decided to work on this new set of illusions together. This article is the result of their efforts.

Figure 1 represents the new Breathing Light Illusion. This new illusion arises in a circular white spot on a black background. The boundaries of the spot are characterized by a gradient in luminance that gives an impression of blur.

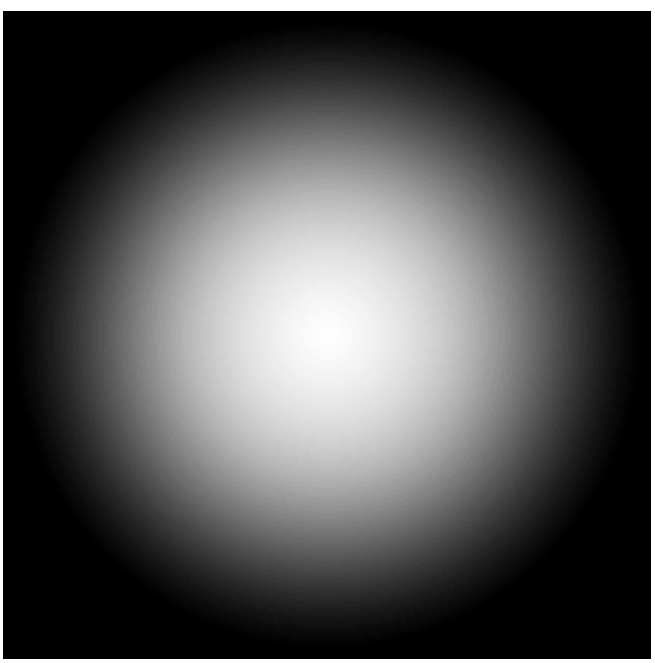

Figure 1. A simple version of the Breathing Light Illusion.

Figure 2 is an example of the new Dynamic Luminance-Gradient Illusion, or what Stubbs called the 'here comes the sun' effect. This example is composed of black radial spokes on a white background that become gradually narrower and whiter from the

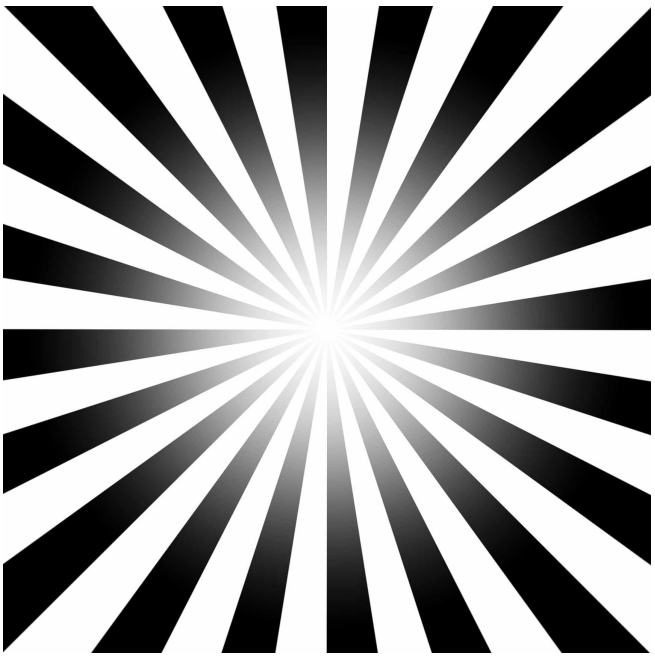

Figure 2. A gray-scale version of the Dynamic Luminance-Gradient Illusion.

borders to the center of the figure. The spokes are used here since these figures originated as part of a series of new directions based on Mach Bands (Stubbs et al 2006).

When one approaches one of these patterns (figure 1 or figure 2), the center becomes lighter and also bigger, whereas when one recedes from them, the spot appears to become darker and smaller. When one approaches the negatives of figures 1 and 2, the illusory effect for the size remains the same while the illusory effect for the brightness is inverted. Color and size are not critical in this illusion; nor is the number of spokes in the Dynamic Luminance-Gradient Illusion. These observations suggest that the gradient of the boundaries is the most important factor—the illusory effect disappears if the boundaries are sharp or luminance changes occur in steps, without any graded change of luminance.

Furthermore, in exploring many possibilities, we realized that other well-known patterns that have similar luminance gradient changes produce these illusory effects. For example, the Vasarely pattern (Vasarely 1970; Troncoso et al 2005) or the pattern of the glare effect (Zavagno 1999) elicit both illusory effects described above if one moves towards and away from them. Many shapes can produce such illusory effects if the gradient of luminance is present at the boundaries (figure 3).

A question that could be raised is why these effects have not been discovered before in view of the fact that the Vasarely pattern is so well known. Part of the answer could be that the common version of the Vasarely pattern is posterized and the boundaries of the figure are made up of different luminance steps, not by a gradual change in luminance like in our pattern. To clarify that, we created a posterized version of the Breathing Light Illusion where the illusory effects are clearly reduced (figure 4).

Informal observations in sixty subjects (age range 19 – 70 years) revealed that everybody was able to perceive the phenomena described above while moving towards or away from these patterns.

These new illusory effects are produced by backward and forward motion like the phenomena reported by Pinna and Brelstaff (2000) and by Gori and Hamburger (2006).

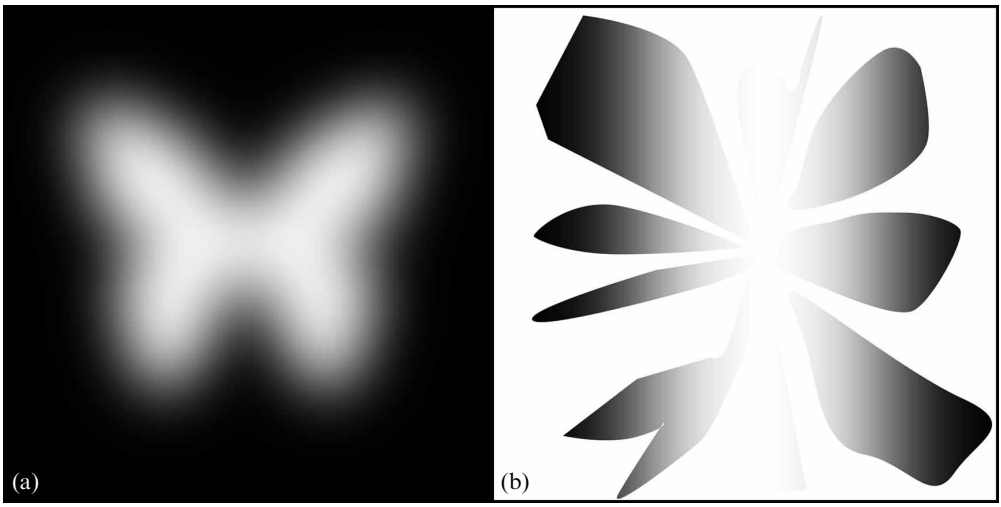

Figure 3. Different shapes do not break the effect of the Breathing Light Illusion: a butterfly (a) and a random shape (b) still present the variation in size and in brightness figure when the observer approaches these stimuli.

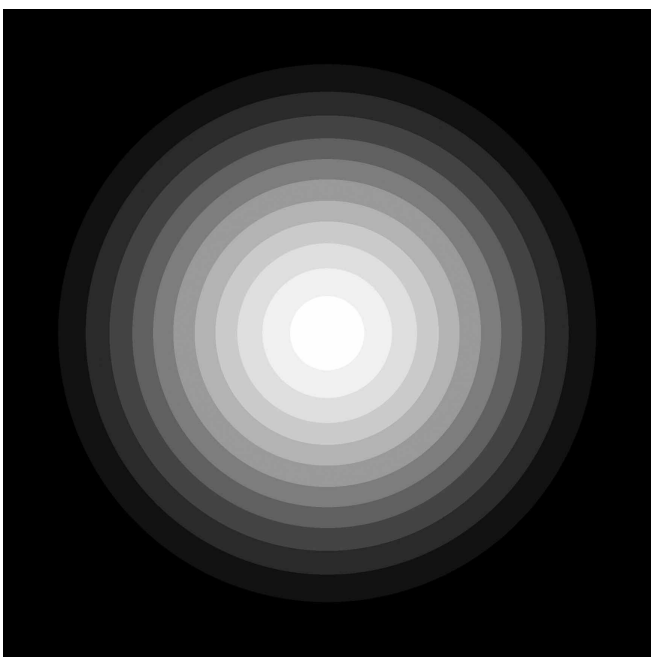

Figure 4. A posterized version of the Breathing Light Illusion. Here, the illusory effects are reduced.

We observed two different illusory effects here that deserve to be analyzed separately. The variation in luminance also has effects on images with sharp boundaries that are put in the center of the Breathing Light Illusion. For example, if a small square is put in the center of the spot and the observer moves backwards and forwards, the small square will show a variation in apparent brightness. Previously Agostini and Galmonte (2002) observed a similar phenomenon with a pattern filled by a linear achromatic gradient from black (outer part) to white (inner part). If a square is put in the center of this pattern, it appears darker than the same square put in a homogeneous background of the same color as the center of the blur pattern. Here, we have

something new: an object put in the center of our pattern changes in apparent brightness as a function of the motion of the observer. This phenomenon is comparable to a physical situation when one light is behind a semitransparent object and the observer moves backwards or forwards. One explanation of this effect could be that these patterns, with gradients of luminance change, suggest to our visual system the presence of an optic flow, like a tunnel with a light at the end.

A variation in size is the other illusory effect that is elicited by our patterns. Size constancy is a well-known phenomenon: if the observer looks at an object in front of him/her and moves closer or further, the size of the object doesn't change despite the variation of the retinal image. With our patterns the size of the diffuse spot varies as a function of the size of the retinal image. If the subject moves closer to the stimulus, the size of the retinal image of that stimulus becomes bigger—with our stimulus the brain does not correct that and we see the size of the spot growing. This phenomenon is quite unique and breaks the usual effects of size constancy. One possible explanation could be that our visual system cannot bring the blurred boundaries into focus and for this reason the correction of the brain for size constancy does not occur. Another explanation is the one we suggested above for the variation in luminance, where our visual system interprets these patters as three-dimensional tunnels with light at the end. In that case the variation of the size could be attributed to an error of interpretation by our visual system that behaves as it would do in a comparable physical situation instead of realizing that it is presented with a bi-dimensional pattern.

For both illusory effects a trivial explanation could be suggested: the reason for the increase of apparent brightness and increase of size could be due to the increase of visual acuity when the subject moves forward towards the stimuli. To rule out this possible interpretation, we created a new pattern based on the Dynamic Luminance-Gradient Illusion with superimposed circles (figure 5).

Here we can see that, when the continuum of the gradient is broken, the two illusory effects disappear. Moreover, it is important to specify that the illusory effects are

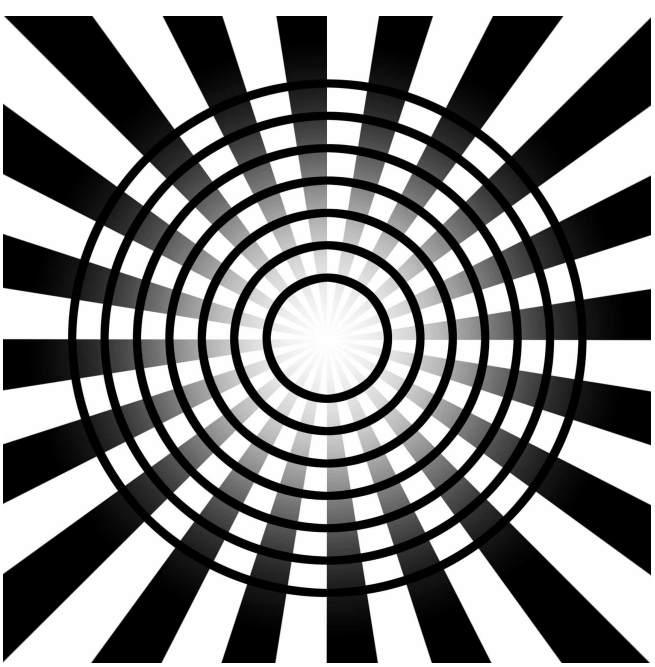

Figure 5. Concentric circles are superimposed on the Dynamic Luminance-Gradient Illusion. The continuum of the gradient is broken and the illusory effects disappear.

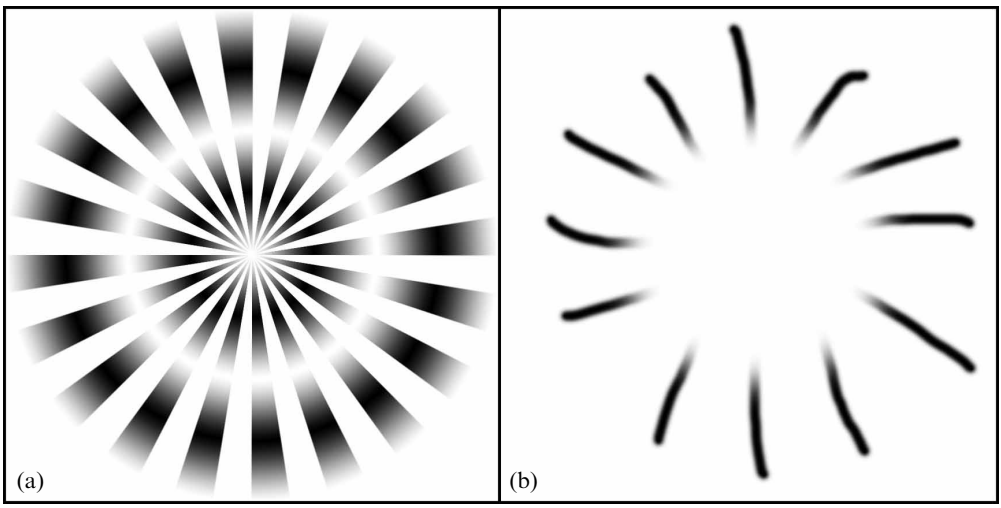

Figure 6. Some variations of the illusions that present the same illusory effects. (a) an example of more than a gradient. (b) An example with illusory borders. Color figures that show one example of hue variation can be viewed on the *Perception* website at http://www.perceptionweb.com/misc/p5668/.

present even with low-contrast stimuli that are very close to equiluminance. We would like to show also some interesting variations with illusory borders, with more than a gradient or with variation in the hue (figure 6).

We suggest that these illusions could be candidates for fMRI studies investigating the illusory variation of luminance and size constancy because our patterns are quite simple and it is easy to create control stimuli with sharp boundaries.

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References

Agostini T, Galmonte A, 2002 "A new effect of luminance gradient on achromatic simultaneous contrast" *Psychonomic Bullettn & Review* **257** 243 – 245
Gori S, Hamburger K, 2006 "A new motion illusion: The Rotating-Tilted-Lines illusion" *Perception* **35** 853 – 857
Pinna B, Brelstaff G J, 2000 "A new visual illusion of relative motion" *Vision Research* **40** 2091 – 2096
Stubbs D A, Best L A, Smith L D, 2006 "Exploring Mach Bands: new variations", paper presented at the Annual Meeting of the Canadian Psychological Association, Calgary, Alberta, 8 – 10 June
Troncoso X G, Macknik S L, Martinez-Conde S, 2005 "Novel visual illusions related to Vasarely's 'nested squares' show that corner salience varies with corner angle" *Perception* **34** 409 – 420
Vasarely V, 1970 *Vasarely II* (Neuchâtel: Éditions du Griffon)
Zavagno D, 1999 "Some luminance-gradient effects" *Perception* **28** 835 – 838

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