Swimmers, Eels, and other Gradient-Gradient illusions

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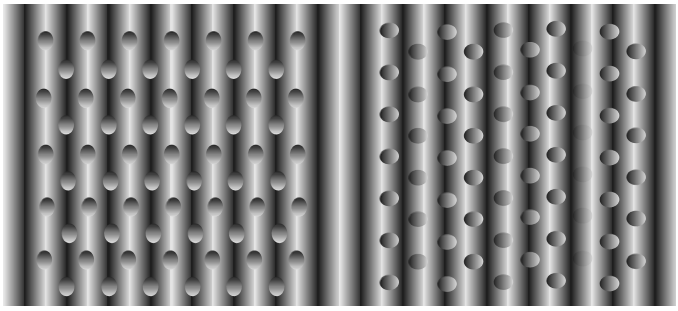
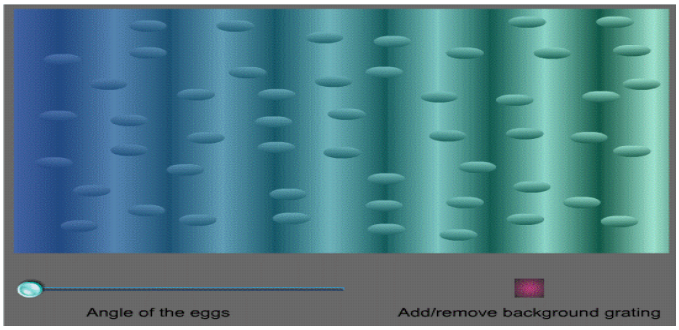
Many studies have shown that gradient borders (or shadows) that surround a *uniform* field create dramatic shifts in perceived lightness. Here, we show lightness and motion illusions that arise when gradient borders surround *gradient* fields (something akin to "shadows around shadows"). The illusions can be seen by clicking on the file IndexGradGrad.html or IndexGradGrad.swf.

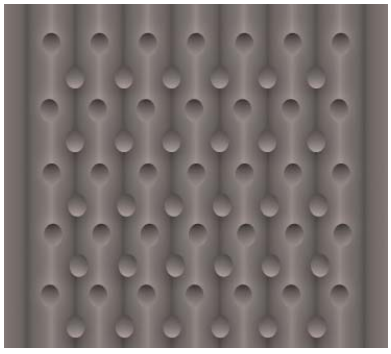
**What to notice:**



***Egg-drops:*** The egg-drop illusion shows the dramatic lightness effects that arise when gradient eggs are placed against gradient backgrounds (the eggs in each of the adjoining figures are identical). The effect occurs when the egg gradients share the same orientation as the background gradient, and when the egg gradients are orthogonal to the background gradient.




***Swimmers and eels:*** When gradient eggs move across gradient fields, the eggs appear to bob up and down. The interactive movies show this effect in a variety of spatial configurations and with different interactive features. The effect is similar to a footsteps illusion within a single object: the bright part of the egg moves toward the bright part of the gradient, and the dark part of the egg moves toward the dark part of the gradient.



**What causes these effects?**

We contend that there is a direct correspondence between perceptual effects in the displays and the information present in the displays; the visual system simply extracts information that we don't usually consider when describing the stimulus. For instance, if the low spatial-frequency information is removed from the egg-drop display (see the adjoining figure), the luminance values of the eggs in the resulting image correspond to the relationship of perceptual light and dark in the original image. It is possible that the visual system adaptively adjusts its spatial response to eliminate redundant or unnecessary low spatial-frequency information (see Frazor and Geisler, 2006).

Similarly, the swimmers and eels arise because motion energy is produced when the contrast at the edges changes (or contrast at larger spatial scales). The mechanisms underlying these effects for one-dimensional stimuli were described by Lu and Sperling (1999) and by Shapiro et al (2005). We think that the effects here show how these mechanisms respond to two-dimensional stimuli. In the words of Lu and Sperling (1999) "there is no great mystery as to why [such motion effects] occur." What is curious is why such effects consistently contradict our notions of reality.