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Last but not least

Similarity between Petter's effect and visual phantoms

Abstract. Here we draw attention to similarity between Petter's effect and the visual phantom illusion. Phantoms are visible when the spatial frequency of the inducing grating is low or the occluder is thin, whereas phantoms are invisible when the spatial frequency of the inducing grating is high or the occluder is thick. Moreover, phantoms are perceived in front of the occluder when they are visible, whereas the occluder is seen in front of the inducing gratings when phantoms are invisible. These characteristics correspond to Petter's effect, in which the thicker region tends to be perceived in front of the thinner region when two regions of the same lightness and of different sizes overlap, since 'thick' corresponds to low spatial frequency of the inducing grating or a thick occluder while 'thin' corresponds to high spatial frequency of the inducing grating or a thin occluder.

When two objects of the same lightness and of different sizes overlap, the period the thicker region is perceived in front of the thinner region is longer than the period the thinner region is perceived in front of the thicker region (figure 1). This phenomenon is called Petter's effect (Petter 1956) and has been extensively studied (Kanizsa 1979; Shipley and Kellman 1992a; Tommasi et al 1995; Masin 1999; Singh et al 1999). Two characteristics have been investigated to explain Petter's effect. One is the size of objects and the other is the length of the interpolating contours. In the former case it is claimed that the larger object tends to be perceived in front of the smaller one since an object near to an observer tends to appear larger than an object distant from the observer. In the latter case it is claimed that an object completed by a shorter interpolating contour tends to be perceived in front of an object completed by a longer one, since modal completion requires more 'energy' than amodal completion and the larger object in front is usually accompanied by shorter interpolating contours than does the smaller one (Petter 1956; Takeichi et al 1995; Tommasi et al 1995; Forkman and Vallortigara 1999). Evidence favors the latter position. Recently, Singh et al (1999) examined the effect of the support ratio (Shipley and Kellman 1992b) on Petter's effect and obtained positive data; Forkman and Vallortigara (1999) reported Petter's effect in domestic hens.

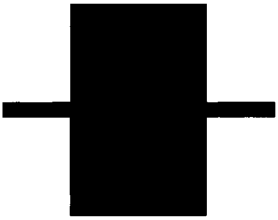
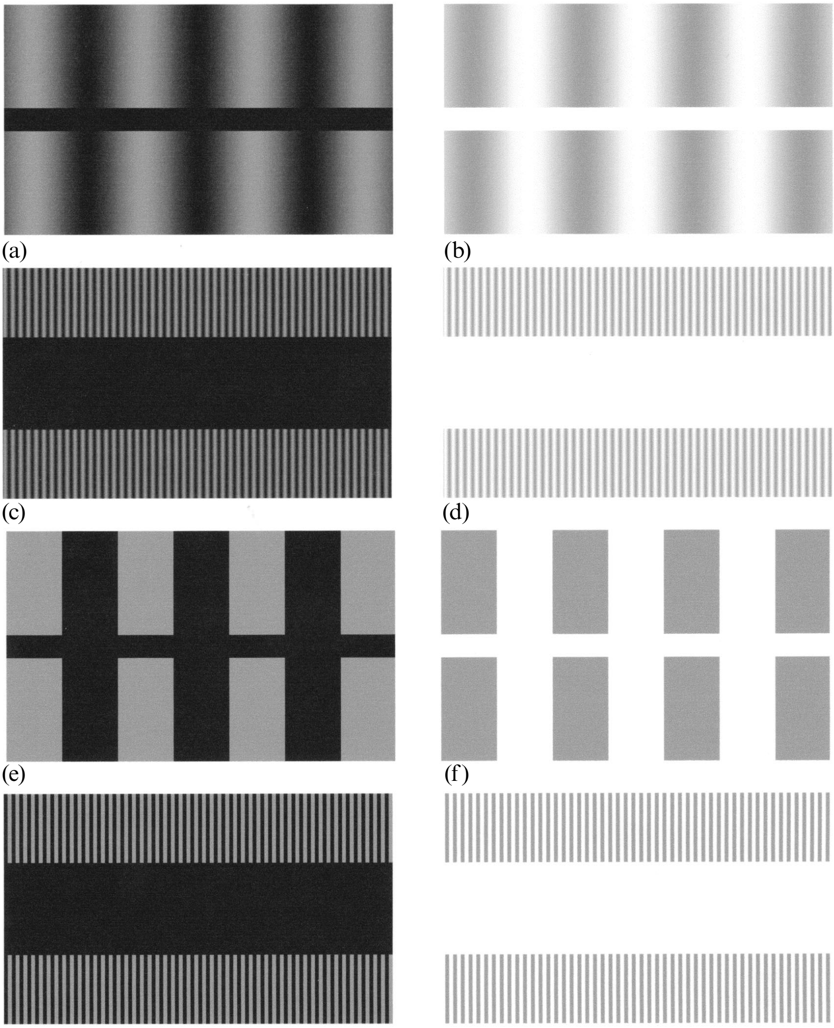


Figure 1. An example of Petter's effect, in which the thick vertical rectangle tends to be perceived in front of the thin horizontal rectangle.

Here we try to explain Petter's effect from a different viewpoint, focusing on the unique characteristics of the visual phantom illusion. This illusion is a kind of a perceptual completion phenomenon, which appears in a configuration like figure 2. The most important feature of this illusion is that phantom gratings appear continuous with inducing gratings across and in front of the occluder. The visual phantom illusion was first discovered by Rosenbach (1902) and developed by Tynan and Sekuler (1975) as 'moving phantoms' because of its strong dependence on motion. It was later revealed that phantoms can be generated by flickering the grating (flickering phantoms)



(a) (b) (c) (d) (e) (f) (g) (h)

Figure 2. Examples of visual phantoms. (a) and (e) Black phantoms, in which dark regions of the inducing grating appear to bridge over the black (horizontal) occluder. (b) and (f) White phantoms, in which light regions of the inducing grating appear to bridge over the white occluder. (a), (b), (e), and (f) The spatial frequency of the inducing grating is low and the occluder height is small. In this case, phantoms are frequently seen in front of the occluder. (c), (d), (g), and (h) The spatial frequency of the inducing grating is high and the occluder height is large. In this case, the occluder is seen in front of the inducing grating. (a) – (d) The inducing grating is sinusoidal-wave. (e) – (h) The inducing grating is square-wave.

(Genter and Weisstein 1981) as well as by low-luminance stationary gratings under dark adaptation (stationary phantoms) (Gyoba 1983).

Visual phantoms have two unique characteristics. One is the spatial frequency characteristic and the other is the perceived depth. The former refers to the tendency that phantoms are visible when the spatial frequency of the inducing grating is low or when the occluder height is small, whereas phantoms are invisible when the spatial frequency of the inducing grating is high or when the occluder height is large (Gyoba 1983). The latter refers to the phenomenon that visual phantoms are perceived in front of the occluder when they are visible, whereas the occluder is perceived in front of the inducing grating when phantoms are invisible (Brown and Weisstein 1988, 1991).

The reason why phantoms are always seen in front of the occluder will be discussed in a separate article (Kitaoka et al, 2001).

We think that these two characteristics have a close relationship to Petter's effect. Figures 2a and 2b show the black and white versions of visual phantoms, respectively, in which phantoms are perceived in front of the occluder. This clearly visible demonstration is due to the low spatial frequency of the inducing grating and the thin occluder. On the other hand, when the spatial frequency of the inducing grating is high and the occluder is thick (figures 2c and 2d), phantoms are invisible and the occluder occludes the grating. Moreover, visual phantoms have also been investigated with square-wave gratings, the characteristics of which resemble those of sinusoidal-wave phantoms (Gyoba 1983). Figures 2e – 2h show the square-wave versions of figures 2a – 2d. These square-wave figures are quite similar to figures which demonstrate Petter's effect. Figures 2e and 2f show that vertical bars tend to be seen in front of the horizontal bar (= occluder) whereas figures 2g and 2h demonstrate the reverse.

In conclusion, Petter's effect has a strong resemblance to the characteristics of visual phantoms, which belong to a class of completion phenomena but have so far drawn little attention to the study of Petter's effect. It is therefore suggested that a deeper understanding of Petter's effect could be brought by further investigation of visual phantoms, and vice versa.

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