Discuss low-level and high-level explanations of illusory contours essay

It would appear that the process of perceiving images, objects and color is an effortless activity, however the underlying mechanisms involved are fundamentally very complex and not fully understood even today.

Only in the last one hundred years have scientists started to make some progress in understanding vision and perception, and visual illusions in particular provided a window into these processes. Even when we intellectually can determine that we are looking at an illusion, it does not keep us from being effected by its properties. This indicates a split between our perception of something and our conception of it. In many cases our higher order cognitive abilities cannot influence our lower order perceptions (Gregory, 1975). For example in the famous Kanizsa's illusion, the solid triangle in the center appears to have well-defined contours.

Observers generally report a strong phenomenal impression that contours continue between the inducing areas of the stimulus and that the region bound by the illusory contours appears either lighter (or darker) than the background. It emerges as an opaque surface that is superimposed on the background figure and although we are aware of illusory properties of the triangle we cannot stop ourselves experiencing the illusion (Sekuler ; Blake, 2002). This occurrence is by no means unique to Kanizsa's triangle. There are many other visual stimuli which produce similar results upon viewing. The illusory contour phenomenon has been studied quite intensely by psychologists over the years. Pradzny (1985) reported that over 440 papers had been published on this topic.

These studies reveal many links between the illusory contour phenomenon and other visual phenomena such as monocular depth perception, binocular depth perception, amodal boundary completion, neon color spreading effects, etc. Despite this research effort, scientists still disagree on the mechanisms behind the illusory contour phenomena and at what stages of visual system do they actually appear. (Sekuler & Blake, 2002). Several lines of evidence support the view that subjective contours reflect normal, built-in assumptions of the visual system. Nonhuman creatures also see subjective contours (Bravo, Blake, and Morrison, 1988; Nieder and Wagner, 1999), which is understandable since the visual system of those creatures evolved in the same environment as ours. Brain damage, however can selectively disrupt the ability to see subjective contours, leaving other aspects of vision unaffected (Eysenck & Keane, 2000).

In order to try and consider the present evidence for the stage formation of illusory contours, it is important to distinguish between the two main theories of perceptual order. The bottom-up processing implies that our awareness of the surrounding world is basically determined by the information received by the sensory receptors. This view originated from the direct perception theory put forward by Gibson (1979). He argued that perception essentially involves ‘ picking up’ the rich information provided by the optic array and involves little or no unconscious information processing, computations or internal representations. He believed that the amount of data contained on the retinal image is often underestimated.

The theory has been accepted as a valuable explanation of perception in animals where visually guided behavior is very transparent. Animals often have to detect information in the difficult conditions and the idea of conceptual representation of its environment seems a bit far fetched. However, there are many aspects to which Gibson's theory fails to offer an explanation, such as the functioning of constancies, illusions, experience of cataract patients etc. (Gross, 1998).

The opposite view comes from Gregory's theory of cues and hypotheses, which is also known as concept driven processing or a constructionist approach. The top-down processing suggests that perception is the end product of a process which starts with sensory stimulation but also refers to making deductions about what things are like, drawing on our previous knowledge and expectations of the world. This makes our perception indirect. Gregory's view is supported by the fact that perception is sometimes inaccurate as in the case of visual illusions.

He argues that when we experience a visual illusion what we perceive may not be physically present in the stimulus (and therefore not present on the retinal image) but our brain attempts to fill in the gaps on the basis of previous experience. Unfortunately, by adapting this view, it becomes impossible to explain why vision is generally accurate even in novel situations and why the system has different adjustment times depending on the type of the imagery (Gross, 1998). In relation to the illusory contours: there are three defining properties of illusory contours: clarity (or sharpness of the contours), brightness (of the illusory figure), and depth (the " depthfulness" of the illusory figure) (Lesher, 1995). Illusory figures need not exhibit all of these properties.

For example, illusory contours can appear without an accompanying illusory figure (no depth), such as in offset-grating stimuli. Two major types of illusory contours can be distinguished: edge-induced and line-induced. Edge-induced illusory contours consist of solid inducing elements containing edges, or gaps, locally consistent with an occluding figure of the same luminance as the background. Line-induced illusory contours, on the other hand, can be seen as the limiting case of edge-induced figures, where the inducers are typically " thin." In this case, the associated illusory contours are not parallel to the inducers, but instead roughly perpendicular to them (the Kanizsa triangle presents both types of inducers).

The three black, circular " pac-men" act as edge inducers, while the thin lines work as line-end inducers (Lesher, 1995). Several researchers have suggested cognitive theories of illusory contour perception, most notably Gregory (1972) and Rock (Rock ; Anson 1979). In these theories, illusory contour formation is largely the result of a cognitive-like process of postulation. Illusory contours are viewed as solutions to a perceptual problem: " What is the most probable organization that accounts for the stimulus?" Although there is ample evidence for the role of cognitive influences in illusory contours, current studies point to the importance of relatively low-level processes in the formation of illusory contours. Two lines of evidence point to an early neural mechanism for illusory contour completion: (1) neurophysiological data, and (2) psychophysical studies of the similarities between real and illusory contours.

In an influential paper, von der Heydt and colleagues (von der Heydt et al. 1984) presented results from single cell recordings suggesting neural correlates of illusory contours in area V2 of the macaque monkey. Almost half the cells examined exhibited sizeable responses to drifting bars or edges and also to the illusory contour induced by drifting line gratings. Cells were not simply responding to individual line-ends, however, since the typical cell would not respond to a grating with only 2 or 3 bars, but would respond with increasing strength as other bars were added, until a saturated level of activity was reached.

Von der Heydt et al. (1984) also studied neural responses to notch stimuli - dark rectangles with parts missing, forming an illusory rectangle. Cellular activity fell off with increasing notch separation and was greatly reduced when only a single notch was present, in parallel with the perceptual disappearance of the illusory figure. In all, the cellular recordings of von der Heydt et al. revealed cells whose responses to illusory contour variations resembled human psychophysical responses to similar variations. Although some have described these findings as the discovery of “ illusory contour cells”, von der Heydt et al.

(1984) tried to draw a clear distinction between the stimulus-response relationship, on the one hand, and perceived entities, on the other. For instance, they used the term “ illusory contour stimuli,” rather than “ illusory contour cells,” and they borrowed the term “ anomalous contours” from Kanizsa (1955, 1979) to define a stimulus property without reference to perception (Lesher, 1995). Psychophysical evidence: Many psychophysical studies have provided evidence for a common early treatment of both real and illusory contours by the visual system (Lesher, 1995; Spillman ; Dresp 1995). For example, Smith and Over (1975; 1979) have revealed similarities between the two types of contours in the realm of motion aftereffects, tilt aftereffects, orientation discrimination, and orientation masking. Tilt aftereffects are particularly interesting.

A tilt aftereffect will occur if one adapts for a few seconds by looking at lines oriented counterclockwise from the vertical, and then one is exposed to a test stimulus of vertical lines. The latter will appear to be tilted clockwise, away from the adapting orientation. There is compelling evidence from recent studies showing that tilt aftereffects cross over between real and illusory contours (Paradiso et al. 1989). Thus adaptation with real lines can affect the perception of illusory contour orientation and vice-versa.

An important question concerns the level at which real and illusory contours have similar status. Motion and tilt aftereffects are often attributed to short term habituation in early visual stages (Movshon et al. 1972). Thus the evidence from psychophysics is that real and illusory contours share internal processes at an early level of the visual system. In fact, there is considerable evidence pointing to the functional equivalence of real and illusory contours in the operation of the visual system (Lesher 1995). Paradiso et al.

(1989) studied whether adaptation to illusory contours produces tilt aftereffects comparable to those obtained for regular real lines. They initially established that illusory contours used in both adaptation and test phases produce strong tilt aftereffects. Can adaptation to illusory contours induce an aftereffect when real lines are used in the test phase (or vice versa)? Paradiso and colleagues showed that the answer is yes. Adaptation to real lines induces a strong aftereffect when testing with illusory contours, but a significantly weaker aftereffect is obtained when adaptation to illusory contours is used and real lines are tested.

The authors attribute this asymmetry to the corresponding asymmetry in the distribution of receptive field types in areas V1 and V2 (cells responding to illusory contour stimuli are typically found only in V2). In summary, the existence of a tilt aftereffect with illusory contours and its dependence on adaptation angle indicate the existence of orientation-selective neurons that respond to illusory contour stimuli. This is pointing out that real and illusory contours share an early visual pathway. In a recent study, Grosof et al. (1993) suggested the existence of neurons in V1 of macaque that respond to line-end stimuli similar to offset gratings.

The results remain controversial, however, and await further controls to establish the role these neurons play in illusory contour perception (Lesher, 1995). In conclusion it is reasonable to say that the representation of illusory contours in the visual system takes places in the early stages of perception. Although making a link between single cell activities and perceptual phenomena is problematic, the evidence here seems to suggest that the perceptual completion of boundaries involves the neural completion of a presence, rather than “ ignoring an absence.”