Pictures as strange objects of perception

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Abstract

Pictures have a double reality – objects in their own right and representing quite different objects in a different space and time. We may call these Other Worlds of pictures.

The first artists were cave painters; though there were far earlier pictures of bird's eyes on butterfly wings, produced by natural selection. For perception I distinguish 'cues' from 'clues'. This is from innate knowledge, to knowledge learned by individual experience. Knowledge is key to perception – as perceptions depend on and also provide knowledge.

Trompe l'oeil is the most dramatic use of cues and clues; but the more realistic a painting the more dramatic are its illusions, especially associated with moving around the painting, or (most dramatic) a trompe l'oeil dome of a cathedral. There is an attempt to classify phenomena of illusions.

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1. Introduction

Rather than looking at art history we look here at the biological origins of pictures – with associated phenomena of illusions. It is hoped that this may provide a context for thinking about the history of art.

Any picture is remarkable as it has a double reality. Like any ordinary object it is in our world of Here and Now, and miraculously a picture is also in Another World in a different space and time. It is indeed miraculous that we see entirely different objects, such as people, in a blob of paint.

F. G. Barth et al. (eds.), *Sensory Perception*

Fig. 1 Bird's eyes 'painted' on butterfly wings by natural selection. This is pre-human art, designed to attract and warn

Other Worlds of pictures was the invention of cave artists of, perhaps, half a million years ago. Pictures are as magical to us now as they must have been to the first artists. Actually these were not quite the first pictures, for pictures have a much earlier biological origin deep in evolution – bird's eyes painted on butterfly wings, by Natural Selection millions of years ago (Fig. 1). These are remarkably realistic, with their eyespot reflections, serving as false though effective warnings to birds. As we also see them as eyes, these first pictures suggest that bird vision (and birds are descended from dinosaurs) is quite similar to ours.

2. Cues and clues

Vision works from innate *cues* triggering reflexes and inherited behaviour patterns, learned by the genetic code, and in 'higher' animals and man from sophisticated *clues,* based on individual knowledge learned by brains. The ideal example is the inferences of the Victorian fictional detective Sherlock Holmes from small clues, depending on his wide knowledge including brands of tobacco and varieties of human behaviour. Although this suggested distinction between cues and clues may not be generally accepted, it seems useful for thinking about origins of perception in evolution and from individual experience.

3. Trompe l'oeil

Pictures present patterns that are accepted as familiar cues and clues for recognising objects and events in the normal world. In art, depicted cues and clues are most effectively presented in trompe l'oeil paintings. We may ask . . .

3.1 Why is trompe l'oeil so effective?

We have said that everyday perception works from innate cues and learned clues for recognising objects, with their sizes and where they are in surrounding space, for interactive behaviour in a largely hostile world. Trompe l'oeil presents these same cues and clues but pictured as patterns on flat surfaces, generally with marked perspective and painted shadows suggesting depth – though in a flat picture this is illusory (Fig. 2). It is interesting that photographs seem to be less effective than the best trompe l'oeil paintings. This is presumably because the artist is free to use exaggerated though fictional cues and clues, based on experience of real objects and events. As a picture is physically very different from the objects it represents it can evoke bizarre illusions, especially with movement.

Fig. 2 Though a flat pattern, this still life evokes three-dimensional objects from painted cues and clues normally from the world of objects (Julian Merrow-Smith, Still Life with Autumn Fruits, 2010)

3.2 Moving illusions of trompe l'oeil

Visual cues and clues derive from interacting with objects, and they work well for interactive behaviour with normal objects. But strange distortions occur when the viewer moves around a trompe l'oeil picture, which, though flat, represents objects in three-dimensional space. As the observer moves around, the picture's flat images do not transform at all like retinal images of normal objects, including those portrayed in the picture. This absence, or very different change at the eyes with movement, produces remarkable dynamic distortions that defy description.

The bizarre movements and distortions of a large trompe l'oeil dome, as one moves under it, are truly wonderful. For example, the painted ceiling of the church of Sant' Ignazio in Rome or the false dome of the cathedral in Arezzo in Tuscany are dramatic and tell us a lot about how eyes and brains work, and sometimes get things wrong.

The founder of the modern science of vision, Hermann von Helmholtz (1821–1894), suggested a General Principle for explaining many visual phenomena, which comes to our aid here. We may state Helmholtz's Principle simply as: *Perception attributes objects to images.* This explains many illusions, as being false attributions. Seeing pictures as other objects depends on attributing more or less familiar objects to patterns of pigments. It is curious that we see a picture both as a picture and, at the same time, attribute other (often fictional) objects to it. So we see both the picture and what it represents. This is quite different for retinal images, as we do not see into our own eyes.

Helmholtz's Principle applies also to movement. When one moves around a portrait, with its eyes staring out at the viewer, *its eyes seem to follow one's every movement*. This is because, in normal life, eyes that continue to stare at one must be rotating to follow one's movements. We attribute this rotation of normal eyes to the fixed and flat but apparently three-dimensional eyes of a picture. The more realistic the picture, the more powerful is this illusory movement of its eyes.

Returning to the false dome: like the painted eyes, a true dome could only keep an unchanging image in our eyes as we move under it if (impossibly) it rotates to follow our movements. So this is what we see, although it is impossible and has zero probability! But there is more to these illusions of movement with large architectural trompe l'oeil, such as a false dome, for they undergo remarkable static distortions when we have moved away from the 'correct' position for viewing them. This is because these retinal images have not changed as they would for a three-dimensional object, such as a truly hollow dome. There is a continually up-dated expectation of shape changes according to the three-dimensional shape the object is *seen* to have – though this is inappropriate for a picture, as the picture is truly flat. As these pictures are *seen* in depth though they are flat, so there are discrepancies between what is expected and what happens at the eyes. The difference between the expected and the optical changes of the retinal image gives these static and dynamic distortions.

We attribute a face even to the sketchiest portrait, making the task of the artist easier than might be thought. Indeed, except for trompe l'oeil, the viewer contributes at least as much as the artist for seeing a picture. So we see 'faces in the fire' and the 'man in the moon' even from random patterns. There is a continuum in art from inkblots to trompe l'oeil, with wonderful revealing phenomena along the way (Fig. 3).

4. Classifying illusions

Vision evolved over millions of years – though not of course originally for pictures – which we see through processes that evolved for interacting with dangerous and rewarding objects. Vision's perception from a distance – and so power to predict – was immensely useful for survival. Pictures, though not immediately useful, depend on these life-death lessons from dangers and rewards of normal objects. Pictures are a fortunate gift for humans, bought by ancestral disasters.

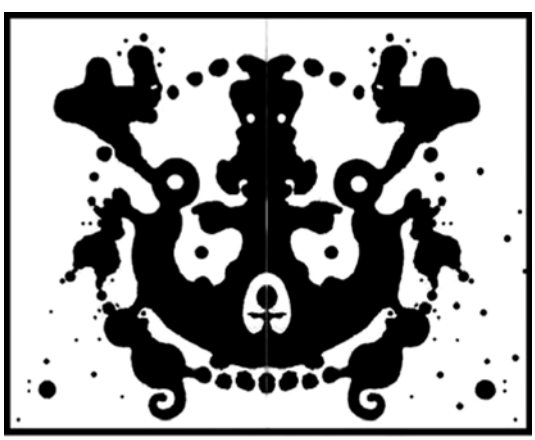

Fig. 3 Seeing scenes and people in ink blots shows the creative dynamics of vision.
www.inkblottestwallpaper.com/INK-BLOT TEST 01

With the risks of any dangerous speculation, key stages of evolution of vision seem to be from: passive *Receptions* of stimuli, for behaviour by reflexes and tropisms from cues, to active constructive *Perceptions* from visual clues, from knowledge of objects and how they behave. Finally, at least human brains developed *Conceptions* for thinking and communicating abstract ideas with symbols. Paintings, in their strange Other Worlds, involve all three.

The linking theme is increasing use of knowledge, from *receptions* to *perceptions* to *conceptions*. As misapplied knowledge can be deeply misleading it is not surprising if errors (phenomena of illusions) become richer and more interesting through this development from control by stimuli to perceptions as guesses – hypotheses of what is out there.

These speculations suggest that it might be interesting to classify phenomena of illusions. Here is an attempt, by kinds and causes, which will take us to pictures (Table 1). The idea is that there are very general rules for perception (here called 'sideways rules', rather like grammar in language) and top-down knowledge of objects and their characteristics and uses, and finally conceptual understanding. As classifying has been so important through the history of science, we may find it useful here for understanding the phenomena of illusions and the wonder of pictures.

Conclusion

Art works by using 'cues' and 'clues' important for survival in a dangerous world, where objects are more than patterns in the eyes. Art is not only cultural, it has its roots in the biological evolution of perception by which brains represent the world of objects for intelligent predictive behaviour.

References

Gregory RL (1997) Eye and brain: The psychology of seeing (5th edn.). Oxford University Press, Oxford, UK

Gregory RL (2009) Seeing through illusions (1st edn.). Oxford University Press, Oxford, UK

Ebert-Schifferer S, Staiti P, Wheelock A K, Singer W (2003) Deceptions and illusions:Five centuries of Trompe L'Oeil paintings (1st edn.), National Gallery of Art, Washington DC

Gombrich E (1950) The story of art (1st edn.). Phaidon, London, UK

Websites for trompe l'oeil dome:
www. museumplanet. com/tour.php/venice/l/9;
http://commons.wikimedia.org/wiki/File:Sant' Ignazio_-_painted_dome_-_antmoose.jpg

Table 1

Kinds and Causes of Illusions

KINDS	CAUSES: Receptions →	Perceptions	→	Conceptions
		Side-ways Rules	**Top-down** Knowledge	Understanding
NOTHING	**Blindness** Long-term total blindness has no sensation – like behind one's head.	**Perceptions as hypotheses** Perception is *attributing objects to images*, forming predictive hypotheses. **Inappropriate rules** Produce illusions with normal physiology.	**Agnosia** *Lack of visual knowledge* Failure to recognise even familiar objects (generally from brain damage.)	**Ignorance** Without understanding, the world looks like a conjuring trick.
INSTABILITY	**Jazzing** Op. Art. McKay Rays (Repeated lines stimulate on-off cells with eye tremor). ***Shifting contours*** Ouchi illusion. (Lack of 'border-locking'?)	**Grouping** Random dot patterns group and regroup by Gestalt Rules: closure, contiguity, common fate etc.	**Constancy Scaling** 'Constancies' partially compensate changes of size and shape to make the visual world stable. Inappropriate Constancy scaling produces distortions.	**Brain changing its mind** Conceptions are constructed from memory and imagination, by following cognitive rules and guided by probabilities.
CON-FOUNDED AMBIGUITY	**Sensory differences** Limited by neural noise, and overlapping of response curves. ***Colour*** Red+green yellow light looks the same as monochromatic yellow, (as the R and G pigments overlap, giving yellow when nearly equal).	**Object differences** When their images are the same, different objects must look the same. *Ames Room* Has the same retinal image as a normal room – so must look the same.	**Classifying** Different kinds of objects are often confounded when not familiar or understood.	**Explanations** Depend on analogies and paradigms. As science develops, understanding and appearances separate and may conflict.
FLIPPING AMBIGUITY	**Epilepsy** **Spontaneous brain activity** Neural nets are dynamic, and can be physically unstable. Migraine Visual brain disturbances associated with headache.	**Figure-ground** The most basic decision is whether there is an object present. This is seen dramatically in flipping figure-ground ambiguity, when the brain cannot make up its mind.	**Alternative Perceptions** Perceptions flip to alternatives when the brain can't make up its mind. E. g. *Necker Cube, Duck-Rabbit, young woman/grandmother.* The *Hollow Face illusion* Probabilities normally give stability, but can mislead – a concave hollow facemask looks convex.	**Collapsing wave packets** Objects do not 'flip' to other objects, except in quantum physics. Measurements or perceptions are supposed to 'collapse' many possibilities into particular realities. This creation of physical reality by perception has been ascribed to consciousness. This is totally mysterious.

DISTORTION	**Signal errors** *Contrast:* brightness, colour illusions. *Lateral inhibition* gives only small spatial distortions. *Delay* gives Pulfrich Pendulum phenomenon *After effects o*f continuous motion, tilt, curvature, spatial frequency, colour, etc. may serve to calibrate the senses,	**Cognitive distortions** "Geometrical or ' perspective' distortions: Müller-Lyer; Ponzo; Hering; Poggendorff; Horizontal-Vertical; Harvest Moon etc. On the Misapplied Scaling theory, Depth cues miss-set size-scaling – features signaled as more a distant being expanded. Scaling can also be set 'downwards'.	**Anticipation** Prediction is essential for cognitive perception, but can mislead.	**Reference truths** An object cannot itself be distorted, but may differ from accepted references. Thus a ruler is bent, or too long or too short by reference to some other ruler, accepted as 'true'. Reference to non-illusions is essential for measuring illusions; though illusions can show up as internal inconsistencies.
PARADOX	**Conflicting cues** Parallel channels can disagree when adapted differently. Then perception may reject a discrepant channel or combine aberrant signals or cues into paradox.	**Conflicting clues** The Penrose *Impossible Triangle* can exist as a three-dimensional object, yet appear impossible from certain positions when the sides meet, in the retinal image, though are separated in depth. The false assumption of two-dimensions generates the paradox.	**Conflicting knowledge** Magritte's painting of the back of a man's head – appearing in the mirror instead of his face. This disturbs, as it goes counter to one's visual knowledge of reflections.	**Cognition and physics** Although the brain is a physical system, its 'virtual realities' of perception are not limited by physics; making it possible to imagine and see impossibilities.
FICTION	**Spurious signals** After-images appear as objects that would give the same images, so seen in external space.	**Grouping** Random dots group with the Gestalt Laws – similarity, common fate etc. – into common object features.	**Phantasms** *Faces-in-the-fire; man-in-the-moon; inkblots.* These show the creative dynamics of perception, when alternative hypotheses are evoked from minimal evidence.	**Perceptions and Conceptions** Are both indirectly related to reality, and subject to illusions and delusions.
OTHER WORLDS OF PICTURES	**Cues** Visual cues trigger neural systems, to signal edges, shapes, colours, movement. Artists are free to combine cues in new ways to produce the Other World of pictures.	**Clues** Visual clues are evidence for objects, based on probabilities from previous experience.	**Object knowledge** Confers non-optical properties to images, such as hardness, and warning of dangers and promises of rewards, to personalities of faces. Pictures work by attributing more or less familiar objects to patterns of pigments.	**Pictures** Pictures evoke Other Worlds, of a different space and time from our world.