
The great and golden rule of art, as well as of life, is this: That the more distinct, sharp and wirey the bounding line, the more perfect the work of art, and the less keen and sharp, the greater is the evidence of weak imitation, plagiarism, and bungling. Great inventors, in all ages, knew this: Protogenes and Apelles knew each other by this line. Rafael and Michael Angelo and Albert Dürer are known by this and this alone. … Talk no more then of Correggio, or Rembrandt, or any others of those plagiaries of Venice or Flanders. … The unorganized blots and Blurs of Rubens and Titian are not Art, nor can their Method ever express Ideas or Imaginations ….

Blake, 1948, pp. 617, 625.

As with language so in depiction: the study of ambiguity is one of the main ways in which we can investigate the nature of pictures. But as the quotation from William Blake suggests there are other issues involved beyond that of pure representation. Was Blake right in his belief that the more distinct, sharp and wirey the line in drawing - that is, the absence of any ambiguity in the representation of form – the more perfect the work of art? Other writers have disagreed. Hill (1966) argued that the use of half-resolved, ambiguous forms could be a stimulus to creativity. According to Rawson (1987) the blots and blobs that Blake so despised are ‘an important element in what one might figuratively call the graphic principle of indeterminacy… when the artist wishes to avoid a tight definition or limitation of form by his contour’. Two of the examples he gives are Chinese brush drawings, which can ‘baffle the reading eye as to the precise limits of a form’, and the ‘blot landscapes’ of J. R. Cozens (p. 83).

Blake’s scorn was directed towards artists such as Correggo, Rembrandt, Rubens and Titian who used ambiguous marks: blobs, broad smudgy lines, repeated contour lines around the form or (as in the case of Titian) tonal areas that only refer to the contour by implication (Rawson, 1987). However, in addition to the use of particular kinds of marks ambiguities in pictures can also arise as the result of using particular drawing systems or denotation systems.

The drawing systems are systems that map the spatial relations between features of the scene into corresponding relations on the picture surface. Perspective is one such system, but there are a number of others that have been used in other periods and cultures, or because they are useful in different disciplines (Booker, 1963; Dubery and Willats, 1972, 1983; Willats, 1997). Of these the commonest are oblique projection, which appears in Hellenistic art, Mediaeval art, Persian miniature painting and Chinese art, and orthogonal projection which forms the basis for most Greek vase paintings and is now used for engineering and architectural drawings. Other less common systems are horizontal oblique projection, found in naïve American landscapes and icon painting, and vertical oblique projection, found in Indian painting and some Cubist still life paintings. All these systems can be defined in terms of what Booker (1963) called ‘primary geometry’ as possible projections from scenes.
However, the drawing systems can also be defined in terms of ‘secondary geometry’: that is, the two-dimensional geometry of the picture surface, and especially the geometry of the orthogonals of rectangular objects. (The orthogonals are the lines in a picture representing edges in the third dimension.) In pictures in perspective the orthogonals run obliquely and converge to a vanishing point. In oblique projections the orthogonals run obliquely but are parallel. In orthogonal projection there are no orthogonals, and only the front faces of rectangular objects are shown. In addition there are two further systems that can only be defined in terms of secondary geometry. The first is so-called inverted or divergent perspective, found in icon paintings and some Cubist paintings, in which the orthogonals diverge. The second, and in some ways the more important, is based on topological geometry and is found in children’s early drawings.

Figure 1. We see drawing (a) as a representation of a cube, although it could equally well have been produced as a projection from the scene shown at (b), or an almost limitless number of other similar scenes.

There are two quite different kinds of ambiguities in pictures related to the use of particular drawing systems. In theory all pictures based on one or other of the projection systems ought to be ambiguous in the way they represent three-dimensional shape because any image can be produced by projection from a virtually limitless variety of arrangements of forms in the notional scene (Costall, 1985; Gombrich, 1988). Fig 1a shows a drawing of a cube, and we ‘naturally’ see a cube in this drawing. However, this drawing could in theory have been produced by projection from the arrangement of lines and surfaces shown in fig 1b, and if the scene represented in this drawing were to be gradually rotated clockwise about a vertical axis relative to the observer it would produce the same view as that shown in fig. 1a. During this rotation the ends of the lines e1, e2 and e3 would come together to produce the junction shown at C, which apparently represents a corner. Similarly, the curved line ending in e3 would gradually move into a flat plane passing through the observer’s line of sight and would then appear to represent a straight edge. Moreover, the scene shown in fig. 1b is just one out of an indefinitely large number of possible scenes, which, if viewed from an appropriate viewpoint, could produce the image shown in fig. 1a. Although this kind of ambiguity is always present in theory in
pictures based on projection systems it seems relatively unimportant in practice, because whatever theory may say we persist in seeing fig. 1a as a drawing of a cube.

Figure 2. Giovanni de Paolo (active 1420, died 1482), The Birth of St. John the Baptist. Oil on wood (predella panel from an altarpiece), 30.5 x 36.5 cm. National Gallery, London. Can be viewed at: http://www.nationalgallery.org.uk/cgi-bin/WebObjects.dll/CollectionPublisher.woa/wa/work?workNumber=NG5453

A second kind of spatial ambiguity in pictures can arise from the use of inconsistent mixtures of drawing systems. The space represented in Giovanni de Paolo’s The Birth of St. John the Baptist, (fig. 2) is ambiguous because the mixture of drawing systems used to portray this space is anomalous: the fireplace is in perspective but the bed is in an incoherent version of oblique projection (Willats, 1997). This kind of ambiguity can be found in pictures from a wide variety of periods and cultures including mediaeval paintings and drawings, Byzantine mosaics, Orthodox icon paintings and Persian miniature paintings, and it was used by many twentieth-century painters, notably Giorgio de Chirico, Francis Bacon and Marc Chagall for expressive reasons. The space represented in Cubist paintings is also typically ambiguous but for different reasons: the Cubists wanted to represent the true shapes of objects in their entirety, and tried to do so by combining several different viewpoints within a single picture and using systems other than perspective.

What is it about the use of particular drawing systems that makes one drawing or painting ambiguous and another unambiguous? As I have said, the space in Giovanni de Paolo’s The Birth of St. John the Baptist is ambiguous because it is represented using a mixture of various different drawing systems, but other way of putting this is to say that not possible as a projection from one single coherent scene. The human visual system is designed to make sense of the information available at the retina derived from the projection of light coming from real scenes. In the perception of real scenes this information is continually changing as we move our eyes, or as the scene changes, but at any one moment this information is derived from a single view. But because the visual system is not designed to make sense out of simultaneous combinations of views from different viewpoints, and picture perception is parasitic on scene perception, combinations of such views in pictures look anomalous. The best the eye can do is to try to make sense of sense out of those parts of the picture whose geometry could have been derived by projection from a single viewpoint – the fireplace in the Birth of St. John, for example, or the bottom of the bed. But the viewpoints for these two parts of the scene are not compatible, so the space in between looks ambiguous.
Ambiguity can also result from the use of particular *denotation systems*. Gombrich (1988) describes this kind of spatial ambiguity in his chapter on ‘Ambiguities of the Third Dimension’. He gives as an example a chain of rhomboids that we see as a zigzagging band of rectangles (fig. 3). As Gombrich pointed out there are two possible readings of this chain of rhomboids and we can change from one to the other by an effort of will. But ‘what we cannot do even with the greatest effort is to see or imagine the various irregular shapes the rhomboids would have to make to fit any in-between position, though reason and mathematics assure us that an infinite number of such irregular shapes must exist’ (p.222). The ambiguity here arises because we can see the vertical line in the centre of the drawing as representing either a concave or a convex edge, and the two vertical lines on either side as convex or concave.

Whereas the drawing systems control the spatial relations between features, the denotation systems determine what these features stand for, refer to, or denote. In line drawings, for example, lines in the picture are commonly used to stand for a variety of different features in the scene, including edges, contours, thin wire-like forms such as hair, and the boundaries between areas of different colours or tones. In the example given by Gombrich all the lines stand for edges, but slightly different kinds of edges. Some are the edges of planes having a surface on one side only (occluding edges). Others have surfaces on both sides and the lines representing the angles between them can change their meaning from concave to convex.
Drawings 4a and 4b are both in oblique projection, but while (a) is (relatively) unambiguous, (b) is ambiguous and can be seen in three different ways, so the difference in ambiguity here is not a result of the drawing system used. Instead, it results from the use of two slightly different denotation systems. Drawing (b) contains three kinds of line junctions: L-junctions, arrow-junctions and Y-junctions. In drawings of this kind arrow-junctions and Y-junctions stand for corners, but in both cases these corners can be either concave or convex to the viewer. The arrow-junction in the centre of the drawing, for example, can be seen as either concave or convex, so that it can be seen as representing the concave corner left when a small cube has been removed from a large cube, the convex corner of a small cube stuck up into a larger concave corner, or the convex corner of a small cube sticking out of a large cube at an oblique angle. In drawing (a), however, also contains a T-junction standing for the point at which an edge just disappears behind a face. This tells us that the L-shaped face at the bottom of the drawing must be in front of the two faces on either side of the edge it partially hides, and geometry tells us that the two remaining faces must recede from this front face. As a result drawing (a) is unambiguous. 

In drawing (c) some parts of the drawing seem to recede in 3-dimensional space, but the depicted spaces are not coherent, the drawing as a whole is anomalous and the spaces are ambiguous. This is because the combinations of lines and line junctions in this drawing could not be derived by projection from a possible object. For example, the T-junction in the middle of the drawing suggests that the top edge of the L-shaped face at the front disappears behind the face on the extreme left, but at the same time the arrow-junction at the bottom suggests that this face shares a convex face with the adjacent L-shaped face. Huffman (1971) showed that there are rules governing combinations of lines and line junctions representing possible objects, and if these rules are not obeyed the drawing depicts what he called an ‘impossible object’. In other drawings there may be, according to the rules, more than one way of interpreting the meaning of the lines and in these cases the drawing will be ambiguous, like the drawings shown in fig. 3 and fig 4a.
The single most important denotation rule governing line drawings is that a given line segment must have the same meaning along its whole length. This rule is obeyed in drawings (a) and (b) but not in drawing (c). In (c) the vertical line in the middle of the picture denotes a convex edge with faces on both sides at the bottom, but an occluding edge with a face to one side only at the top. As a result fig. 4c represents an ‘impossible object’.

I have said that drawing (a) is unambiguous, but this is not strictly speaking true: like all drawings it could in theory be derived from a limitless number of possible scenes. Why then do we see it as a cube with a smaller cube removed from one corner? Biederman (1987) has argued that we see pictures in this way as the result of a built-in assumption on the part of the human visual system that pictures normally show objects and scenes from what is called a ‘general direction of view’: that is, a view whose geometry does not change as the result of a slight change in the viewpoint.

The central organisational principle is that certain properties of edges in a two-dimensional image are taken by the visual system as strong evidence that the edges in the three-dimensional world contain these same properties. For example, if there is a straight line in the image (collinearity), the visual system infers that the edge producing that line in the three-dimensional world is also straight. The visual system ignores the possibility that the property in the image might be the result of a (highly unlikely) accidental alignment of eye and curved edge. Smoothly curved elements in the image (curvilinearity) are similarly inferred to arise from smoothly curved features in the three-dimensional world. These properties, and the others described later, have been termed nonaccidental (Witkin and Tenenbaum, 1983) in that they would only rarely be produced by accidental alignments of viewpoint and object features and consequently are generally unaffected by slight variations in viewpoint.


Another way of putting this is to say that the visual system normally adopts the most likely interpretation of the features and combinations of features in a picture, and ignores the possible but unlikely interpretations. Fig. 1a, for example, shows a possible image of a cube. If we were looking at a real cube a step to one side would not change the image significantly: the arrow-junction at C, for example, would still remain as an arrow-junction and the adjacent vertical line representing a vertical edge would still remain straight. If we were looking at the scene represented in fig. 1b, in contrast, a step to one side would totally change the geometry of the image. The arrow junction at C would dissolve into the ends of three separate lines e1, e2 and e3, and the straight edge below C would become curved. The visual system, however, ignores the possibility that fig. 1 could represent this scene because it is so very unlikely that the accidental alignment of the three ends of the lines to form a junction, and that the curved line could appear straight, could come about in a view of a real or notional scene. Consequently, we see fig.1a as a drawing of a cube.

I have said that drawing (a) in fig. 4 is unambiguous; but even this is not quite true. By a considerable effort of will it can be seen as depicting a concave corner, with an irregular folded plane stuck up into it. To make this interpretation, however, we have to assume that we are seeing this folded plane from a special viewpoint, in which the two separate edges to the left of the T-junction happen to project a single vertical
straight line. However, a step to one side would change this coincidence which violates the ‘general direction of view’ constraint, so we would normally discount this possibility, making the ambiguity in this drawing more difficult to see than the ambiguities in drawing (b).

Figure 5. Pablo Picasso, *Rites of Spring*, 1959. The silhouettes at the ends of the arms of the dancing figure are probably intended to represent tambourines, similar to those held by a dancing figure in Nicholas Poussin, *The Triumph of Pan* (London, National Gallery). Can be viewed at: http://www.wga.hu/frames-e.html?/html/p/poussin/2a/19triump.html

This ‘general direction of view’ constraint applies to all kinds of pictures, not just line drawings. Round objects will always project round regions as images and as a result we see the heads of the two human figures in Picasso’s *Rites of Spring* (fig. 5) as round volumes or ‘lumps’. Long objects will nearly always produce long regions as images on the retina, although there are two special end-on views in which the images will appear round. However, because such end-on views are unlikely the visual system rejects this possibility in pictures and we see the round areas in the picture as heads and the long areas as arms and legs. Similarly, relying on the ‘general direction of view’ constraint, we see the arms of the figures and the horns of the goat as curved and the pipes played by the figure on the left as straight.

Figure 6. The regions at the ends of the dancing figure in fig. 5 are ambiguous and can be seen as representing either cylinders or discs. Taken from Willats (1981), fig. 3).

The objects at the ends of the dancing figure in the centre are, however, ambiguous. The similarity between the silhouette of this figure and a figure in Poussin’s *The Triumph of Pan* (fig. 5) suggests that the more or less rounded regions at the ends of the arms are intended to represent tambourines, i.e. flat drum-like discs. However, there are no ‘natural symbols’ for discs as there are for lumps and sticks. The chances of a disc producing a round region as an image on the retina are just about equal to the chances of it producing a long region as an image. Consequently, there is no unambiguous way of representing discs in silhouettes (Willats, 1992a). This ambiguity, as fig. 6 shows, can be resolved by using a different denotation system: line drawing instead of silhouette.
Fig. 7 shows two gladiators in combat, taken from a rock drawing made c. 1000 BC. Both figures appear to be holding curved clubs or swords, but it is not clear whether the long vertical regions at the top of the picture are intended to represent long clubs or disc-like shields. The fact that these two examples come from very different periods and cultures suggests that the difficulty of representing discs unambiguously in silhouettes has its origin in the design features of the human visual system rather than arising from the conventions of particular cultures.

Another source of ambiguity in silhouettes is that it can be very difficult to represent the occlusion of one object or part of an object by another. As fig. 4a shows, T-junctions are powerful tools for avoiding ambiguity in line drawings, but in silhouettes T-junctions cannot be represented. In fig. 5 we can interpret the interlocking regions at the bottom of the figure playing the pipes as folded legs, but only because we know that this image as a whole represents a human figure; by themselves these interlocking regions would be quite ambiguous. For this reason, and because of the difficulty in representing discs, silhouettes are more likely to be ambiguous than line drawings.

A third major source of ambiguity lies in the nature of the marks used in drawings, but in order to understand this kind of ambiguity it is crucial to make a distinction between the picture primitives in drawings and the marks used to represent them. The ‘primitives’ of a system are the smallest units of meaning available in a representation, and in pictures the denotation systems define the relations between scene primitives and picture primitives. However, scene primitives and picture primitives are abstract concepts, whereas the marks in a picture are the actual physical features on the picture surface used to represent the picture primitives. Lines as picture primitives can be represented by many different kinds of physical marks: trails of ink, the traces of a graphite pencil, the lines of stitches in an embroidery or lines of tesserae in a mosaic pavement.
Although the terms ‘scene primitives’ and ‘picture primitives’ are relatively new, the idea behind the distinction between marks and picture primitives is a familiar one. Maynard (2005), p. 98 discusses this in some detail and cites a number of remarks to this effect, including the following:

Points, lines and planes do not really exist in our three-dimensional universe; these elements are but mental concepts. Artists are aware that when they draw a “line” with charcoal and pencil, they are creating nothing but the symbol of the mental concept of a line.

Hale (1985), p. 79.

“Lines? I see no lines!” said Goya, one of the greatest masters of line. He meant that there are no lines in nature – that line is an idea, an abstraction.


Although the idea that lines are mental concepts comes through clearly enough in both these passages, both are nevertheless somewhat confused. This confusion, common to nearly all writing about drawing, is to a large extent due to the lack of an agreed vocabulary making a clear distinction between marks and picture primitives. Lines, properly speaking belong only to pictures and not to scenes, but it is unfortunate that the same word is used to describe both marks and picture primitives. In the first passage cited here Hale has tried to make this distinction by putting lines as marks in inverted commas.

Any discussion of ambiguity in drawing must make a clear distinction between picture primitives and the marks used to represent them. Figs. 4 and 8, for example are both line drawings, but the ambiguities they contain spring from quite different causes. Fig. 4b is ambiguous because the lines, as picture primitives, can be interpreted in several different ways, and representing the lines by different kinds of marks would in no way alter this ambiguity of meaning. Fig. 8 on the other hand, Altdorfer’s Scene with Women and Riders, has a strange and slightly ambiguous look about it because most of the lines are represented, not by black marks on a white ground, as is usual, but by white marks on a dark ground. The denotation system in
this drawing, in contrast, relating lines as picture primitives to features such as edges and contours, is quite conventional.

It is astonishing that line drawings are so effective as representations because as Gibson (1971) pointed out there is no obvious correspondence ‘between the optic array from a line drawing and the optic array from the object represented’ (p. 28). We might assume that lines correspond to abrupt changes in tone in the optic array (‘luminance steps’) but this is only true to a very limited extent. Very abrupt changes of tone occur, for example, at the edges of cast shadow, but artists and draughtsmen normally avoid representing these luminance step edges by lines in a line drawing. Scanning photographs automatically to find such step edges in the 1980s resulted only in poor line drawings (Marr, 1982). More recently, however, Pearson, Hanna and Martinez (1990) were able to produce very respectable line drawings by scanning photographs for a combination of luminance steps and luminance valleys, a combination of features of the optic array that, they showed, corresponded to the light coming from contours.

Line drawings consisting of black lines on a white ground provide pictures that are very effective as representations and are found in virtually all cultures. However, line drawings consisting of white lines on a black ground are not nearly so effective. White lines on a black ground provide luminance ridges in the optic array, and this led Pearson et al. to suggest that the early stages of the visual system may contain a feature detector that responds to luminance valleys but not to luminance ridges. If this is true it suggests that the effectiveness of black-on-white line drawings has a physiological basis, rather than that their use is a matter of convention.

This suggestion has considerable explanatory power. It might explain, for example, why the Greek vase painters working in the fifth century B.C. changed from black-figure painting (light lines on a black ground) to red-figure painting (dark lines on a lighter ground) (Willats, 1997). It might also explain why artists’ drawings containing mixtures of black-on-white lines and white-on-black lines, such as the detail of Altdorfer’s Scene with Women and Riders shown in fig. 8, often seem to have an ambiguous other-worldly, quality. Perhaps there is a parallel here with the ambiguities that arise as a result of using mixtures of drawing systems within a single picture. The space in Giovanni de Paolo’s Birth of St. John the Baptist (fig.2) is ambiguous because it has been depicted using a mixture of drawing systems incompatible with the geometry of the light coming from a possible scene. In a rather similar way Altdorfer’s drawing (also produced in the late mediaeval period) looks ambiguous because it contains an optically incompatible mixture of mark systems.

There are only three basic types of picture primitives: points, lines and regions, and each of these differ with respect to only a few basic properties. Lines as picture primitives, for example, only vary with respect to their size, length and curvature, while regions may vary according to their size, curvature and extendedness, together with a few other secondary shape properties such as ‘being pointed’ or ‘being bent’. In contrast, there are an almost limitless number of different kinds of marks, and as Rawson (1969) pointed out the differences between them may depend on many different factors, including the different media used by artists, the grounds on which the marks are made, the instruments used to make the marks, the way these
instruments are held by artists in different periods and cultures and the different gestures and arm movements used by individual artists.

In some line drawings – those that make use of Blake’s distinct, sharp and wirey bounding lines - the marks and the picture primitives they represent share the same dimensionality and similar shape properties. This is true of many Greek vase paintings of the classical period, many of Picasso’s line drawings, and many of David Hockney’s drawings. In these examples the line primitives have zero thickness, while the marks used to represent them are thin and of uniform thickness, so that both lines and marks are effectively one-dimensional. In addition the shapes of the lines as marks correspond closely to the line primitives used to define the contours of the figures. Because drawings of this kind are quite common we often jump to the conclusion that there is little difference between marks and picture primitives.

Figure 10. A ‘tadpole’ drawing of a man by a five-year-old boy. Collection of the author.

In other drawings, however, the properties of the marks and the primitives they represent may be very different. Young children, for example, nearly always use lines of uniform thickness as marks, but these lines are used to represent different picture primitives at different stages in the developmental sequence. In the very earliest, scribbling, stage the lines are used merely to produce areas of dark tone, standing simply for ‘something there’, or at the most round or long volumes (Matthews, 1999; Willats, 2005). In the next stage of ‘tadpole’ drawings a dramatic change occurs in the mark system. The lines are no longer used to cover the whole drawn areas, but instead define regions standing for volumes. In the drawing of a man by a five-year-old shown in fig. 10, for example, the head or head/body is represented by a round area, defined by a closed boundary line, denoting a round volume or lump, and the single lines can be understood as representing long regions standing for long volumes. This change to the use of single lines rather than patches of scribble to define regions has the advantage that areas of scribble can now be used to stand for textured features such as hair.
At a still later stage, that of the so-called ‘threading’ drawings of which an example is shown in fig. 11, the outlines are beginning to suggest contours. However, there are no T-junctions representing points of occlusion, and at this stage the picture primitives are still essentially regions. It is not until the age of about 10 years that the lines in most children’s drawings genuinely represent contours as picture primitives (Willats, 1999b, 2005).

In these children’s drawings the marks are lines used to define regions that are only implied. In nineteenth-century silhouettes the reverse is true and it is the lines that are implied. The only marks present are the areas of dark tone, but these do not correspond to regions as primitives. Instead, the picture primitives are the lines implied by the boundaries of the black areas; and these lines in turn stand for the contours of smooth surfaces (Marr, 1977). However, there are other kinds of silhouettes in which both the marks and the picture primitives are regions rather than lines. Figs. 5 and 7 provide examples: in Picasso’s Rites of Spring and the eleventh-century Gladiators in Combat the shapes of the outlines of the silhouettes have little significance and are quite irregular. Instead, the smallest units of meaning in both these pictures are the shapes of the regions (round or long) together with other secondary properties such as ‘being bent’ and ‘being pointed’.
Within a single picture marks in the form of lines may be used to represent picture primitives that refer to a variety of different kinds of scene primitives. In Raphael’s Study of the Three Graces (fig. 12) some of the lines refer to the contours of the figures, and their curves and inflections correspond to the actual forms of these contours. Other curved lines, however, have been used to provide what Rawson (1987) called ‘bracelet shading’. Such lines serve two quite separate functions. First, because they are closely spaced, they combine to provide areas of tone that can be used to represent the shapes of smooth surfaces through tonal modelling. Secondly, they represent surface contours, and as recent advances in computer graphics have demonstrated surface contours can provide a powerful way of defining the curved surfaces of forms (Marr, 1982, pp. 226-233). In some cases such contours may actually be present in the scene, as in the hair of the woman on the left in fig. 12. In other cases the surface contours are only implied, as in the forms of the neck and buttocks of the central figure. Other hatched areas based on straight lines, notably on the outstretched arm of the figure on the left, have also been used to provide areas of tone, but the lines here do not represent surface contours but only contribute tonal modelling.

Lines can be used to denote a great variety of scene primitives, as Gombrich pointed out by reproducing a drawing by Saul Steinberg in which a single straight line is used to denote, successively, a drawn mark in a scene, the surface of the sea, a washing line, the horizon, the top of a bridge, the edge of a table and the corner between a wall and a ceiling. This variety of possible references, together with the bewildering variety of ways in which lines can be represented by marks, provides a fruitful source of ambiguity in pictures. In addition, these references may prove even more ambiguous according to whether we are thinking of them in terms of picture production or picture perception.

In fig. 10 the round area enclosed by an outline, typical of tadpole figures, was intended stand for the head or head/body as a three-dimensional volumetric scene primitive. In terms of picture perception, however, the design features of the human visual system are such that we as adults, and perhaps children too, cannot help but see such lines as representing contours. This ambiguity in the meaning of marks as between production and perception has profound implications for children’s drawing development. In the very early stages the use of round regions defined by outlines to denote round volumes is logical enough, but results in drawings which provide only poor and ambiguous representations, especially for rectangular objects such as dice or houses. This prompts children to seek better ways of representing the shapes of objects, leading them, eventually, to discover a combination of mark and denotation systems in which the lines stand for lines as picture primitives with T-junctions and end-junctions denoting points of occlusion. Because occlusion is the most powerful of all depth cues this results in drawings that are far more effective as representations of three-dimensional shape and consequently more recognisable as pictures of objects (Willats, 2005).

Seeing the shapes of three-dimensional objects in pictures is a subjective experience, but Jan Koenderink has shown that it is possible to measure the depth of pictorial
space objectively. Koenderink (1998) was able to do this by showing subjects photographs of objects on a computer screen and inviting them to lay a simulated ‘gauge figure’ consisting of a representation of a small circle on to the apparent surface of the object at randomly selected points. When this is repeated a few hundred times the tilts and slants of the gauge figures give, when integrated together, a measure of the shape of the depicted surface. Koenderink, van Doorn and Christou (1996) also measured the perception of pictorial shape in line drawings and silhouettes. They found that the perception of shape in silhouettes was poor, but for line drawings it was as good as it was for photographs. This result agrees with our intuitions that it is easy to see shape in line drawings but difficult to see shape unambiguously in silhouettes, and with the results of experiments comparing the ability of subjects to recognise objects in pure line drawings with their ability to recognise the same objects in full colour photographs (Biederman and Ju, 1986).

As humans we have a strong natural disposition to see recognisable objects in all kinds of two-dimensional displays. Without this faculty picture perception would be impossible and the very idea of a picture would be meaningless. But we not only see objects in pictures we also see them in accidental formations such as Leonardo’s famous stains on a damp wall. According to Wolheim (1998) this kind of ‘seeing in’ precedes pictorial representation, both logically and historically. Such accidental formations are not, of course, produced by projection from real objects, and many of the marks in them may be quite irrelevant to the shapes we see in them. However, the human visual system seems to have the ability to ignore this irrelevant information in order to make sense of what seems visually meaningful.

In Raphael’s _Study of the Three Graces_ (fig. 12) the outlines are single and distinct, and their convexities and concavities correspond closely to what we can accept as the contours of possible figures. This was Blake’s ideal. But for most of us today Rembrandt’s _Child Being Taught to Walk_ (fig. 13) with its broad, irregular and rather indeterminate outlines seems just as great a work of art. What Blake objected to in the work of artists such as Correggio and Rembrandt was the ambiguity of their outlines, but in the drawings of great draughtsmen this ambiguity may be more apparent than real. The marks artists use to represent contours may take many different forms: the lines may be shaky and irregular, or there may be multiple lines, each of which may
only approximate to an apparent contour. The contour may be embraced by numerous small curves, none of which correspond individually to the curves of the contour itself, as in the figures in Michelangelo’s *The Deposition* shown in fig. 14. Or as in Rembrandt’s *Child Being Taught to Walk* the lines as marks may be so broad that the contour seems lost. But although we see the marks in all these drawings, what we also see in them are the more abstract picture primitives that represent the contours in the pictorial image. To this extent the lines of marks are, locally, like the irregular stains in Leonardo’s damp wall, and given the chance our eyes will, of themselves, seek out acceptable images.

![Figure 14. Michelangelo Buonarroti, Row of figures for The Deposition, c. 1540 (detail). Black chalk, 10.8 x 28.1 cm. Ashmolean Museum, Oxford.](image)

Rawson described this distinction between marks and picture primitives in the representation of contours as follows:

On the one hand lines can be drawn so that the scope of the line as it is traced in its curves and inflexions corresponds exactly with the contour of the form. This means that drawn curves, for example, denote curved surfaces of the same curvature as the line itself; the movement of the drawing-point shapes the form and coincides with its contour, embracing it and defining it. On the other hand, lines can be drawn so that no single touch or stroke alone claims ever to embrace and define a form; each touch is smaller than any unit of form or curve in the notional subject. The actual phrased line which emerges in the agglomeration of touches is thus an invention in its own right, and did not happen as a consequence of a comparable phrasing of the hand’s actual movements. The effect of this technique can be a softness or gentleness which must never be mistaken for weakness. It marks the styles of the old age of certain great masters, such as Michelangelo, Titian, Corot, Renoir, and the Chinese Li Cheng, Mu Chi, and Kung Hsien. *It implies that the*
form is allowed, as it were, to speak with its own voice and is not subjected to a
dogmatic and emphatic contour.


Here, Rawson takes his examples from the styles of old age, when the irregularity of
the marks may arise at least in part from some physiological weakness. ‘Among the
great draughtsmen Poussin, for example, in his developed style always treats his
outlines as being without any purely linear expression. So that in his later drawings,
when the trembling of the hand with which he was afflicted makes his contours no
more than shaky limits, his forms are still beautifully clear’ (Rawson, 1987, p. 104).

However, the general principle that there is no necessary connection between the
clarity of the marks in a drawing and its integrity as a work of art applies to artists of
all ages. That is not to say that ambiguous and indeterminate marks or stereotyped
gestural mark-making ought ever to be used as a substitute for sloppy thinking and
observation. ‘Of course it demands that the form be genuinely conceived: for strength
in this method depends on the strength of the mind’s conceptions alone and not any
established routine of the hand’ (Rawson, 1987, p. 114).

I have described the sources of ambiguity in pictures under three headings: the
drawing systems, the denotation systems and the mark systems. In formal terms all
drawings are necessarily ambiguous\(^9\), but the ambiguity arising from the fact that any
projection to the picture plane can be derived from an indefinitely large number of
possible scenes is not of much practical importance because the visual system rejects
possible but unlikely interpretations. In some drawings, however, there may be two or
more equally likely interpretations, such as the two possible interpretations of the
configuration of lines and line junctions available in fig. 3 and the three possible
interpretations the object in fig. 4b. In these cases the picture will be ambiguous, and
it is possible by an effort of will to change from one interpretation to another.

In other pictures there may be no plausible interpretation of the shapes and spaces
represented. In the case of The Birth of St. John the Baptist shown in fig. 2 this is
because the geometry of the picture does not correspond to a single projection of a
possible scene. Here the resulting ambiguity comes about because the picture is based
on a combination of several different drawing systems, so that it shows a combination
of views taken from several different viewpoints, something that cannot occur in the
perception of real scenes. The ambiguity in Altdorfer’s Scene with Women and
Riders, in contrast, arises as the result of a particular mark system, in which some of
the edges and contours are represented by white lines on a dark ground: that is,
luminance ridges rather than luminance valleys. This produces an array of light that
the visual system is not designed to recognise.

A greater or less degree of ambiguity in a drawing may or may not be an advantage,
depending on the purpose the drawing is intended to serve. For example, although
engineers’ and architects’ working drawings should be as unambiguous as possible it
may well be helpful when sketching out designs for new products or buildings to use
forms that are relatively indeterminate. Sketches of this kind can act something like
Leonardo’s stains on a damp wall, so that the designer can see in them new and
unexpected shapes.
Spatial ambiguities arising from the use of mixtures of drawing systems, such as those in Giovanni de Paolo’s *The Birth of St. John the Baptist*, were very common before the discovery of formal perspective. Maynard (2005) illustrates and discusses a thirteenth-century drawing of a water-powered saw by Villard de Honnecourt in which the spatial relations are highly ambiguous, and cites suggestions by both Panofsky (1991) and Ferguson (1992) that one of the driving forces behind the discovery of perspective was the desire to produce technical drawings that were less ambiguous:

Apropos a design revolution wrought by “linear perspective,” Ferguson remarks that Villard’s drawing “is ambiguous, although it would not be difficult for the mind’s eye of the reader who had seen an up-and-down sawmill to move the elements into the proper places”. He adds: “On the other hand…[a Renaissance] drawing tells a reader what the sawmill looks like and how it operates”

Maynard, 2005, p. 15

In this respect the motive behind the development of perspective in one aspect of the history of art seems similar to that driving children’s drawing development: the desire to reduce ambiguity in the interests of producing drawings that are more effective as representations because they look more like the objects they are intended to represent.

Villard’s drawing of a saw mill was intended as a technical drawing, in which ambiguity is undesirable, but the spatial ambiguities typical of many icon paintings seem wholly appropriate in pictures that were intended to represent a spiritual world beyond that subject to the normal laws of space and time (Willats, 1997). Orthodox icon paintings, especially those of the fifteenth and sixteenth centuries, are full of spatial ambiguities. These include the use of inverted perspective, mixtures of drawing systems, and false attachments. It seems unlikely, however, that such ambiguities were introduced deliberately, and it was probably only in the twentieth century that artists began to see such ambiguities as desirable, and to use them more or less consciously as a means of expression. The spaces represented in many of Giorgio de Chirico’s paintings, for example his *Mystery and Melancholy of the Street* and *Gare Montparnasse (The Melancholy of Departure)*, both painted in 1914, are highly ambiguous, being represented using mixtures of drawing systems similar to those used in *The Birth of St. John the Baptist* (fig. 3). More recently, the spatial systems in many of Francis Bacon’s paintings such as his *Three Studies of Lucian Freud* are similarly ambiguous, heightening the tension between the figures and their surroundings (Willats, 1997).

The deliberate use of ambiguities arising from the denotation systems is perhaps less common in the work of twentieth-century artists, the most notable exceptions being M.C. Escher and Paul Klee. Gombrich gives an example from Klee’s work: his *Old Steamer* is based on the same kind of ambiguity as the pattern of rhomboids shown in fig. 2. ‘It is only when we ask ourselves how we are to imagine the rickety vessel that we notice the possibility of several readings. The plank on top of the wheel may be imagined as going backward or upward, and it is this ambiguity that adds to the impression of rocking instability that Klee, the great explorer of forms, certainly aimed at’ (Gombrich, 1988, p. 222). Many of Klee’s paintings and drawings contain
similar ambiguities, often based on examples taken from the Gestalt psychologists (Teuber, 1980; Willats, 1997).

Ambiguities arising from mark systems in which the normal direction of tonal contrast is reversed make an occasional appearance in Cubist paintings. Braque’s *Still Life: The Table* provides a good example (Willats, 1997, fig. 229). As Gombrich (1988) pointed out, black patches are used to represent the highlights on the apples, but in addition some of the outlines are dark on a light ground while others are light on a dark ground. Moreover, these inversions of tonal contrast are combined with the use of inverted perspective.

The reversal of the normal direction of tonal contrast is quite common in icon painting. The use of white lines on a dark ground probably originated as an attempt to represent highlights, but is now often given a theological interpretation: light is supposedly represented as shining out of the figures of Christ and his saints and angels rather than on them (Ouspensky and Lossky, 1994). From a visual point of view this, like the other ambiguities in icon painting, gives an unworldly appearance to the forms that seems appropriate to the other-worldly space that icons are intended to represent.

Finally, the ambiguities arising from the use of multiple or indeterminate marks, rather than the sharp bounding lines insisted on by Blake, can have advantages for both the artist and the viewer. The use of multiple outlines in the representation of the shapes of objects allows the artist or draughtsman to find the contours of the object to be represented through a process of trial and error, adjusting each contour to all the other contours in the drawing. But in addition, marks can provide a powerful means of expression. Again, Rawson puts this very well:

> The main bulk of the marks will not just refer to everyday objects but will ‘qualify’ them by investing them with analogous forms from quite other fields of experience…In the case of all art, including visual art, ambiguity and multiple meanings may be of the essence. It is well known that, in poetry, puns, oblique illusions, metaphorical connections, all enhance the total meaning. So it is with visual art as well. Forms should have the widest possible scope of recollection.


What is true for the artist is also true for the viewer. On a representational level the use of indeterminate outlines has the advantage of allowing the viewer to take a more active role in the perception of pictures. Instead of being forced to accept one definitive contour the viewer is left free to seek out, through the mechanism of ‘seeing in’, the contour that best accords with his or her knowledge of the forms of natural objects. But in such marks we see more than the pure representation of form. Rawson compares the ‘blobs’ found in Chinese ‘spilled ink paintings’, Cozen’s blot landscapes and Rembrandt’s smeared lines with the Rorschach test patterns that can evoke a subjective response on the part of the spectator. But blobs are just an extreme example of the part chance can play in the production of marks. All marks have, to a greater or lesser extent, a degree of ‘graphic indeterminacy’ which allows the
spectator some entry into the ultimate meaning of the drawing. In this way the viewer is left free to contribute what Gombrich called ‘the beholder’s share’.

Ultimately, all drawings are ambiguous, and this ambiguity can arise through the use of incompatible mixtures of drawing systems, picture primitives that can have more than one meaning, and the representation of these primitives by all sorts of varied or indeterminate marks. The presence in a drawing of some or all of these features is in itself neither a virtue nor a vice. What counts is the contributions these kinds of ambiguity can make to the meaning and intention of the drawing. Blake’s distinct, sharp and wirey lines may be entirely appropriate for engineering drawings, and some great artists have gloried in them as a way of showing their skill, but their use does not of itself guarantee that the resulting product will be a work of art.

Notes

1 ‘There are three main vehicles which Chomsky deploys to expose our intuitions [about language]: paraphrase, anomaly and ambiguity.’ Taking his cue from Chomsky, Clowes used a similar methodology as a way of investigating the nature of line drawings.

Clowes (1971) p. 80.

2 ‘Like lighting, perspective alters things; it distorts their true shape… Perspective is directed upon things like the beam of a lighthouse; it falls upon them but without dwelling on each or finding out about them; it mindlessly displays and distorts the parts of the scene that the situation either reveals or hides from its view… It is true that reality shows us objects mutilated in this way. But in reality we can move around: a step to the right and a step to the left completes our vision. Our knowledge of an object is, as we have said, a complex sum of perceptions. Since the plastic image does not move, the plastic image must be complete within a single glance and so has to reject perspective.’ Rivière (1912), p. 392, 393.

3 Maynard (2005) lists this as no. 12 in Gombrich’s explanatory principles: ‘We feed the information from the picture plane into the same kind of mill into which we also feed the information from the optic array.

4 This example is analogous to Chomsky’s examples of ambiguity in language: ‘flying planes can be dangerous’ has two possible interpretations and ‘I had a book stolen’ has three (Chomsky, 1965, pp. 21, 22).

5 The terms ‘scene primitives’ and ‘picture primitives’ were first used in papers on the automatic analysis of pictures by computers in the early 1970s.

6 ‘One point of quite extraordinary importance in drawing is never properly discussed. It is taken so much for granted that it has become “invisible”. Books on drawing have been written which never even mention it. This is that drawing techniques all assume the use of dark lines drawn on a lighter ground. Only at a specific stage in the history of European art did the idea of drawing with white or light tone on a darker ground produce a special kind of drawing with its own principles. … Apart from this epoch in European art lines of light on a darker ground, where they occur, amount to no more than an occasional tonal inversion of normal methods of dark on light’ (Rawson, 1987, p. 38).

7 ‘Round’ here means ‘saliently extended in all three dimensions of space’ rather than being spherical. (Willats, 1992a, 1992b).

8 An experiment in which drawings of objects were degraded by removing the T-junctions or converting them to L-junctions showed how important T-junctions are for recognition purposes. Drawings degraded in this way proved virtually unrecognisable. In contrast, drawings in which parts of contours were removed in places where they could be conceptually replaced by subjects through collinearity or smooth curvatures were readily recognisable (Biederman 1987).
In engineers’ and architects’ drawings this ambiguity is of course minimised by using at least two related views.

In Gombrich’s (1988) reproduction of this painting (fig. 229) all the tone values have been incorrectly reversed.

In this respect ambiguity is one more tool in what Maynard (2005) calls the artist’s ‘tool kit’ – that is, repertoires of pictorial devices.

Rawson (1987, p. 115) cites Raphael, Leonardo, the Caracci, Rubens, the Chinese Liang K’ai and Shih Tao, and the medieval Indian wall-painters as examples.

References


