CHAPTER 18

Axes of symmetry, recession and the constancies

Introductory

Figure 1 : The bakery from along the esplanade

What I have called the "bakery façade illusion" is both described and explained in "What Scientists can Learn from Artists". In this chapter, its importance for artists when drawing from observation will be emphasised. Another illusion that causes artists problems concerns all receding surfaces. As we shall see

the explanation for both of these lies with manifestations of the phenomena known as the "constancies of visual perception". In this chapter we will concentrate on two of the most dangerous for artists, namely the "orientation" and "receding surface" illusions.

Although the bakery facade illusion is easier to demonstrate because of the trapezoid shape of the bakery facade, it to be found whenever receding surfaces are obeying the rules of linear perspective. For example, whenever a rectangular surface is seen in recession. As we shall see the "receding surface illusion" needs no special case to emphasise its omnipresence .

The bakery façade

As part of the linear perspective lesson, I take the students to look at the view of the local bakery illustrated in *Figure 1*. In order to make sure that we are all looking at the same thing, I choose a viewpoint from which, as in the photograph, the front façade of the bakery is situated in the middle of the space between two trees. I point out that the shape of the façade seems to go clean against the laws of linear perspective, according to which the further end would normally be expected to be shorter than the nearer one. This is partly because the base of the roof actually does slope *up*, away from the viewer, from left to right, and partly because slopes which contradict the laws of linear perspective are correspondingly exaggerated experientially.

Having called attention to this surprising feature, I ask the students questions about its characteristics. I start by asking, "*Can you see how the roof is sloping up and away from you?*" The answer is always, "*Yes*". I then ask, "*Can you see how the wall in front of it is sloping down and away from you?*" As before, the answer has never been anything but, "*Yes*", said in a tone of voice which suggests, "*Of course I can*". It would seem that the direction of the orientation the slope is so obvious to the students that none of them seem to give it a second thought.[1]

Indeed, no sign of doubt is evinced until I draw their attention to the esplanade wall to their left and the fact that they are looking *down* onto its top surface. Even then, it is only when reminded of the method of establishing an eye-line by reference to horizontal surfaces (as described in the previous chapter) that the penny drops and the realisation dawns that, according to the laws of linear

1 Lest you think the answer was in part due to the way the question was asked, it is worth mentioning that I first became aware of this illusion because of the regularity with which students drew the wall sloping in this downward direction, when they were drawing from observation.

perspective, the wall in front of the baker's façade should, if anything, be seen as sloping *up, away from them*. In other words, it should slope in the opposite of the perceived direction.

Students often find this realisation impossible to square with their experience until, having been reminded of the usefulness of *in front/behind relations*, they are asked to look at the angle between the top of the esplanade wall and either or both of the two, approximately vertical tree trunks that frame the bakery façade. When they do so, it is immediately obvious that these angles are more or less right-angles, perhaps with a hint of a slope in the direction that the laws of linear perspective predict.

To understand the reason why everybody seems to be deceived by the direction of the slope of the wall-top, it will help to rehearse the conclusions arrived at in "*What Scientists can Learn from Artists*".[2] There it is shown how studies of a syndrome known as "*unilateral neglect*", reveal the existence of *preconscious visual processing* and tell us about some of its characteristics. In particular, they demonstrate that one of the ways in which eye-brain prepares for the *conscious* visual analysis is by *preconsciously* imposing a *vertical axis of symmetry* on the object selected for its attention. The *bakery façade illusion* can be added to other evidence that supplies strong support to the possibility that a *horizontal* axis of symmetry may be used in an analogous way.

This being the case, an explanation for the illusory slope of the wall suggests itself. This has three steps to it:

- The eye-brain *separates the facade from its context*.
- An *horizontal axis of symmetry* is imposed upon it.
- The axis is rotated so that it aligns with an already existing "*template*" for vertical or horizontal axis, situated in the visual processing part of the brain.

The third step by its very nature entails a *dissociation of the shape* (along with its axis) from existing contextual reference and there is no automatic way of re-establishing this when it comes to the stage of conscious visual analysis. In the absence of any guidance, the eye-brain settles for giving the axis a vertical or horizontal *default position*.

As an illustration of this, *Figure 2a* shows the placement of an axis of symmetry (the dashed line) on a near horizontal trapezoid, which is approximately

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the same shape as the bakery façade. Notice that the baseline representing the top of the wall is horizontal and the axis of symmetry slopes upwards from left to right. Faced with this situation the eye-brain rotates the axis so as to fit it into the referents in the brain's internal visual space. *Figure 2b* shows the outcome. As a consequence of the axis becoming horizontal, the base-line now slopes downwards from left to right. This result is analogous to the *bakery façade illusion*, in which the wall top seems to slope in the same downward direction.

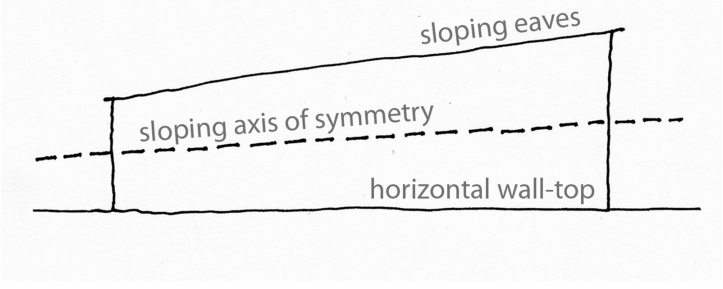

Figure 2a : Measured Reality

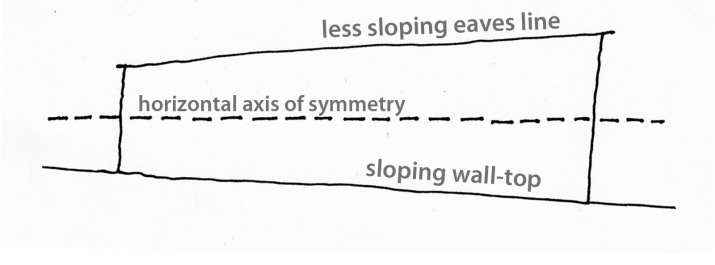

Figure 2b : Experienced reality

Another example

As mentioned in the previous chapter, we are all familiar with the problem of hanging a picture on a blank wall. We easily feel satisfied that we have got the top edge horizontal and the side edge vertical, but when we step back to admire our handiwork we will be very lucky if the whole thing is not askew. The reason we deceive ourselves so regularly is that the axes of symmetry determined by the parallel edges of the rectangular frame are automatically rotated by the eye-brain to coincide with its vertical and/or horizontal internal axes. Hence the edges of

the frame appear to us as being vertical and horizontal, whether they are or not.

Receding trapezoids

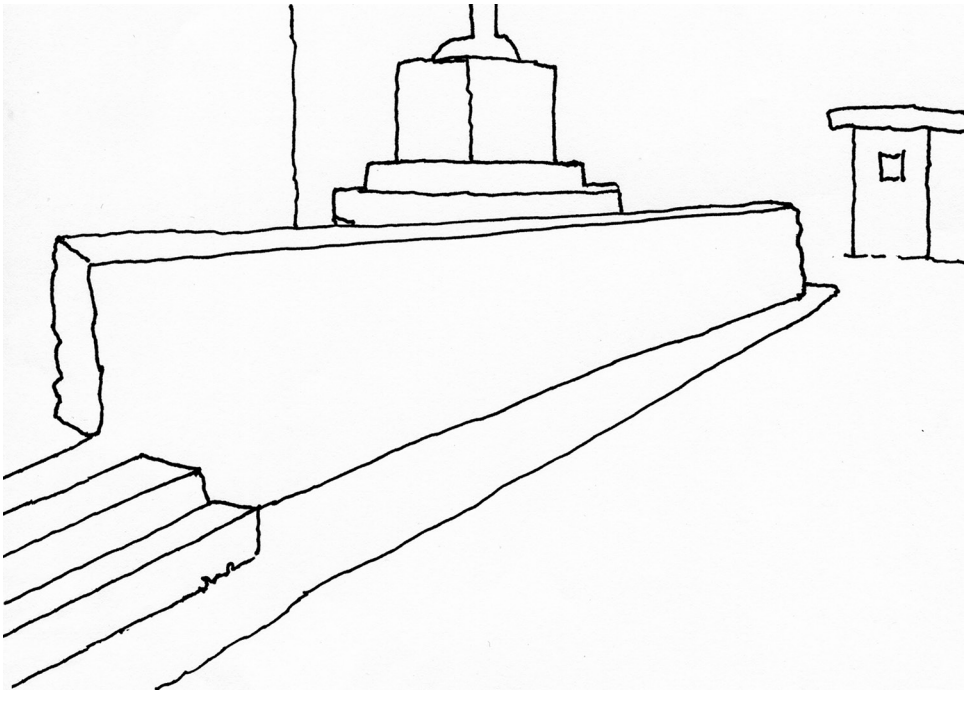

Figure 3 : The wall in front of the crucifix

Other examples of being deceived by the *bakery façade illusion* abound, since *they can occur when any rectangular surface is viewed in recession*. An example, which is difficult to illustrate using a photographic image in a book,[3] occurs on the way back to the Painting School. *Figure 3* shows a perspective line drawing of the scene concerned. In the top centre can be seen the plinth of a crucifix, which is said to have been placed on the site where witches were burnt in mediaeval times. Below it is a wall which, is less high at the far end than at the near end (because the road beside it is sloping upwards). As the students

3 Because photographs are viewed from close and gives too much contextual information..,

approach this, I draw their attention to the edge that defines the top of the wall, asking them if they perceive it as sloping *down*, away from them or *up* away from them. Although, by now, they ought to be on their guard, nearly all of them plump for the first possibility. Only after it is pointed out that (as with the wall of the esplanade) they are looking down onto the top of the wall, do they begin to have doubts. And, only when they have been persuaded to check the slope using in-front/behind referents (in this case, the verticals and horizontals on the plinth), do they realise that they have been subject to another manifestation of the *bakery façade illusion*. *Figures 4a* and *4b* shows how this has come about. *Preconscious processes* takes the wall out of context, impose on it an axis of symmetry and, then, rotate it until it arrives at the horizontal *default position*. It is only when it reaches this stage that it becomes available for conscious experience.

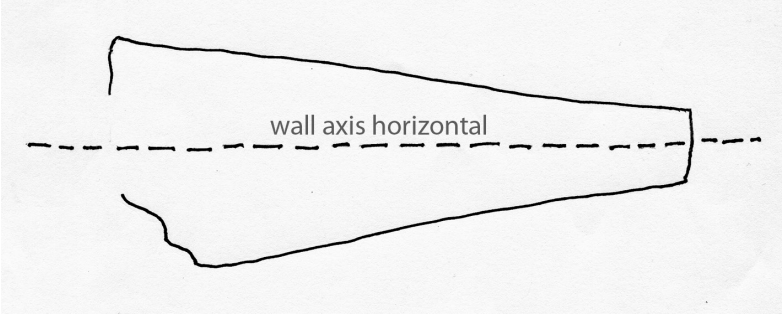

Figure 4a : Measured reality : Top of wall horizontal.

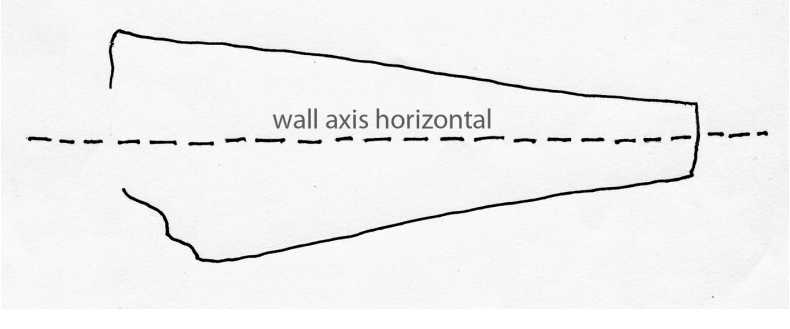

Figure 4b : Experienced reality : Axis of symmetry horizontal

Perceived length of receding surfaces

Obviously, these illusions will considerably complicate the already extremely difficult task of judging the orientation of edges in natural scenes. Nor is that the end of the bad news. There is also *a problem relating to the perceived length of all receding surfaces of all kinds*. It turns out that it is quite impossible for the human eye to judge this accurately, except by indirect means. Everyone, without exception, tends to make an overestimate. This truth is easy to illustrate: Just ask a friend to hold an arm out towards you (as illustrated by the in Figure 5) so that you can see its full length. How long would you estimate it to be?

Figure 5: Photo of arm extended illustrating recession

Now, look at where the hand visually cuts your friend's vertical body and look at the distance upwards from there to his or her shoulder. You will see that this distance appears to be much shorter than your earlier sense of the length of

the arm. The power of the illusion is astonishing. No matter how convinced you are that your eyes are being deceived, unless you look at in the context of its background, there is no way you will be able see the outstretched arm as being any shorter.

The *receding-surface effect* is omnipresent in the visual world. For example, it can influence the appearance of a street scene such as the one illustrated in *Figure 6*. Even in a photograph, it is surely surprising to realise that the measured distance down the road from the feet of the man with the beret to the dark shadow-line that crosses the street and cuts into the rim of the second bowl of flowers, is approximately the same as the vertical distance from the bottom of the picture to the top of the man's hand. Few would disagree that the section of the road in question appears to be longer. Similarly surprising is the fact that the distance between the right-hand side of the shuttered window (situated above and slightly to the left of the man's head) and the drainpipe to its left is the same as the length of the wall receding back from the man's legs and the nearer side of the break in the wall (an opening for some steps) which is directly below the latter. Again, it is the receding surface which looks much longer.

Figure 6 : Street scene with receding road and wall

Figure 6 also illustrates another aspect of the problem. Distortions in the depth of surfaces also affect the appearance of both the orientation of their edges and, consequently, the angles between them. Thus, the bottom edge of the wall, behind the man, as traced on a tracing-glass, actually slopes *up* away from us much more than the eye tends to reveal.[4] It would seem that most people see it as much more horizontal. Indeed, a surprising number of them perceive it as sloping down, as it is in the real world.

The tendency to *perceive orientations incorrectly* is well worth relating to the difficulty, mentioned earlier, of producing an *accurate preliminary perspective framework* when starting to draw a real scene. Clearly the *receding-surface illusion* contributes yet another dimension to the already severe problem of having to depend on poor capacities for estimating the orientation of edges.

The universality of the receding-surface effect

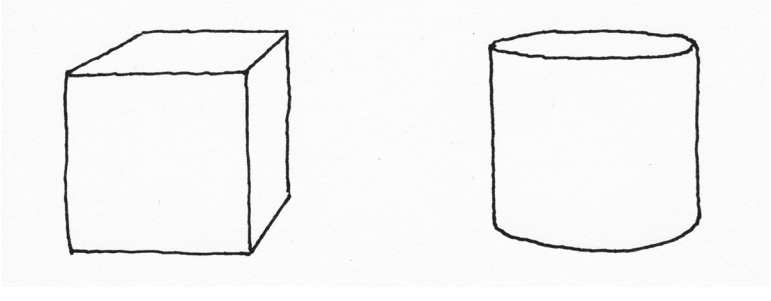

Figure 7a : Perspective copies of a cube and a cylinder

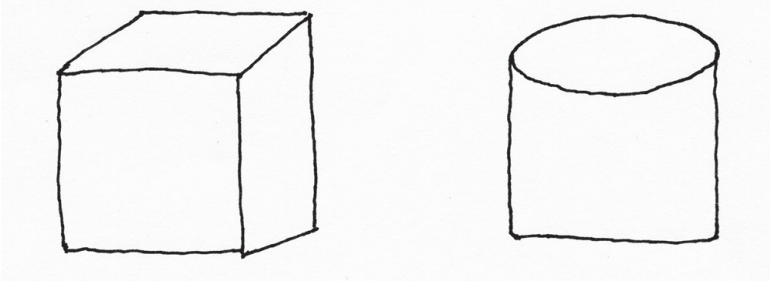

Figure 7b : Intellectually realistic copies of a cube and a cylinder

4 Indeed, many students report that they see it as sloping down.

The receding-surface illusion permeates everyone's visual world. *Figure 7a* shows two perspective drawings, one of a cube and the other of a cylinder. *Figure 7b* universal tendencies in copies of them (much more noticeable in the drawings of beginners and children, but found in drawings by all but the most skilful adults).[5] As any teacher of drawing skills knows, these are forms and tendencies which crop up everywhere. Thus, the cube panel also illustrates typical outcomes in drawings depicting table tops, the seats of chairs, boxes, etc. And the cylinder panel shows the tendency for bowls, vases, cups, flower tubs, etc.

Nor is the problem confined to regular shapes. It also applies to more irregular ones, such as car bonnets, cushions, fields, etc. For all these objects, if there is a receding surface visible, *it will prove impossible to judge its extent without using in front/behind references*.

Very popular amongst the ways of providing such a reference is the use of a pencil held up between the eye and the object and used as a gauge. However, while there is nothing theoretically wrong with this idea, it has two disadvantages in practice. The first of these is revealed by the regularity with which mistakes are made by people using this method: Correct application requires a great deal more rigour than is generally realised. The second, and more important one is that using the pencil absolves artists from the need to use referents which are intrinsic to the scene being depicted. Observation of student performance make clear that this deprivation results in the students being distanced, just that little bit more, from the supposed subject of interest. A better approach is to look for context-related measures analogous to the ones I suggested when visually assessing the wall length in *Figure 6* (such as the distance from the bottom of the picture to the top of the man's head). This may sometimes prove difficult to find, but even so the search will invariably result in your getting better acquainted with the scene in question.

The constancies of orientation, size and shape

In *"What Scientists can Learn from Artists"*, much is made of the *constancies,* including *orientation constancy, size constancy* and *shape constancy*.[6] *Figure 8* illustrates how all three influence on our perception of a rectangle viewed in recession. The *left hand side* image shows how the receding rectangle would ap-

5 For examples of children's distortions see, Phillips, W. A., Hobbs, S. B. and Pratt, F. R., 1978, "*Intellectual Realism in Children's drawings of Cubes" in "Cognition*", Vol.. 6, pages 15-33.

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pear if photographed or traced on the tracing glass: The *further* line 'c' is shorter than the *nearer* line 'a' and lines 'b' and 'd' slope accordingly. The *right hand side* image illustrates *experienced reality*. In it, the lines 'b1' and 'd1' are both nearer to the horizontal and 'c1' is more equal in length to 'a1'. These distortions can be explained by a combination of orientation, size and/or shape constancy:

- *Orientation constancy*. The *bakery facade illusion* shows viewers twisting the axis of symmetry of a trapezoid towards the horizontal. Here the same phenomenon occurs in a different context causing the edges of the right hand side image to twist in a clockwise direction, causing the bottom edge to seem flatter.
- *Size constancy* causes other distortions. If we look separately at the verticals 'a' and 'c', our analytic looking systems will try and stretch or squash both of them into an identical visual space. As a result they will appear to us as more equal in length than they really are, as represented in the rectangle on the right by the verticals 'a1' and 'c1'. Accordingly, the angles between them and the lines joining their tops and bottoms are pushed in the direction of 90 degrees and the slopes of lines b1 and d1 are twisted in the direction of the horizontal.
- *Shape constancy* causes the trapezoid to seem more like the rectangle it would be if viewed from the front. In other words it has much the same effect as size constancy.

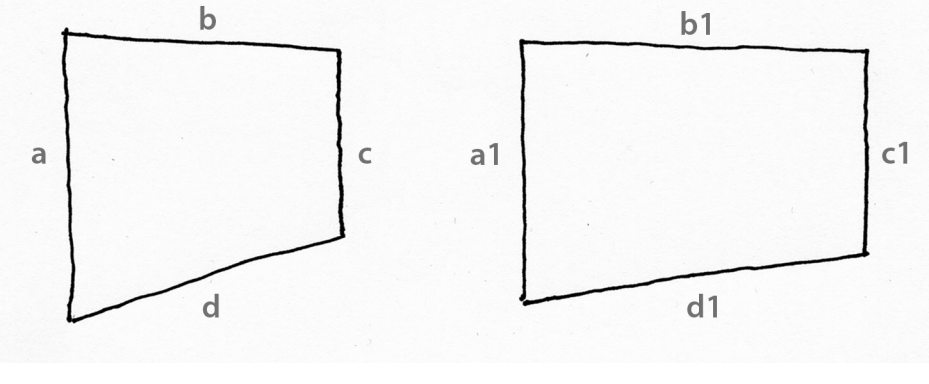

Figure 8 - Effects of orientation, size and shape constancy on the apparent angles and lengths of the edges of a rectangle.

The overall effect of these distortions is that the orientation of absolutely

all edges are likely to be misjudged, as are every single one of the angles at the corners of rectangles in recession. This creates a difficult enough situation in itself but the problem is exacerbated if these falsely judged orientations and angles are used in the construction of a perspective framework into which other parts of the image are to be fitted. Any attempt to do this will face insoluble problems analogous to trying to fit a quart into the pint pot. Be warned.

Tipped up landscapes

Figure 8 : Panoramic landscape

Figure 9 : Landscape with fields going into the distance

As must be obvious by now, the same cluster of effects occur when viewing landscapes. In the list of examples above, individual fields have already been mentioned, but the tendency to see receding surfaces as too extensive applies to the whole landscape, stretching from the eye to the horizon. For this reason, unless counter-measures have been taken (such as the use of *in-front/behind relations*), there is a universal tendency to depict receding landscapes as taking up too much of the picture surface. In *Figure 8*, even though it is only a photograph, the fields and hills seem to go back far into the distance and it comes as something of a surprise to find that the three poplar trees in the centre take up approximately a third of the vertical height from the base of the picture to the sky line.

Figure 9 shows more fields receding into the distance. This time the vertical house-end wall provides a guide to the measured height of the distance between the foreground wall top and the horizon. Even if copying the photograph, unless we use the house end as a comparator, it is likely that we would produce a picture in which the distance between the top of the wall and the horizon is significantly greater than if we do make use of it. If faced by the real landscape the discrepancy would almost certainly be considerably greater still.

Figure 9a : Detail of Figure 9

Figure 9a shows the central area of the same scene. Since the house and the foreground tree and are no longer available as referents, substitutes for them have to be found. Thus, various vertical objects such as foreground branches, trees and power-line posts, etc. can be used as measures to guard against allowing the landscape to expand unnaturally upwards.

Figure 10a : Receding landscape without post

Figures 10a, 10b and 10c can be used to make all this clearer. Figure 10a is the same as Figure 10b except that in it the vertical post has been removed. Even though what we are looking at is a small photograph with straight edge borders on a flat surface, as opposed to an expanse of real landscape receding into the distance, the fact that the post functions as a vertical in front/behind comparator has a clear effect on the perceived depth of the landscape. The image without the post has a much greater sense of distance. Experience shows that, if students set themselves to depict any real receding landscape without reference to an analogous in front/behind comparator, their productions will be influenced by this expanded sense of distance such that all the features within their picture will be vertically stretched.

Figure 10a : Receding landscape with post

The outcome of such vertical stretching will be deformations along the lines of those found in *Figure 10c*. Notice that this image has had to be cropped so as to give it the same proportions as the images in *Figure 10a* and *Figure 10b*. More importantly, notice how the vertical stretching has caused the angles at the corners of the field to become more obtuse. It is no coincidence that these deformation are analogous to those that occur in the intellectually realistic version of the top face of the perspective cube illustrated in *Figure 7b*. As with the cube top, the landscape in *Figure 10c* seems to have been tipped up such that the further parts of it come nearer to the viewer. In the light of this phenomenon it is not surprising to find that there is an universal tendency amongst my students to produce analogous distor-

tions when attempting accuracy in depictions of panoramic views.

Figure 10c : The image stretched in the direction of experienced reality

Squashing illusory pictorial space

If we imagine the photograph as being a painting, we can see that this tipping up would bring the distant landscape nearer to the picture surface. Alternatively, this transformation of appearances could be described as a *squashing of illusory pictorial space*. Due to their interest in exploring the dynamic relation-

ships between the real picture surface and the contents of illusory pictorial space, this phenomenon was seen as being of great significance by *Modernist Painters* like Cézanne and Bonnard They also realised that it had both theoretical and compositional advantages.

Experienced reality

As a conclusion to the chapters on *linear perspective* and as an introduction to the later discussion of the advantages of distortion, it is important to re-emphasise that the "*reality*" described by the laws of linear perspective is by no means the only one. In the light of the evidence that receding surfaces regularly appear to stretch back further than they should according to literal measurement, is it not be reasonable to describe the apparent additional depth that characterises experienced reality as a *"fact"* of perceptual experience?

Figure 10: A still life by Cézanne, with tops of plates and vase and table all tipped up.

Many artists since the Modernist revolution in the second half of the nineteenth century have concluded that such "*facts*" are more "*real*" than those which can only be constructed by means of artificial measurement or copying devices such as tracing on glass or using a perspective frame. They concluded that it is more interesting to depict this "*experienced reality"* whether it applied to landscapes, interiors or still lives.

A pioneer in promoting this point of view was Paul Cézanne. *Figure 10* provides one of many illustrations of his practice of tipping up table tops, bowl tops, vase tops, etc.. He also regularly treated whole landscapes in the same cavalier spirit. He was followed by a cavalcade of others pioneers like Henri Matisse, Pierre Bonnard and Pablo Picasso who took the idea a great deal further. One of their discoveries was that tipped up landscapes and still lives take up a much greater proportion of the picture surface and, thereby, provided a very useful compositional device.

Implications

For artists who are drawing from observation, the main practical implications of this chapter should be obvious. We have to be very careful before trusting our eyes too blindly. More positively, knowledge of all the tendencies described, due to head movement, levelling off axes of symmetry and the constancies of orientation, size and shape, can help artists to look out for manifestations of them and to take steps to counteract their distorting effect. These would require that the whole context be kept in mind in such a way that everything is related to everything else, wherever possible using in front/behind relations.

Although, when faced with actual scenes, it can sometimes be hard to find useful comparators, the effort of looking for them is always well worth while, if only because it can help artists to become more intimately acquainted with the subject matter they have chosen to analyse. From this point of view, the harder it is to find suitable references, the more rewarding is likely to be the activity of looking for them.

If, despite all efforts, no useful referent can be found, the best extrinsic reference is perhaps the plumb line beloved of Matisse. However, be very careful about using the pencil held up as a measuring device. It brings a whole bundle of new complications into the situation.[7]

7 "*Drawing with Feeling"*, *Chapter 2, Figure 5*