CHAPTER 7

The perception of surface and of interreflections

Introductory

As preparation for grappling with Georges Seurat's game-changing ideas about painting with light, it will be helpful to be clear about the role of reflected-light both in creating our sense of surface and in enabling our eye/brains to work out how surfaces relate to one another.

Light and surface

The ideas which follow concerning *surface-reflection* can be generalised for all surfaces, including those of lakes (*Figures 1-4)*, of fields (*Figures 6-9)*, books (*Figure 10)* and paintings. They also relate to interreflections between surfaces *(Figures 11-15)*.

Figure 1 is an image of a row of trees and their reflection in a lake. The water is mirror-smooth, with the trees and sky clearly reflected in it. Indeed the image is so clear that, if the picture is turned up-side down (*Figure 2*), the scene in the reflection is very nearly the same as when it is the right way up. Notice in particular that the lake has virtually no *sense-of-surface* to hinder the notion of entering into the mirror-image space. Now imagine that the water has been agitated by a stiff breeze. The reflected image of the row of trees and the sky would be fractured and jumbled up and the expanse of water would become uniform in appearance (*Figure 3*). No trees are now visible in the water. What we see is a fairly uniform colour and a more or less flat expanse of water. However, from a closer viewing position (*Figure 4),* it becomes evident that its surface is made up of numerous little wavelets, and that the distant view optically combines regions of reflected-light with ones that take their colour from the murky brown water. As we shall see later, it is the *reflected-light* that provides the eye/brain with the information that it uses to give the expanse of water in *Figure 3* its sense of surface. The murky brown is what we can see of its *body-colour*.

Figure 1 : Smooth water surface giving mirror reflection

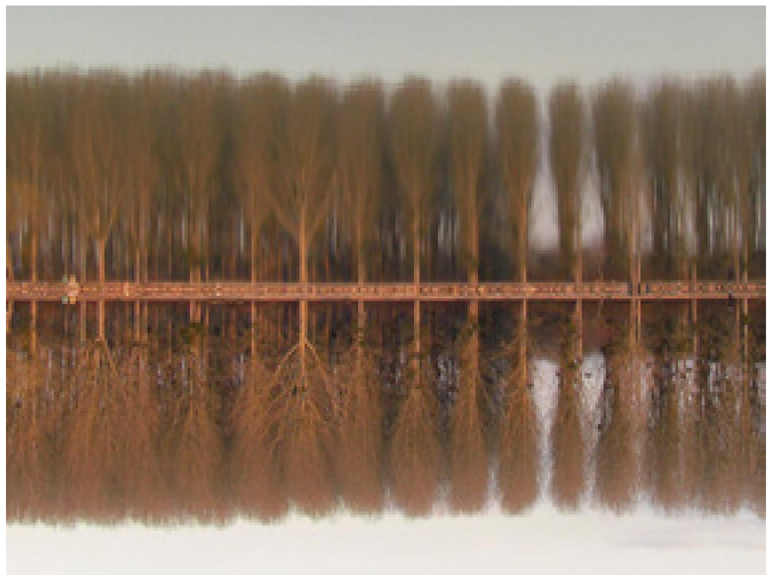

Figure 2 : Upsidedown version of Figure 3. The mirror image is almost as clear as the scene it is reflecting.

Figure 3 : Rougher water.

Figure 4 : Close up of the water in Figure 3 showing both surface-reflection and body-colour of water and lake bottom. Due to optical mixing, these blend into a unified colour (Figure 3) when viewed from a distance.

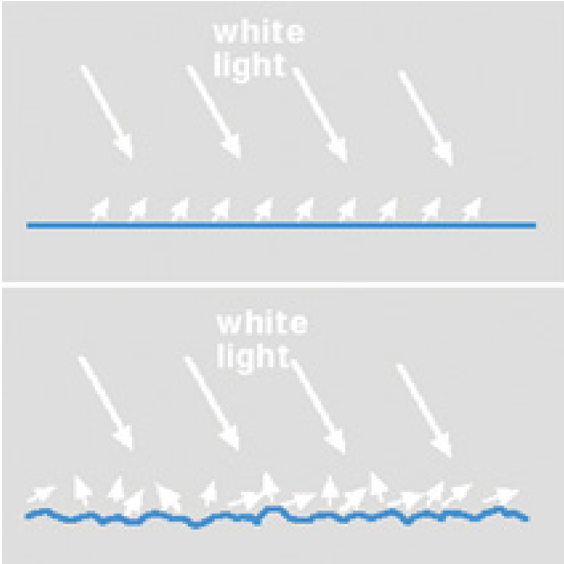

Figure 5: Diagram showing reflections from smooth and rough water.

The diagram in *Figure* 5 illustrates the two extremes just described. The top half represents the mirror-like surface of the lake shown in *Figures 1 and 2*, while the bottom half illustrates the light being scattered in all directions by the rough water, as in *Figure 3 and 4*. The crucial thing to notice is that, when a surface is mirror smooth, we do not see it as a surface whereas, when it is rough, we do. From this we can deduce that the ***sense of surface*** is provided by the myriad of fractured mirror reflections in ***scattered-back light*** that are entering our eyes from just about every point of the compass. It is this multiplicity of light sources, each with its own colour characteristics, that, when optically mixed by our eyes, result in the almost uniform grey-blue of the surface of the water in *Figure 3*. Only when the wavelength combinations coming from the different directions are sufficiently similar, will the colour of the water correspond to a specific colour in the scene (as when the sea looks blue on a cloudless day).

If we move from side to side or from nearer to further in front of a mirror, changes occur in what is reflected in it. The same is true of movements in relation to the myriad of mirror reflections that characterise the broken up surface of the lake. As we move our eyes across its surface, the composition of the light being reflected from it will change producing a seamless modulation in the optically mixed colour.

What applies to water applies to all surfaces

Figure 6 : Close up of a field - Looking into the sun.

Figure 7 : Distant view of a field - Looking into the sun.

Figure 8 : Close up of a field - Looking away from the sun.

Figure 9 : Distant view of a field - Looking away from the sun.

As suggested in the subtitle, what applies to water applies to every other surface, all parts of which are on a continuum from glossy to matt. In nature, the vast majority are matt. If so, the fractured reflected-light will create ***optical mixtures*** tending, to a greater or lesser degree, in the direction of achromaticity. *Figures 6-9* provide examples of how much appearance can change as a result of surfaces being looked at from different viewing positions relative to the direction of the main light source. In *Figures 6 and 7*, the sun is in front of the viewer and its light is being ***transmitted*** through the blades of young barley. These act as green filters that absorb all but the wavelength combination that characterises the particular green we see. Where the light has been blocked from penetrating the blades, shadows have been created. The contrasts between their darkness and the lightness of the transmitted light produces a textured effect.

In *Figures 8 and 9,* the sun is behind the viewer such that the purity of the green of the leaves is compromised by the large contribution from the *reflected-light*. As a result the green of the barley leaves look much "*whiter*" (desaturated) than the green in *Figures 6 and 7*. Notice however that the combination of the body-colour and the reflected-light does not mean an overall diminution in lightness. On the contrary, the lightest greens in *Figures 8 and 9* are a great deal lighter than those in *Figures 6 and 7*. The overall effect is that in *Figure 7* the field is perceived as being both more fully saturated and darker, while in *Figure 9*, the green is both more desaturated and lighter.

Viewing angle and rectangular flat surfaces

Figure 10 illustrates the way I demonstrate to my students the importance of viewing angle on the appearance of a flat matt surface.

Figure 10 : A book with a matt red cover from four viewing positions, showing a progressive change the visibility of the reflected-light.

On my bookshelf is a somewhat battered book with a matt red cover. Having placed this on the mantelpiece with the light coming in through the window to the left, I ask the students to move across the room from left to right in front of it, so as to look at its surface from different angles. The first viewing position (the furthest left image in the row) is slightly to the left of frontal, such that the angle between the main light source, (the window), the surface of the book and the viewers' eyes is very slightly less than 90°. As the students move towards their right, the angle becomes slightly obtuse and then more and more so, until the students are looking at the book from a much side on position (the furthest right image in the row). As can be seen from the four viewing positions, each move rightward results in the reflected-light becoming more evident and, in consequence, the body-colour component being progressively obscured and the overall colour of the surface more desaturated. From this demonstration we learn the rule that to see the body colour of the book at its purest there must be an acute angle between our viewing position, its surface and the light source.

A similar rule can be applied to all surfaces, including flat, multicoloured ones, such as paintings. In every case the purity of the body-colour or colours is progressively desaturated as the angle between the main light source, the surface and the line of sight becomes more and more obtuse.

It hardly needs adding that it is the interests of both artists and viewers to find the viewing position from which the colours in paintings can be seen to their best advantage. As just indicated, this means ensuring that the angle between the main light source, the picture-surface and their line of gaze is less than 90°. As illustrated in *Figure 10*, it only has to be marginally less to achieve the desired result.

Interreflections

Figures 11, 12 and 13 illustrate the phenomenon of interreflection. They can be seen as analogous to *Figures 1 and 3* with respect to the way that they show the difference in the visibility of interreflections between an object situated on a glossy surface and the same object situated on a matt surface.

In *Figure 1* and *11* the reflections of trees and the box are easy to see in the smooth lake and the silvery surface respectively. In contrast, in *Figure 3* and *Figures 12* and *13,* the reflections are either very difficult or impossible to see, whether in the roughened surface of the lake or in either of the matt surfaces on which the box is now placed.

Figure 11 : Box on shiny silvery surface

Figure 12 : box on matt-white surface

Figure 13 : Box on matt-red surface

Looking at matters in a different way, it is not possible to discern any reflections from the flat surface of the lake onto the trees in *Figure I and 3,* and it might take a little time to detect the influence of the reflections of the different supporting surfaces one the appearance of the surface of the box shown in *Figures 11, 12 and 13*. However, it will become apparent if comparisons are made between the blue of the box surface as it appears in the three images.

Figure 14 : A Chinese ginger jar placed on 3 different surfaces.

The same points can be made by analysing the interreflections in *Figure 14.* In it the same Chinese ginger jar is placed on three different surfaces. Only when the surface is highly reflective (as with metallic surface) is the image of the jar visible. There is no visible trace of it on either the matt white or the matt red. However, since the jar is glazed, reciprocal reflections can be discerned on the lower part of its surface in all three cases. Once again, these are made even more obvious by making comparisons between the different images.

In summary, *Figures 11-14* all illustrate cases of interreflections between two abutting surfaces. In some cases they are easily visible and in others impossible to see. However, whether they are visible or not, artists who are attempting to draw or paint them from observation would be well advised to take them into account. The reason is that the visual system that extracts information from reflected-light uses ***interreflections*** to tell the eye/brain that the object is situated on the surface and not separate from it. It it is they that establish the absence or presence of ***connectivity***. Perceptually speaking, they anchor the object to the surface upon which it is situated. Or, to put the same thing another way, they prevent it from being perceived as floating free.

Three significantly different types of border

Figure 15 : Card on matt red surface

Figure 15 is an image of a greetings card standing on a red surface. It has three kinds of border. They occur between:

- The base of the card and the supporting surfaces.
- The two sides of the vertical crease which separate the two differently oriented surfaces of the card that face away from each other.
- The card and the scene behind, including parts of the red surface.

Important to notice is that although there are no interreflections between the two faces of the card that are separated by the crease, both of them are influenced by reflections from the red surface, a fact that contributes to the perception of the two faces being part of an integrated whole.

Interreflections or lack of them provide the eye/brain with information that it used in making us aware of the characteristic differences between the above border relationships. As suggested in the *"Introduction to the science* found at the beginning of this volume, it uses their presence or absence, whether alone or in combination, to indicates one or more of three different features of appearances. These are: (a) A support relationship; (b) A change of plane; and, (c) An in front/behind relationship that involves spatial separation.

As we shall see when we get to the practical parts of the book, from the point of view of the artist trying to recreate these three different kinds of relationship in their paintings, it is important to remember that, while the first necessarily provides interreflections, the second may or may not (depending on the relationship of the object to other surfaces), and the third never does.

Visible and invisible effects of light

As the various illustrations should make clear, some of the above effects of light on surfaces are clearly visible, others are only too easily overlooked, and yet others are completely invisible.

Even within the "*clearly visible"* category, comparisons between the surfaces in question may be required to draw attention to their contribution to appearances. In the "*easy to overlook"* category, they are essential. *Figures 10-16*, can be used to show how comparisons between surfaces can reveal telltale differences between:

- The front face of the box and the three different coloured surfaces in *Figures 11, 12 and 13*,
- The bases of the three ginger jars in *Figure 14* and the three different coloured surfaces upon which they have been placed.
- The two identical bands of metallic grey pigment at the top and bottom of the left hand side of the card in *Figure 15. N*otice that a main reason for the colour difference between them is that the two bands are at two different distances from the red surface upon which the card is standing.

It hardly needs adding that within the *invisible category* there is no possibility of consciously seeing the interreflections.

However, it is now established that the reflected-light provides information that, even if it never reaches consciousness, is regularly used by eye/brain sys-

tems in the perception four of fundamental qualities of appearance namely:

- Surface solidity
- Surface profile.
- Interconnectivity between surfaces.
- In front/behind relations.
- The quality of the light that permeates the whole-scene.

My way of demonstrating to students that the eye/brain is able to make interpretive use of surface interreflections of which they have no conscious awareness, involves painting both sides of the border between interreflecting surfaces with a complex mixtures of complementary pigment colours that are diluted to the degree that their effect remains below the threshold of visibility. More on this in *Chapters 9 and 10.*

Implications

The purpose of this chapter has been to:

- *Illustrate: (a) that the nature of surface-reflections vary according to differences in the smoothness and the roughness of surfaces responsible for them; (b) that the smoothness corresponds to "glossy" and roughness to "matt"; and, (c) that all surfaces can be categorised in terms of a continuum between these two properties.*
- *To emphasise that the vast majority of surfaces are to be found towards the matt end of the matt/glossy continuum.*
- *To explain the role of viewing angle in determining the degree to which surface-reflections interfere with the perception of body-colour.*
- *To show examples of interreflections and to give substance to the idea that, whether visible or not, they are very important in visual perception because of their role in establishing (a) the presence or absence of interconnectivity between surfaces, (b) whether something is in front or behind something else.*

The next chapter explains the method that Seurat developed for depicting reflected-light in all its manifestations.