
CHAPTER 23

More on viewing conditions

Introductory

This chapter continues the story of how my interest in thin lines led to previously unknown, or little explored, ways in which viewing conditions can affect appearances. Sometimes the changes they bring about are dramatic. At others, they can be extremely subtle or even virtually invisible. Whenever visible, they are well worth taking into account.

The Stirling Series

The ideas concerning lighting and viewing conditions fed into a series of paintings that I called the “*Stirling Series*” (because I made the bulk of them when I was working at the *University of Stirling*). They had their origins in a colour course I had taught at *Wimbledon School of Art*. One of the projects I gave to the students involved exploring optical colour mixing, using alternating, narrow strips of complementary colours. I informed the students that, according to theory, it should be possible to make identical greys by optically blending any pair of complementaries from any part of the colour circle. Later, after the course was over, I was to speculate that these differently constituted greys might respond differently to changes in viewing conditions and I decided to make some paintings that would harness this variability. The process was to prove to be extremely fruitful, although not for the reasons I had proposed.

Figure 1 illustrates a frontal view of one of the paintings from the *Stirling Series* as seen from a distance at which the individual stripes are barely visible. *Figure 2* shows the alternating 1/32 inch stripes as seen from closer up. Although the rate of gradation is very slow, the colours vary systematically both from left to right and from top to bottom.

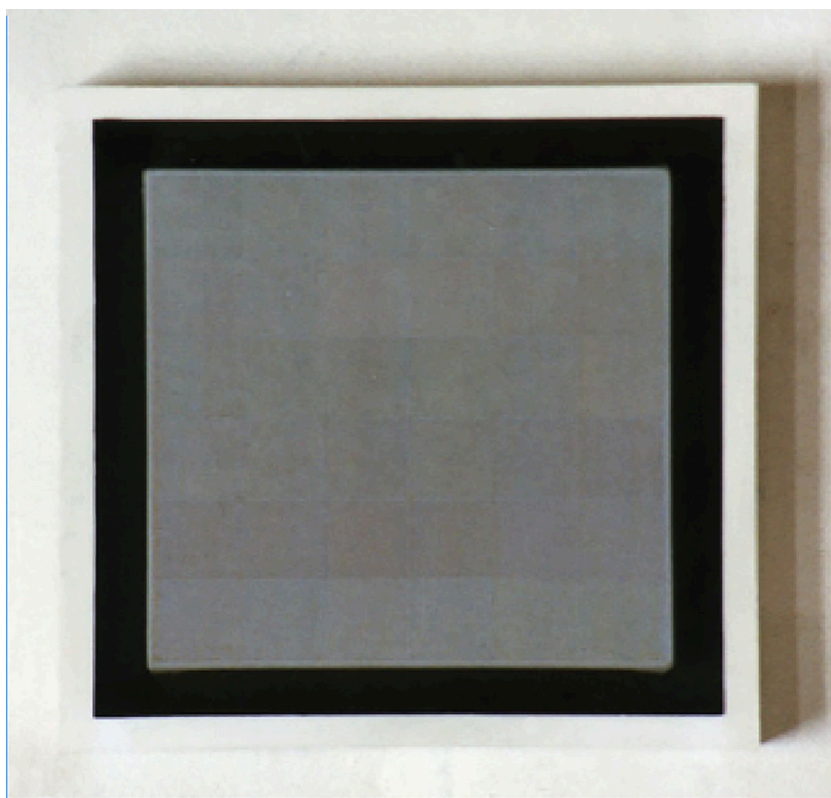


Figure 1 : A painting from the Stirling series.

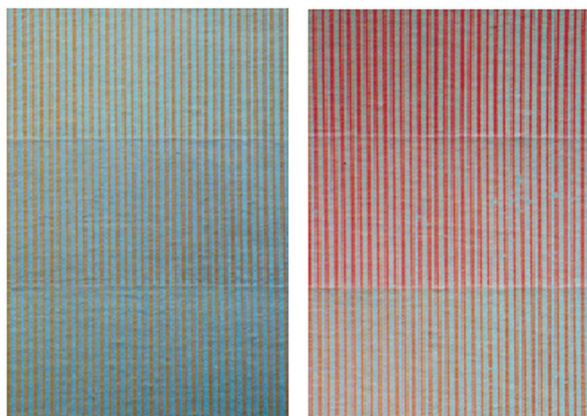


Figure 2 : Two close-up view showing details the narrow stripes

A first test was to see if it is actually possible to create an identical neutral grey from a large number of different complementary pairs. For my experiment, I chose 12 inch square, canvas covered stretchers. These I divided into 36 smaller squares, each of which I painted with a different colour with each square being only just noticeable different (JND) from its neighbour. Next:

- I covered the entire picture surface with juxtaposed strips of 1/32 inch wide *Letraline* tape
- I lifted up every second tape, such that a 36 colours could be painted into the 1/32 inch wide channels that produced in this way.
- I lifted up the remaining strips of *Letraline* tape, to reveal the 36 different pairs of juxtaposed complementary colours.

I had no doubt that there would be substantial changes in the appearance of these paintings if viewed first daylight and, the, in tungsten light. But would the effects of natural variations in daylight be noticeable? It was my admittedly not very confident hope that they would be. My hesitation was because, even in those days, I had heard of **colour-constancy** and strongly suspected that this phenomenon might scupper my hopes of creating continuously dynamic surfaces. However when, buoyed up by my ignorance, I made a trial painting I was more than pleasantly surprised. The colours seemed to be doing all that I could wish for and much more. I was elated and five paintings later my worries had been blown away. It was plain to see that the colours were indeed changing over the course of the day and, to my excitement-blinded mind, the only explanation for their volatility seemed to be a combination of the way the squares were composed and the variations in the daylight illuminating them.

It was at this juncture that I was appointed to my university post. For a change, I felt I had time and money on my side. Accordingly, I decided on a gradual, homing-in approach, starting with pairs of fully saturated colours, seeing where that got me and, then, little by little, painting by painting, adjusting the colour pairs, in the hope that, sooner or later, I would arrive at my dreamed of uniformly grey 72 colour painting.

Luckily, not yet being a scientist, I did not realise the importance of starting with controlled, stable lighting conditions. If I had, I would have never embarked upon such a sloppy experiment and, accordingly, I would have missed out on the many excitements involved in making and experiencing the first twenty-eight-paintings in the series.

As it was, I powered on blithely, looking at the outcomes in natural light at various times of day, and enjoying the riches of the colour dynamics that were revealed to me.

Outcomes and explanations

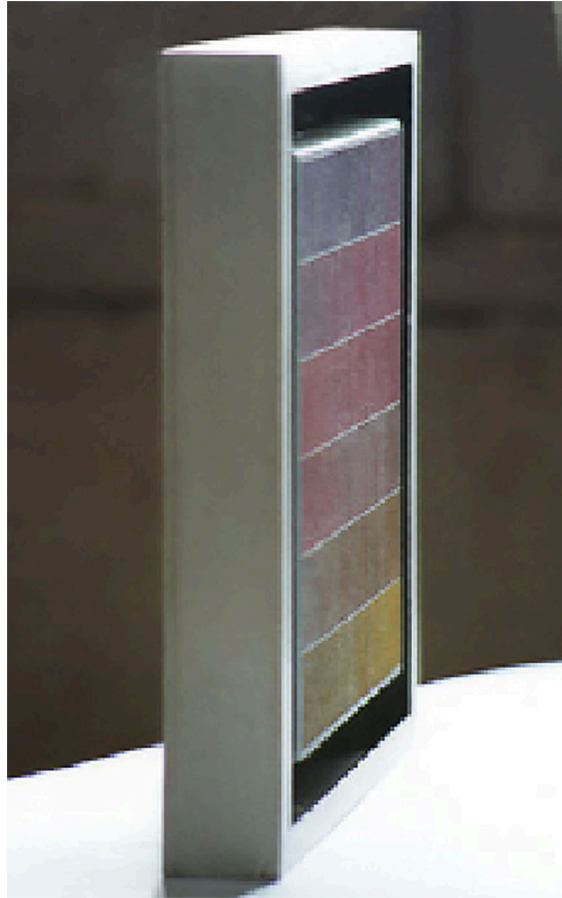


Figure 3: Side on view of the painting in Figure 1.

As just indicated, the paintings thus produced were full of surprises and excitements. The most immediately evident of these occurs, either if they are looked at side-on or when the main source of illumination rakes across their surface. Instead of being perceived as tending to grey, the surface takes on a vivid, luminescent quality, with something of the characteristics of shot-silk. *Figure 3*

gives some idea of this.¹

Figure 4 (top part) diagrams a cross-section of the surface of a painting made according to the method described above. It shows a ground of one colour (in the diagram blue), upon which has been painted an array of .09 millimetre wide, vertical stripes of a complementary colour (in the diagram orange). Due to the fact that the stripes have been made using very thin masking tape, they are not only the same width as the masking tape, but also the same height. Accordingly, the result takes the form of a relief. This means that although the blue ground is visible when viewed from in front (near vertical arrows), it is not when viewed from the side (more sharply sloping arrow). If the line of sight is sloping, as illustrated, only the blue can be seen. If it is vertical both colours can be seen. However, because the lines are so thin, they mix optically from a couple of paces away from the picture surface and tend towards grey. Accordingly, as the spectator moves from in front to the side the painting changes from grey to orange.

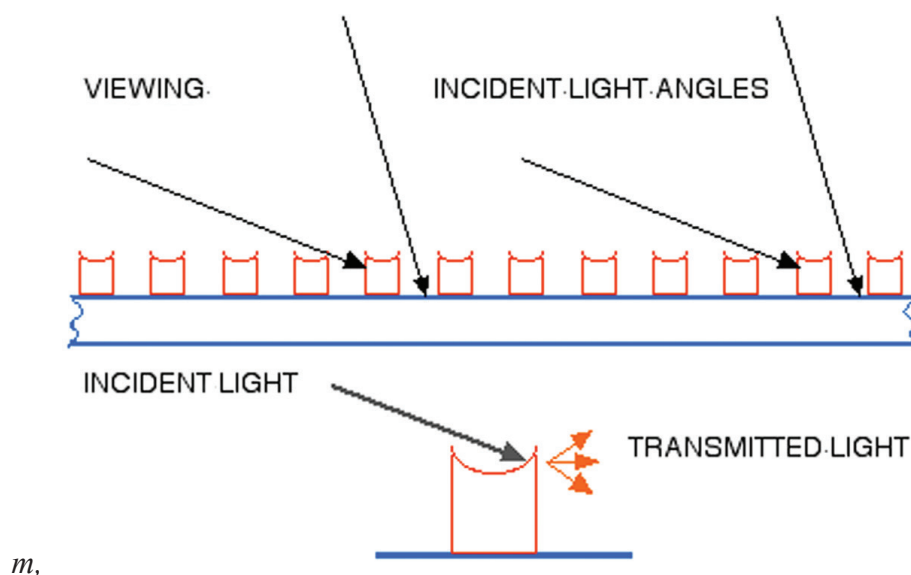


Figure 4 : Diagrammatic profile of a Stirling series painting in which orange stripes are painted on a background of blue.

But that is not all. Figure 4 (bottom part) illustrates the fact that the method of using masking tape as a guide to the facture of the every thin stripes produces

1 Unfortunately, it is impossible to reproduce the luminescence in a printed image.

convex ridge profiles with a peak on each side. These peaks provide a translucent ridges of paint. The effect can be compared with light penetrating young poppy petals or young blades of young cereals, when looked at from the side opposite the light source. The result is a luminescence of a kind that, as far as I know, cannot be found in any other painting.

Analogous transformations occur with changes in the angle at which the sun, or some other strong main light source, strikes the picture-surface. It glows as if with an internal light source.

A casual survey of people looking at the *Stirling Series* paintings makes it clear that a large majority of them are most excited by the luminescent side-on views. For myself, I prefer frontal and near-frontal perspectives and the discovery of the different nuances of grey that can be seen from them.

Chromo-luminarism

Earlier, in discussing *Chromo-luminarism*, I explained how the painters and critics of the time were excited by the luminosity and vitality created when mosaics of dots of complementary colours are seen from the viewing-distance at which the individual dots are on the point of fusing into a uniform area of colour. Similar excitements are available from my *Stirling Series* paintings. Indeed, because of the regularity of line and the level of control over the paint mixtures in these paintings, the combination of vitality and luminosity is almost certain to be more dynamic than those that Felix Fénéon got so excited about. . In this respect, my paintings provide an example of how abstract art, by concentrating on single issues and using modern techniques, can bring ideas, first developed in representational painting, to a new level of fruition.

An Op. Art experience

A great surprise was the discovery of an *Op. Art* aspect in my paintings. I had long been interested in optical effects in paintings, particularly in those made by my mentor Michael Kidner in the mid 1960s and in the colour works of Bridget Riley, which followed not long afterwards. In the late 1970s I saw an exhibition of the latter's work that made a great impression on me. It was in the *Rowan Gallery, London*, and consisted of four large paintings, each made of repeated sequences of brightly coloured stripes. According to my memory they were along the lines of the stripes in *Figure 5*.

I must admit that, at first, I found the paintings harsh to look at, but I was determined to stay around long enough to give them a fair chance to grow on me. I stood there for a considerable time trying to conquer my aversion for the crude, brash, colour effects with which I was confronted. Perhaps because it was all a bit overwhelming, my eyes began to go out of focus. Then suddenly, the stripes jumped out from the wall, creating luminescent pillars of colour, which I experienced as surrounding me.



Figure 5 : Vertical stripes in repeated colour sequences.

While enjoying being trapped in this *virtual-space*, I tried to work out what had happened. The hypothesis at which I arrived was that, as a result of going a bit cross eyed, I had managed to overlay the retinal image of one set of stripes with that of its neighbour, thus creating a stereoscopic effect. Afterwards, I found that every time I repeated the process, the pillars of colour surrounding me again.

An additional discovery was that, in some of the paintings, where the colour repetition was only partial, the overlaying process acted as a method of colour mixing.

When I got back to Stirling, I mentioned what had occurred to one of my colleagues. His reaction was dismissive: “*Oh, that’s just the ‘wallpaper effect’*”, he said. He then explained that, due to stereopsis, the same three dimensional-ity can be produced by the same overlaying manoeuvre, with any pattern that is repeated over a large surface (such as those found on many wallpapers). I was interested but not discouraged. I argued to myself that, however banal it might

be for a scientist, my experience in the *Rowan Gallery* had been very powerful and rewarding. It had suggested new possibilities for generating experiences of colour and space, as well as offering a novel approach to optical colour-mixing.

Gentle Op. Art

The idea of de-focusing my eyes having been planted in my mind, I now found that my stripy paintings offered a version of the “*wallpaper effect*” experience. It occurs when the spectator views the painting from closer than the point of colour fusion, but not so close that surface-texture clues give too much information about the paint as physical substance on a solid surface. Within this range of viewing-distances and with a little glazing over of the eyes, a stereoscopic illusion is likely to occur, whereby one of the sets of lines, jumps out from the picture-surface and hovers in front of it producing eye and mind intriguing effects. But this is by no means all for, under these conditions, the seemingly nearer lines become active in unexpected ways, though to describe exactly what happens is difficult. The best I can do is to resort to somewhat mystic and poetic language, for the lines seemed both to *remain rigid* and to *dance and bend like sunlit reeds in a gentle breeze*. I realised that it is a branch of *Op. Art*, without any of the in-your-face shock. Instead there was what I experience as a far more worthwhile dimension. It was as if my mind had *entered an essentially quiet, yet mysteriously vital space*.

Viewing Distance

As time passed by, I found myself spending more time with scientists. Under their influence, I became convinced of the desirability of controlling the lighting conditions under which my paintings were viewed. Someone suggested that I contacted *Phillips* (the electronics multinational) in Holland and, much to my surprise, the response to my letter was an invitation to *Eindhoven* to discuss my problems. My astonishment was even greater when, after an extremely agreeable and informative visit hosted and guided by a delightful and knowledgeable Dutchman,² I was supplied gratis with all the lighting equipment that I could need. From the point of view of the story being told, the main characteristic of the gift was its stability: There was never any change its wavelength composition and, unless I used the dimmer switches, the level of the illumination remained constant.

The effect on my painting-project of installing this stable light source can

2 Dr. J.J. Roufs, Research Fellow at the *Phillips funded Institute of Perception*, Eindhoven.

only be described as *dramatic*. Almost immediately, it became clear that there was something very wrong with my theorising, for the colour in the paintings continued to change even when the lighting conditions did not. Obviously, the transformations of colour I had been seeing could not be due to fluctuations in the spectral composition and/or intensity of the ambient illumination. In the snakes and ladders game of my creative adventure, I had slid back to square one.

Fortunately for me, the death of one explanation led to the birth of another and it was not long before I became aware that the changes in colour, which I had been interpreting as due to changes in lighting conditions, were in fact due to *changes in viewing-distance*.

I first noticed this when I was concentrating my attention on a blue/orange colour pair. When looked at from close to the picture-surface, the two colours were roughly equal in lightness. But, if I stepped back a couple of paces, the blue became something approaching black and the orange became very bright and luminescent.³ I looked at other colour pairs and similar transformations took place. For example, green/red pairs, the green got duller and the red brighter. In the case of yellow/violet pairs rather than a lightness shift, a colour shift took place: The violet became redder and the yellow became greener.

Research into what I had discovered

In both “*What Artists can Learn from the Scientists*”⁴ and in two journal articles,^{5,6} I describe the research that these findings triggered and how they led to the conclusion that the *viewing-distance effect* is due mainly to two factors:

1. *Chromatic aberration*⁷ in the crystalline lens that enables fine focus, which is situated at the front of the inside of the eyeball.
2. The link between *focus and lightness*.

Because of chromatic aberration, the different wavelengths of light focus differ-

3 Recalling the seeming luminescence of the orange thin-bar elements in the *Grey Series*, described earlier.

4 *Chapter 10*.

5 Pratt, Francis and MacDonald, Randal R., 1981, ‘*Effects of distance on heterochromatic matching*’. *Perceptual and motor skills*, Vol. 50, pages 1127-1138

6 MacDonald, Randal R., Pratt, Francis and Beattie, Martin E., 1982. ‘*Effects of viewing distance on metamerism matches*’. *Perceptual and motor skills*, Vol. 54, pages 119-126

7 The function of all lenses is to bend light. Unless specially designed, they bend different wavelengths differently, with short (blue) wavelength bent the most and long (red) wavelengths bent the least (the same as a prism and for the same reasons).

entially. Because of the connection between focus and lightness, the part of the spectrum that is *in focus* is seen as relatively lighter and brighter. In practical terms this means that, when spectators stand a couple of paces or further from the picture surface, the longest (red) wavelengths are in focus. As they approach nearer to it, progressively shorter wavelengths come into focus. Finally, from close-up, after running the gamut of the spectrum, the shortest wavelengths (blue) are in focus. Accordingly, as spectators approach the painting, the relatively lightest and brightest colour moves from red to orange, to yellow, to green and, finally, from the nearest viewpoint, to blue.

This hypothesis explained why the appearance of the violet, being a composite colour containing both red and blue, changes with variations in viewing distance. Thus, as it increases from close-up to two metres, the red component gets lighter and the blue component darker, thus causing a shift towards a redder violet.

The only explanation I can think of for the tendency for the yellow in a yellow/violet pair to look greener, is that it is the outcome of d as an induced-colour effect, with the redder violet causing an induced green.

In the paintings of the *Stirling Series* paintings, due to the exaggeration of any contrast effects due to the thinness of the colour stripes, the tendency towards luminescence is maximised.

The second series

As far as my painting was concerned, I was left with little alternative but to look for ways of exploiting the new discovery. Fortunately, after a period of doubt and despair, exciting prospects emerged, and these led to the second half of the *Stirling Series*.

If changes in viewing-distance differentially affect the relative lightness of colour pairs and if the view stands either nearer or further away, the only way of keeping the perceived relation between them stable is to adjust the painted colours. From any new fixed viewing position one of the two colours will either have to be toned down or made brighter. In short, if the aim is to keep the relationship between the colours stable every different viewing distance will require different colour pairs.

Since in this context, what applies to any one pairing of complementary or near-complementary pairings, applies to all pairings, I had the feeling that there might be a number of interesting possibilities to be explored. Eventually, after

the usual stage of frustration, a new approach occurred to me. My idea was to make another set of stripy paintings, using the same format as before but, this time, varying the lightness of the colours from left to right along each horizontal row, such that, as the cold colours got darker, the warm colours got lighter or *visa versa*. Theoretically, it should be possible to make paintings in which, no matter the viewer's distance from the picture-surface, there would be one pair in each row of colours that were equal-lightness. In other words, the location of the equal lightness event would shift with variations in viewing-distance. Accordingly, the act of either approaching or moving away from the painting would cause ripples of movement across the picture-surface, as the pairs of stripes in balance moved along at different rates in each of the six horizontal rows.

With the basic idea in place, I began to think of its potential ramifications. In particular, I saw possibilities deriving from the relief effect (mentioned above and diagrammed in *Figure 2*). After allowing these to swirl around in my head for a while, the idea occurred to me of making paintings two at a time, using identical colours for both paintings, but reversing those used for the ground and the ridges. My intention was that each pair would appear the same in both paintings, when looked at from in front and with a light-source shining vertically down the stripes, and different, when viewed and/or illuminated from the side. The greater the sideways movement of the viewer or the more acute the angle of the main light source, the greater the difference between the two paintings would become. I explored these ideas in some fifteen pairs of paintings.

In these ways, the discovery of the viewing-distance effect on appearances led me into a new world of colour. The paintings, seemed *continually in a process of becoming* and this property of movement-generated emergence and dissolution gave a new meaning to the colours. As surfaces, they became magic in exactly the same way as the ever-changing surfaces in nature are magic. However, being unlike any natural surface, the paintings have their own unique experience-enriching excitements to reveal to anyone who wishes to contemplate them with an open mind.

Implications

Although this chapter has been focused on paintings that have little superficial resemblance to the vast majority of art works, all the lessons learnt from them have more general applicability, as should become clearer in the next chapter.