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# An oblique effect in aesthetics: Homage to Mondrian (1872–1944)

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**Abstract.** The effect of the orientation of Mondrian's paintings on their aesthetic appeal was examined. Eight paintings, four with horizontal/vertical frames in the original and four with oblique frames, were presented in eight different orientations and rated for aesthetic appeal on a 7-point scale. There was a stronger preference for pictures presented so that their component lines were horizontal and vertical than for pictures presented with their component lines in an oblique orientation. In addition, subjects showed a preference for the original orientation, perhaps because rotation changes the lateral balance of the paintings as well as the orientation of the component lines. There was no overall preference for one frame orientation over another, but there was an interaction between frame orientation and component orientation, resulting in a preference for paintings where the components were parallel to the surrounding frame. It is suggested that the aesthetic oblique effect reported here is related to the oblique effect in orientation perception and the privileged access which horizontal and vertical lines have to the visual system. This offers a possible mechanism for aesthetic judgments of abstract patterns: we find pleasing those stimuli which are closely tuned to the properties of the human visual system.

## 1 Introduction

Mondrian's simple geometrical patterns, assembled from a small array of high-contrast horizontal and vertical black lines and blocks of primary colours, are among the most easily recognisable and influential images in twentieth century Western art. They have been much imitated in the commercial arts where examples of 'Mondrian' patterns occur widely in advertising, fabrics, packaging, interior decoration, and product design. (The sellotape dispenser on the desk in front of us as we write is clearly inspired by Mondrian, with overtones of the visually powerful, if rather uncomfortable chair designed by his contemporary in the De Stijl group, Gerrit Rietveld.)

It is difficult to know how much artists were influenced by contemporary ideas from other disciplines and how much they proceeded by trial-and-error, using their own aesthetic judgments to guide them. However, Mondrian was developing his techniques at a time when there was much interchange between art and science, and the idea of the elemental was pervasive in both (see Jaffé 1970; Vitz and Glimcher 1984). Like Kandinsky, he seems to have been deliberately isolating and simplifying the features of stimuli in the attempt to identify the elementary particles of human perception and visual pleasure. This was not a new idea. The importance of lines as imposed elements in visual perception was recognised as early as 1840 when Delacroix wrote:

"It would be interesting to work out the question of whether regular lines do not exist only in the brain of man" (Delacroix 1980, page 714)

And the theoretical discussion of the distinctive quality of different orientations goes back at least as far as the Dutch painter Humbert de Superville (1770–1849). His ideas were taken up by the French philosophers Charles Blanc (1813–1882) and Charles Henry (1859–1926) whose writings were influential among contemporary French artists, particularly Seurat (see Homer 1964; Vitz and Glimcher 1984). Henry produced an aesthetic protractor for reading off the emotional significance of different orientations.

Blanc suggested that, in order of importance, vertical comes first, because man stands perpendicular to the horizon, then horizontal, and finally the two obliques.

The artistic expression of these ideas can be seen in the spatial organisation of some of the paintings by Seurat and the post-impressionists and it came into full flowering in the move to abstraction in the first two decades of the twentieth century. Malevich and the Russian Suprematists experimented with the aesthetic effects of simple patterns of lines, but it was Mondrian and the De Stijl group in Holland who were most dedicated to the primacy of horizontal and vertical. So strong was Mondrian's commitment that when, in 1925, another De Stijl artist, van Doesburg, insisted on using obliques as well, he formally left the group.

We know now that in one respect Mondrian was right and van Doesburg was wrong. It is one of the most robust findings of recent psychophysics that, over a wide variety of measures, our perception of oblique lines is slightly inferior to our perception of horizontal and vertical (see, for example, the review by Appelle 1972, and the more recent work by Davidoff 1974, Essock 1990, Heeley and Buchanan-Smith 1994, Heeley and Timney 1988, and Zlatkova 1993). In psychophysics, this is known as orientational anisotropy or the oblique effect.

Horizontal and vertical lines are perceptually primary, but was Mondrian also right in arguing that they are aesthetically primary? Do people prefer horizontal and vertical lines to oblique lines? We answered these questions by measuring the effect on aesthetic judgments of rotating Mondrian's paintings so that the component lines became oblique, exploiting his use of canvases with oblique frames (usually referred to as lozenge paintings) to control for effects of frame orientation.

## 2 Method

### 2.1 Subjects

The subjects were thirty undergraduates from the University of Liverpool. Thirteen of the subjects were male and seventeen female. Their mean age was 22.3 years, ranging from 19 to 42 years.

### 2.2 Stimuli

Eight paintings by Mondrian—all oil on canvas—were used. All had sides of equal lengths and consisted of only horizontal and vertical lines. To control for (and investigate the influence of) frame orientation, four paintings had traditional horizontal and vertical frames:

*Composition in a Square (1929)* [52 cm × 52 cm]

*Broadway Boogie-Woogie (1942–1943)* [127 cm × 127 cm]

*Composition with Red, Blue and Yellow (1930)* [51 cm × 51 cm]

*Composition with Red, Yellow and Blue (1921)* [48 cm × 48 cm]

and four had oblique frames:

*Composition I with Blue and Yellow (Lozenge) (1925)* [79 cm × 79 cm]

*Composition with Two Lines (1931)* [80 cm × 80 cm]

*Victory Boogie-Woogie (1943–1944 Unfinished)* [126 cm × 126 cm]

*Composition in a Lozenge (1925)* [77 cm × 77 cm]

Eight slides were made of each painting at eight different orientations 45° apart, producing four pictures with only horizontal/vertical components (original; and 90°, 180°, and 270° rotation) and four with only oblique components (45°, 135°, 225°, and 315° rotation).

There was therefore a total of sixty-four stimuli, with eight in each of eight degrees of rotation. Each block of eight slides contained one example of each picture and one example of each orientation. The order of the eight pictures was counterbalanced with a Latin Square and the sixty-four stimuli were divided into four blocks of sixteen (two complete sequences of eight) whose order of presentation was itself varied in a counterbalanced sequence between subjects.

Slides were made to a standard size which, when projected from a Kodak EktaPro<sup>®</sup> 3000 projector, mounted behind the subject who was seated at a table 3 m in front of the screen, produced an image which subtended an angle of approximately 11°. Room lights were turned off during the experiment and each slide was exposed for 5 s.

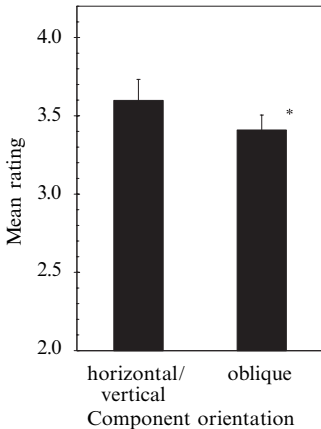
### 2.3 Design and procedure

Subjects were first shown four practice slides of two Mondrian's paintings not included in the experimental set (one square-framed, one oblique-framed, with each in both its original orientation and rotated through 45°). They were asked to rate each picture for aesthetic pleasingness on a 7-point scale, numbered 1 to 7 and labelled 'lowest' at 1 and 'highest' at 7. Instructions were given both orally and in writing. Subjects responded graphically. The sixty-four experimental stimuli were then presented in a continuous sequence.

The data were analysed with SPSS. A two-way within-subjects ANOVA, with an alpha level of 0.05, looked at the factors of component orientation (horizontal/vertical versus oblique) and frame orientation (horizontal/vertical versus oblique). A one-way ANOVA was used to analyse the effect of rotation with respect to Mondrian's original. Paired sample *t*-tests were used for specific comparisons. Homogeneity of covariance was tested for where appropriate with the Mauchly Sphericity Test and, where the data failed this test, the ANOVA was made more conservative according to the Greenhouse–Geisser correction. The data are presented in bar charts of means and standard errors of the means with asterisks indicating the probability level of any significant differences (\* = 0.05, \*\* = 0.01, \*\*\* = 0.001).

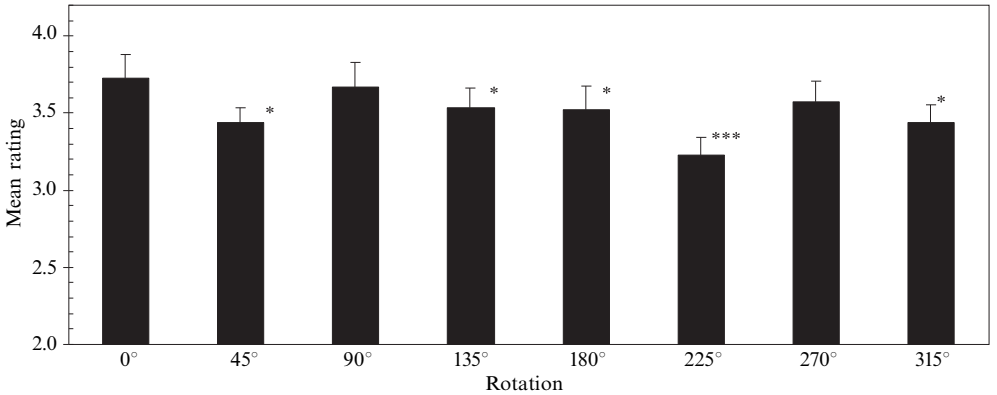
## 3 Results

Figure 1 shows the overall mean ratings given to pictures with horizontal/vertical or oblique components. The pictures composed of horizontal/vertical components were rated as more aesthetically pleasing than those composed of oblique components ( $F_1 = 4.571$ ,  $p = 0.041$ ).



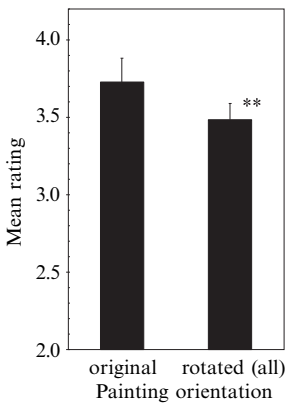
**Figure 1.** The effect of the orientation of the component lines on ratings of Mondrian's paintings. In this and in the other figures asterisks indicate the significance of the difference from the original orientation (see text).

Figure 2 shows the mean ratings for each orientation of the paintings. As would be expected from figure 1, there was a clear pattern of preferences for orientations producing horizontal/vertical components. The overall effect of rotation on preference was significant ( $F_{3,889} = 3.543$  with the Greenhouse–Geisser correction,  $p = 0.010$ ). The original orientation was preferred to all rotations generating oblique components (45°:  $t_{29} = 2.283$ ,  $p = 0.015$ ; 135°:  $t_{29} = 1.825$ ,  $p = 0.039$ ; 225°:  $t_{29} = 4.314$ ,  $p = 0.000$ ; 315°:  $t_{29} = 2.094$ ,  $p = 0.023$ ; all one-tailed), but not to those generating horizontal/vertical components with the exception of the inverted pictures (180°:  $t_{29} = 2.285$ ,  $p = 0.015$ ).



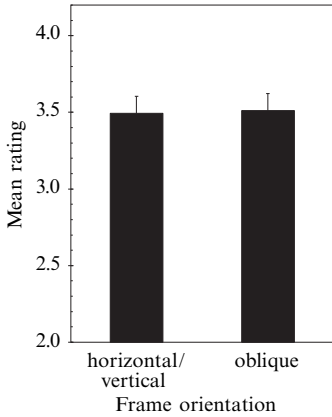
**Figure 2.** The effect of clockwise rotation on ratings of Mondrian's paintings.

An overall comparison of the original paintings with all the rotated versions (figure 3) showed a higher rating for the originals ( $t_{29} = 3.219$ ,  $p = 0.002$ , one-tailed). This effect might have been due solely to the presence of obliquely oriented components in four of the seven orientations in the rotated pictures. This was not the case, since comparing ratings of the original paintings with those for paintings rotated through 90°, 180°, and 270° only, thus excluding paintings with obliquely oriented components, still showed a preference for the original orientation ( $t_{29} = 2.345$ ,  $p = 0.013$ , one-tailed). Original paintings were also preferred more than rotated paintings containing only oblique components (45°, 135°, 225°, and 315° rotations) ( $t_{29} = 3.035$ ,  $p = 0.003$ , one-tailed). This preference was stronger than the preference for the original paintings over the rotated paintings containing only horizontal/vertical oriented components ( $t_{29} = 1.884$ ,  $p = 0.035$ , one-tailed). This pattern of results suggests there are two factors reducing the appeal of Mondrian's paintings when they are rotated, one due to rotation per se and one due to the introduction of obliquely oriented components.

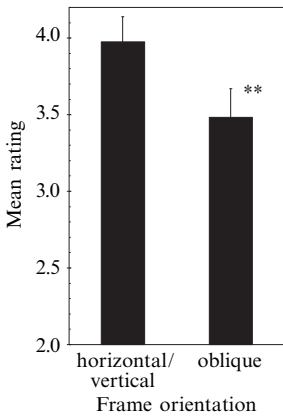


**Figure 3.** A comparison of the mean ratings of Mondrian's paintings in their original orientation and when rotated.

Figure 4 shows the overall effect of frame orientation on aesthetic judgments. There was no difference between horizontal/vertical frames and oblique frames ( $F_1 = 0.201$ ,  $p = 0.657$ ). There was, however, an interaction between component orientation and frame orientation ( $F_1 = 64.998$ ,  $p < 0.001$ ) with the preference for horizontal/vertical components being substantially balanced by a preference for components which are parallel to the surrounding frame. This resulted in a preference among the original paintings for those with horizontal/vertical frames over those with oblique frames (figure 5) ( $t_{29} = 2.855$ ,  $p = 0.008$ , two-tailed).



**Figure 4.** The effect of the orientation of the frame on ratings of Mondrian's paintings.



**Figure 5.** A comparison of mean ratings of Mondrian's paintings which used horizontal/vertical canvases with lozenge paintings which used oblique canvases, all in their original orientation.

#### 4 Discussion

There was a clear preference for paintings with horizontal/vertical components, whatever the orientation relative to either Mondrian's original or to the orientation of the frame. As with psychophysical judgments, there is an orientational anisotropy—an aesthetic oblique effect. The smallness of the effect reflects the fact that subjects persisted in using the central points on the Likert scale despite strong exhortation in the instructions to use the whole range. Failure to use the extreme points of a Likert scale is a common problem in studies of this sort and cannot be taken as an accurate indication of either the subjects' underlying judgments of Mondrian's paintings or of the size of the difference between horizontal/vertical and oblique lines.

Subjects also showed a small preference for Mondrian's original orientation, even when compared with rotated paintings containing only horizontal/vertical components. This extends an earlier study by Lindauer (1969) who found a preference for the original orientation in a set of rotated abstract paintings by artists (Davis, De Kooning, and Pollock) with a much less geometrical style than Mondrian. (Lindauer did not look at oblique orientations, so his results do not bear on the central part of the present study.) Rotation changes the balance of the paintings as well as the orientation of the component lines, and there is good evidence that balance is important in aesthetic judgments (Banich et al 1989; Freimuth and Wapner 1979; Gordon and Gardner 1974; McManus et al 1993; Levy 1988). The procedure most commonly used in these studies was to compare original compositions with their mirror-reversed form. In the present experiment, it is notable that the only rotated paintings with horizontal/vertical components which produced a significantly lower preference than the original orientation were those

rotated through  $180^\circ$  (figure 2). This produced a left/right reversal of the dominant features in the pictures most similar to mirror reversal.

McManus et al (1993), using computer manipulation of the position, though not the orientation, of components in Mondrian's paintings, found that relatively small changes affected preferences. So although disruption of balance could not account for the preference for horizontal/vertical components in the present study, it is clearly a second important factor, particularly in accounting for the preference for Mondrian's original paintings.

Another indicator of the importance of orientation was the significant interaction between the orientation of the frame and the orientation of the components. Subjects preferred paintings where the components were parallel to the orientation of the frame. The orientation of the visual frame in which a line is perceived contributes substantially to the perceived orientation of that line. An oblique frame tends to make vertical and horizontal lines look oblique (Curran and Lane 1962; Howard 1978; McAfee and Proffitt 1991; Witkin and Asch 1948). The effect of manipulating a frame on the psychophysical oblique effect has not been investigated, but it has been shown that tilting the head does not alter the absolute orientation of the sine-wave grating for which we have the best orientation acuity (Buchanan-Smith and Heeley 1993). The favoured orientation is modified by head and body posture. The psychophysical oblique effect must therefore depend on relatively high-level processes in the visual system driven by information not only from the retinotopic information but also from other sources such as the vestibular system and the visual context. If there is a causal link between the psychophysical oblique effect and the aesthetic oblique effect, then the latter too would be subject to these non-retinotopic influences.

Mondrian was right and van Doesburg was wrong. There is something special about horizontal and vertical lines. And the fact that this aesthetic oblique effect is matched by a psychophysical oblique effect provides a possible explanation why Mondrian was right: we prefer horizontal and vertical lines because they are perceptually more powerful. This would be particularly important in abstract paintings like Mondrian's where the aesthetic power depends entirely on the strength of the sensation produced by the form, but it would apply to some extent to all the visual arts. (Interestingly though, engravers, who have only lines available to them to produce all their effects, seem to make use of the psychophysical oblique effect in quite a different way. Shading in engraving is created by brightness assimilation from closely spaced lines and, perhaps because in this case line resolution is not desirable, is nearly always done with oblique lines.)

The neural mechanisms underlying the psychophysical oblique effect are not entirely clear. There is evidence that in non-human primates there are more Hubel-and-Wiesel orientation detectors tuned to horizontal/vertical than oblique (De Valois et al 1982; Kennedy et al 1985; Mansfield and Ronner 1978). But, as we have seen, this cannot be the whole story for, in some situations at least, it is gravitational rather than retinal vertical which is crucial (Buchanan-Smith and Heeley 1993), which perhaps explains why we do not have to stand rigidly to attention to appreciate a Mondrian. As Buchanan-Smith and Heeley suggest, the psychophysical oblique effect is probably a multi-component process. Nevertheless, out of all the possible orientations, horizontal and vertical seem to have privileged access to our neural processing and this privileged access might also account for the aesthetic preference we have for these stimuli.

This leads to a more general argument which one of us has developed fully elsewhere (Latto 1995) and which has also been expounded recently by Zeki (1999). We prefer those shapes and arrangements of shapes which are most effectively processed by our visual systems. The reason for such a mechanism must remain speculative. One possibility is that it is important for the visual system to be stimulated and sometimes pushed to the limit to function effectively, and so, as with other adaptive behaviours,

we have evolved a mechanism for encouraging this. Whatever the reason, successful abstract artists are, through their observation of the world or through trial-and-error, identifying these critical shapes and arrangements. So studying the forms selected by artists provides clues to the way the visual system is tuned.

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