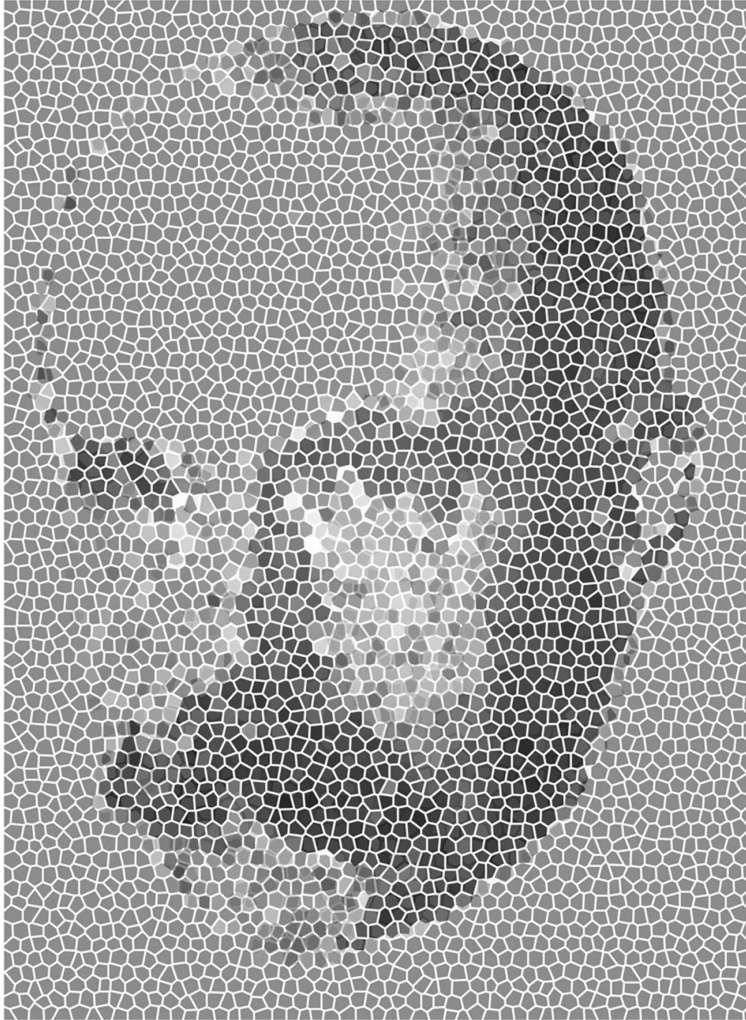Nicholas J. Wade

Artistic Precursors of Gestalt Principles

Fig. 1 *Gestalt mosaic* by Nicholas Wade. Max Wertheimer (1880-1943) is defined by variations in the density of the elements in the mosaic.

Introduction

Gestalt psychology had its origins in perception but its ambit extended throughout the whole of the subject. Its major perceptual practitioner was Max Wertheimer (figure 1) who redefined psychology as the study of configurations or Gestalten. Perception itself was seen as holistic rather than atomistic:

> "The fundamental 'formula' of Gestalt theory might be expressed in this way: There are wholes, the behaviour of which is not determined by that of their individual elements, but where the part-processes are themselves determined by the intrinsic nature of the whole. It is the hope of Gestalt theory to determine the nature of such wholes" (Wertheimer, 1938a, 2).

Like John Watson (1913) with the behaviourist manifesto, and at about the same time, Wertheimer (1912) rejected Wundt's psychology, but for different reasons: Wertheimer opposed Wilhelm Wundt's atomism, considering that complex percepts could not be reduced to simple sensory elements. Not only was it said that the whole is different from the sum of its parts, but the perception of the whole is phenomenally prior to that of its parts.

The philosophical precursors of Gestalt psychology were to be found in Immanuel Kant's innate categories of space and time, in Ernst Mach's emphasis on the analysis of experience, and in Franz Brentano's holistic mental experiences (Ash, 1995). Earlier Christian von Ehrenfels had shown that the perception of a musical tune was not dependent on the precise notes played as long as the Gestalt-qualities – the relations between the parts – were retained (Smith, 1994; Wertheimer, 1991). Wertheimer (1912) extended this approach with a series of experiments on apparent movement (Sarris 1988, 1989). It was the inability to distinguish between real and apparent motion that was taken as damning of any approach that explained perception in terms of its sensations. Gestalt psychology was in the main stream of continental philosophy and used the methods of phenomenology as adumbrated by Goethe, Purkinje, Hering and Stumpf.

Less attention has been paid to the artistic precursors of Gestalt, even though Rudolf Arnheim stated:

> "… from its beginnings gestalt psychology had a kinship to art. Art pervades the writings of Max Wertheimer, Wolfgang Köhler, and Kurt Koffka. Here and there the arts are explicitly mentioned, but what counts more is that the spirit underlying the reasoning of these men makes the artist feel at home. Indeed, something like an artistic vision of reality was needed to remind scientists that most natural phenomena are not described adequately if they are analyzed piece by piece. That a whole cannot be attained by the accretion of isolated parts was not something the artist had to be told" (Arnheim, 1974, 5).

Amongst those who did not require such reminders were the legion of Roman mosaic artists who manipulated parts to produce wholes with exquisite skill and

subtlety. Mosaics not only display the grouping principles associated with Gestalt psychology but they also provide examples of figure segregation and figure-ground ambiguity. A final aspect that will be examined here is the dependence of recognition on figural orientation, an aspect emphasised by Köhler (1940) and also appreciated by Roman artists. Artists were practitioners of perception rather than purveyors of particular interpretations of it.

Pinna and Reeves (2009) have extended the Gestalt grouping principles to embrace meaning, and to relate these higher order properties of vision to art. This article examines another aspect of Gestalt, namely, the meaning imbued to the decorative patterns produced in art compared with the theories proposed by Gestalt scientists. The question is whether artists who manipulated pattern elements in order to produce configurations that displayed Gestalt grouping principles should themselves be grouped with twentieth century Gestalt psychologists. If Wertheimer and his colleagues were drawing attention to universal aspects of perception then these would have been available to earlier practitioners of perception and could have been exploited by them. The distinction between mosaic artists and Gestalt psychologists is that the former left pictorial expressions of their ideas whereas the latter also left a written record of their observations and analyses. Both groups engaged in experimentation but the rules defining them differed fundamentally. Gestalt psychologists could follow the methods of scientific enquiry that were established from the seventeenth century, and apply statistical methods to evaluate the results of their experiments. Artists used their eyes and success was determined by judgements of the eyes of others. Written records were either considered to be irrelevant or they have been lost. Thus, it is not appropriate to compare artists and Gestalt scientists in terms of their theoretical stances but rather in terms of the visual records they left. Accordingly, the emphasis in this article is on the graphical equivalences between (mostly) mosaic artists and the illustrations presented in support of Gestalt theory.

Parts and Wholes

In its early years, Gestalt psychology was principally concerned with perception, and a range of robust demonstrations was devised to support its holistic nature. Wertheimer (1923, 1938c) described many principles of perceptual organisation, of which proximity, similarity, symmetry and good continuation were the principal ones. These were illustrated with sets of figures consisting of filled and open dots arranged in patterns which demonstrated the grouping principles (figure 2). Much of the attraction of Gestalt psychology lay in the power of its perceptual demonstrations, particularly those of figure-ground segregation and perceptual grouping. As Rock and Palmer noted: "Wertheimer's laws of grouping have withstood the test of time. In fact, not one of them has been refuted" (1990, 50).

The Gestalt principles of perceptual grouping were described in two articles by

Wertheimer (1922, 1923). The first presented the general background of Gestalt perception, and the second illustrated the principles of perceptual grouping. They have both been abbreviated and translated in Ellis (1938), and a shortened version of the second one is translated in Beardslee and Wertheimer (1958). The initial article (Wertheimer 1922, 1938b) was published in the first issue of *Psychologische Forschung*, the journal founded by Wertheimer, Koffka and Köhler as the organ of the movement that became known as Gestalt psychology.
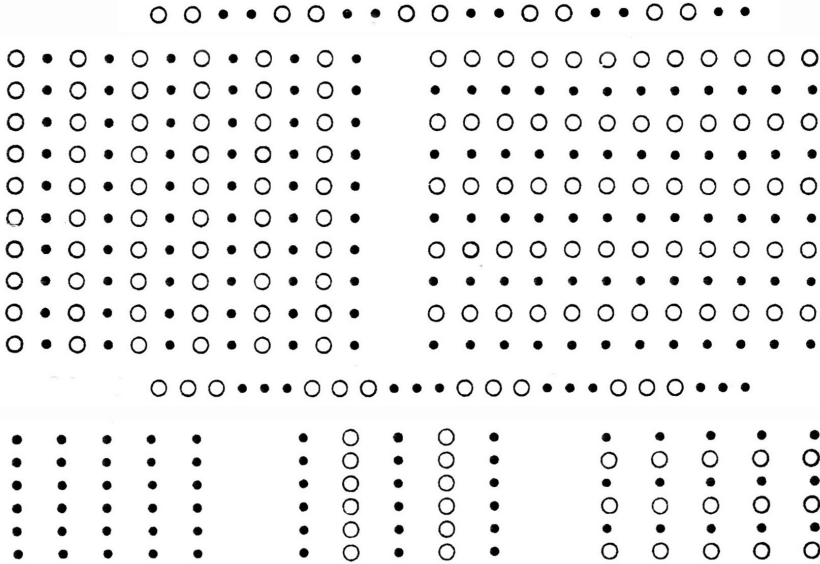

Fig. 2 Examples of Gestalt grouping by similarity as illustrated by Wertheimer (1923). "Other things being equal, if several stimuli are presented together, there is a tendency to see the form in such a way that the similar items are grouped together (*factor of similarity*)" (Wertheimer, 1958, 119).

Since the time of the cave dwellers, art has been concerned with representing objects using an array of techniques, like applying pigment, incising surfaces or modelling solid structures. Roman mosaics fall between these forms of two- and three-dimensional art as the elements are pigmented but solid: they are called tesserae, which consist of small cubes of marble, terracotta, or glass. Of course, mosaics were produced long before the Romans: geometrical designs assembled from small cones were produced in Mesopotamia thousands of years earlier, and Greek mosaics made up from pebbles and more regular stones were produced centuries before (Dunbabin, 2006). However, the art form was raised to new heights by Roman practitioners. Mosaic floors and walls were produced to formulae, and similar designs were produced over vast geographical regions – from Asia Minor to Britain (see Dunbabin, 2006; Johnson, 1995; Ling, 1998). The arrangement of small elements to allude to objects presented different demands, and those of grouping proved paramount. It is difficult to imagine how mosaics

could not address segregating figures from their background, sorting by similarity of colour and the proximity of the tesserae, in addition to good continuation. They were not laid out with strict linear regularity but were often arranged in curves to convey the continuity of contours in the scene represented, as is evident in figure 3, upper. By practicing such procedures, the mosaic artists were able to represent scenes and also to display geometrical decorations. Circles and squares are good figures in the Gestalt sense. That is, they are simple and symmetrical, and will tend to be completed if parts are missing. Many of the mosaics are framed in squares within which the scenes are represented in a bordered circle (as is the case for figure 3, upper). The grouping of the representational elements
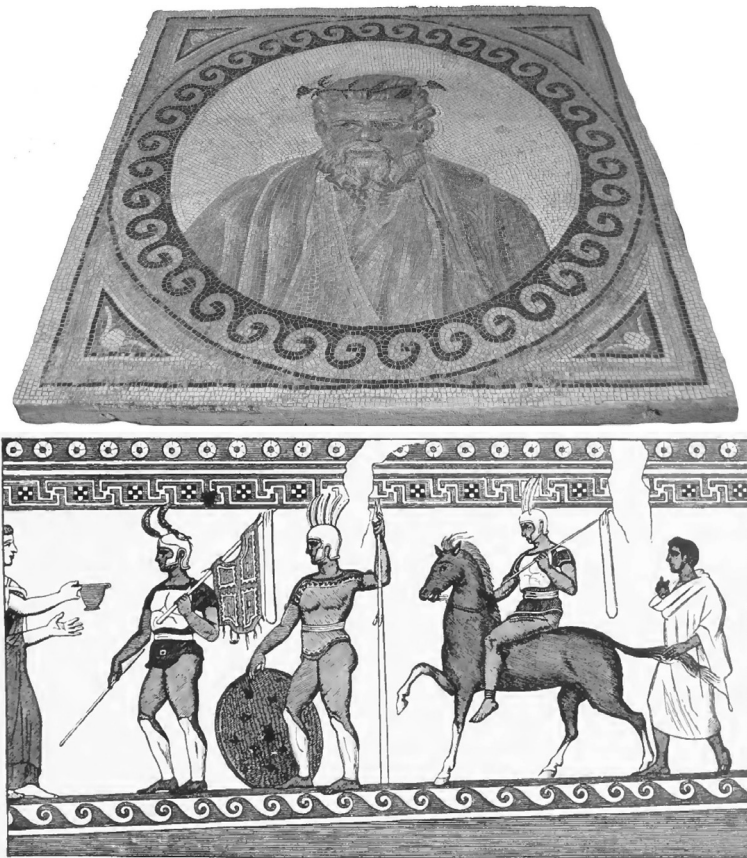
Fig. 3 Upper, a photograph of a fourth century floor mosaic (from Antioch but now located in the Museum of Art at Rhode Island School of Design, Providence) in which the grouping principles are applied to represent Bacchus, who is surrounded by a border employing a wave-crest motif. The contours defining the dark waves are the same as those for the light crests and this motif was employed extensively in mosaic borders. Lower, a drawing of a fourth century B.C. wall painting from Paestum, Italy, showing a wave-crest motif in the lower border (from Woltmann and Woermann, 1894).

is facilitated by colour, although this figure has been reduced to monochrome. Examples of the wave-crest motif, which was frequently employed in mosaic borders, can be found in Greek wall paintings from the fourth century B.C. (figure 3, lower). Together with the meander motif, shown at the top of the wall painting, wave-crest patterns can also be found on Greek painted vases.

Both squares and circles are united in the mosaic boundary of figure 4, and the border itself has a geometrical three-stranded braid motif. The principle of good continuation is clearly expressed in the triangular motif and the triangles are themselves comprised of tesserae. The central portrait (of Medusa) is surrounded by the triangles, which increase in size as they extend from the centre; braids encircle the design and the corners of the quadrants are completed by ornamental birds. The sides of the triangles can be completed as concentric circles or curves radiating in opposite directions. The whole design takes on the appearance of an op art work, with multiple organisations – radiating and concentric – vying for perceptual dominance. The mosaic, which is from Rome, is reproduced in monochrome, but many others were produced in colour, so that shading was manipulated as well as shape.
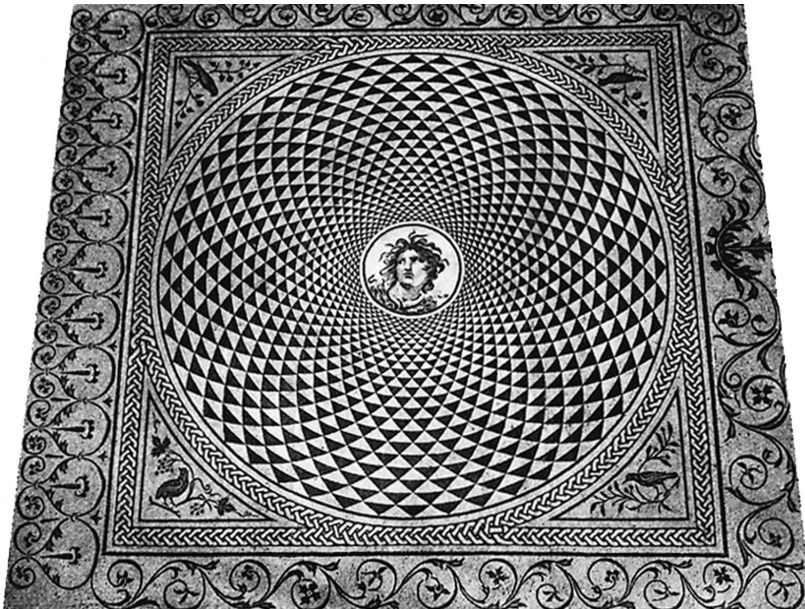

Fig 4 A second century radiating mosaic from Rome demonstrating good continuation (after an illustration in L'Orange and Nordhagen, 1966). The light and dark triangles of varying size are themselves made up from tesserae and they are arranged so that their sides can be continued to form concentric circles or curves that radiate in opposite directions. The border represents interlocking three-strand guilloche.

The Gestalt grouping principles were often beautifully expressed in the geometrical motifs bordering mosaic scenes as well as Greek vase and wall paintings. Certain motifs were used repeatedly and widely. These include braids, meanders, lozenges, chevrons, grids and wave-crests (see Campbell, 1988). In many instances different motifs were applied to the borders of the same mosaic, as is shown in the upper part of figure 5. Various grouping principles are subtly combined in these geometrical designs, some of which reflect the manner in which depth is implied by shape from shading in computer graphics. Shading is adopted to match the symmetry and alternation in the ribbon twists. The perspective meander is given apparent depth due to shading, and the rectangular rods allude to depth on the same basis.
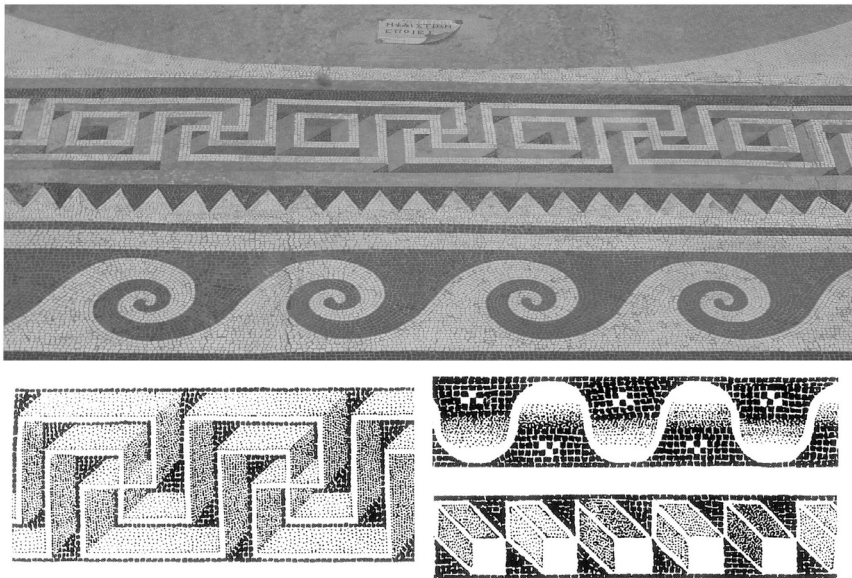
Fig. 5 Upper, photograph of a second century B.C. Greek mosaic from the Acropolis; the border consists of meander, chevron and wave-crest motifs. The original (which is located in the Pergamon Museum, Berlin) is in colour which amplifies the apparent depth in the perspective meander. Above the meander is the signature of the artist (Hephaistion) which is remarkably represented as a trompe l'oeil, as if on a folded surface. Lower, details of some borders in Roman mosaics (derived from Campbell, 1988). In the left design a perspective meander conveys the impression of depth by varying the colour gradations of the tesserae. Shading is also employed in the ribbon twist on the right, which displays the figure-ground ambiguity evident in the wave crests. The lower perspective blocks design utilises shading to distinguish between the sides of the protruding or receding blocks.

Ambiguity

Human communication thrives on ambiguity. It is built into our languages and it is a fundamental feature of pictures. Most of the words we use have more than one meaning and the ambiguity is usually resolved by the context in which they

occur. We play upon linguistic ambiguities to convey subtle distinctions that would be difficult to define precisely. Ambiguities are even more prominent in the province of pictures and they were manipulated to the full by Roman mosaic artists. The border motifs often reflected perceptual ambiguity, as can be seen from the wave-crest and ribbon twist mosaics. However, geometrical designs were not restricted to borders, and beautiful examples of figure/ground alternation have been found at Antioch (figure 6, left). Edgar Rubin (1915) carried out most of his observations with simple figures like Maltese crosses either in black and white or with arms defined by radiating lines and concentric circles (figure 6, right). Rubin described the conditions under which alternation occurs in the context of figure and ground:

> "… when two fields have a common border, and one is seen as figure and the other as ground, the immediate perceptual experience is characterized by a shaping effect which emerges from the common border of the fields and which operates only on one field, or operates more strongly on one field than the other" (1958, 194-195).
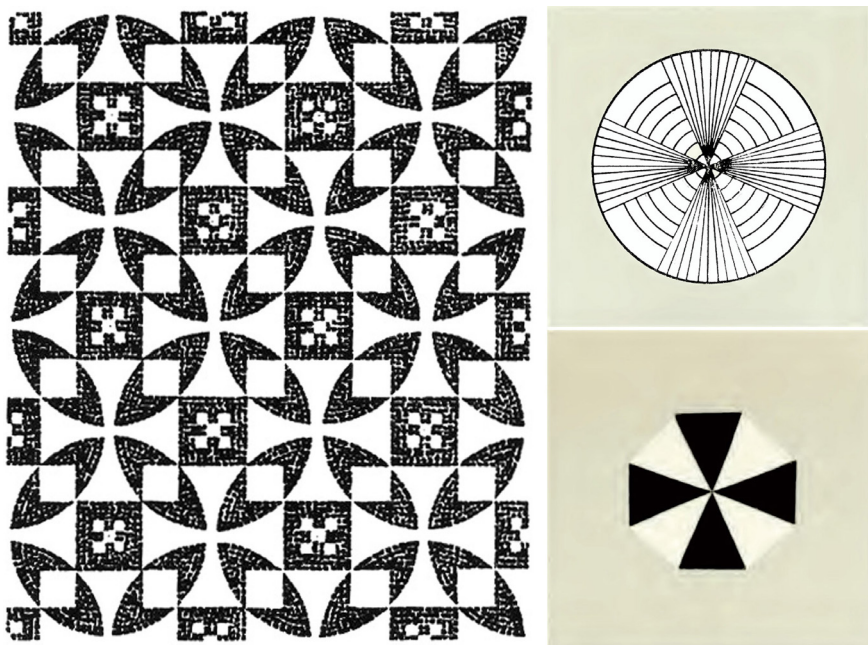

Fig. 6 Left, a geometrical figure/ground reversing design in which circles, squares and crosses fluctuate in visibility (after an illustration in Campbell, 1988). Right, Rubin's (1921) simple cross figures used in his studies; they were black and white on a grey background. With regard to the upper right pattern he wrote: "One sometimes experiences the radially marked and sometimes the concentrically marked cross" (Rubin, 1921, 38). The figure on the lower right was considered to be particularly good for producing alternations: "one can here see either an upright or an inclined cross" (Rubin, 1921, 53-54).

Thus, with alternations in the wave-crest motif the border between the lighter and darker parts is the perceptual purchase of the phenomenally dominant part. In the mosaic shown in figure 6, there are multiple ambiguities, with the patterns forming perceptual circles, squares, symmetrical arcs and crosses. The manipulations of perceptual organisation are far more subtle with such patterns than those given by the Gestalt psychologists. Some mosaic floors are devoted solely to geometrical designs, often of astonishing complexity and variation.

The mosaic manipulations were not restricted to figure-ground alternations, but engaged in spatial ambiguities of apparent depth, too. These we associate with the alternating appearance of Louis Albert Necker's (1832) outline figure, but the effects are of ancient origin. The mosaic shown in figure 7 utilises the lozenge (diamond-shaped) motif: the lozenges radiate from a central point and vary in colour. They are symmetrical, having angles of 45º and 135º, so that eight lozenges radiate from a point to complete a circle. At the outer boundaries of the lozenges, squares are bordered by chevrons giving the impression of cubes with patterned faces. However, the cubes are spatially ambiguous because each lozenge can be a face of two cubes. Similar designs have been found in the House of Dionysius, Cyprus (Kondoleon, 1995), and in the mosaics of Pompeii (Lingelbach, 2008). In the latter, the corners of large squares define the edges of lozenges which in turn define the sides of smaller squares at 45° to the sides of the larger square. The smaller square can be seen as the face of two cubes. Lingelbach (2008) has also drawn attention to an even more complex third century mosaic in Portugal; it is made up from white, blue and brown tesserae, and the lozenges and squares are arranged to produce multiple organisations so that the surface itself appears to be uneven. These systematic manipulations of simple geometrical shapes to represent solid forms are testament to the knowledge of perceptual organisation in the designers of the mosaics.
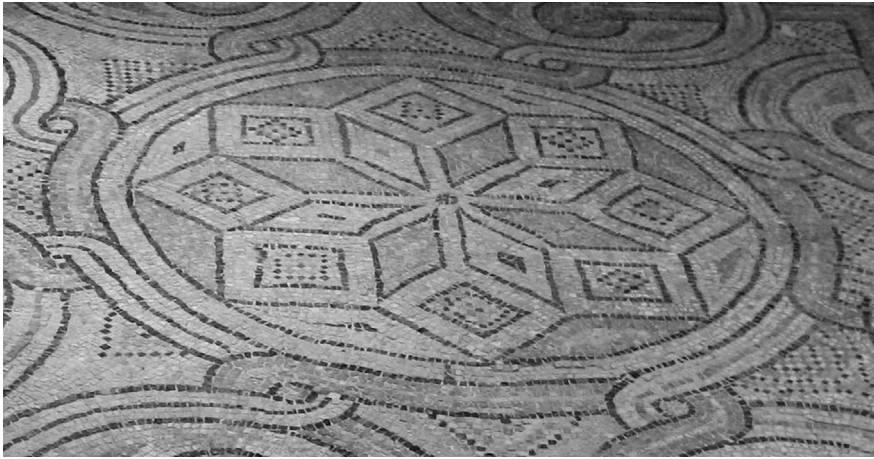
Fig. 7 Photographic detail of a fifth or sixth century Roman mosaic in Domus dei Tappeti di Pietra, Ravenna, illustrating spatially ambiguous motifs; the eight radiating lozenges form sides of cubes, but a given lozenge could be the face of two cubes. The tesserae in the original are coloured black, off-white and light brown.

During the Renaissance, tiles replaced mosaics as the elements for floors, but similar geometrical themes were played, usually with differently coloured tiles of marble. The churches and charterhouses of Italy are replete with tilings of intricate complexity. The examples shown in figure 8 can be seen in the Certosa di Calci, near Pisa; they date from the seventeenth century. Ambiguous representations of cubes could be constructed from four-sided tiles having the same shape, with opposite angles of 120° and 60°. An example is shown in the upper left illustration of figure 8: the three faces have different colours and a given face can be part of two cubes having different perceptual orientations. The configuration is like that called the Beaunis cube, and essentially the same patterns can be found in Roman mosaics (see Dunbabin, 2006; Lingelbach, 2008). The other examples in figure 8 are more complex both structurally and perceptually. The floor depicted in the upper right has two structural elements, squares and quadrilaterals with two corners at 90° and the others at 60° and 120°. It induces a strong impression of depth that is ambiguous: the dark square can appear either above or below the flanking quadrilaterals. The tiled floors shown in the lower figures are made up of elements having the same shape, but differing in the shades of marble, so that they give the impression of solidity. That on the left has elements with quadrilaterals having angles of 60, 90, 90 and 120°, whereas the one on the right is comprised of triangles with internal angles of 30, 30 and 120°. There are many perceptual configurations that emerge when viewing it. The tiled floors found throughout Europe, especially in Italy but also in Great Britain, Turkey, Spain, Portugal and Germany, are based on squares, rhombi, parallelograms, hexagons or octagons, but none of the patterns utilise pentagons

(Lingelbach & Wade, 2010). Despite the fact that the five-point star is one of the oldest known symbols, pentagons are very rarely used as decorations. There are some to be seen on the columns of Monreale Cathedral, Sicily (built in the late twelfth century) which is known for its synthesis of Arabic, Byzantine and Norman styles of architecture and art. The arches between the columns are made up of pentagons which are decorated with "darts" and "kites". Thus the twelfth century artists seemed to know about the non-periodic as well as periodic tiling.
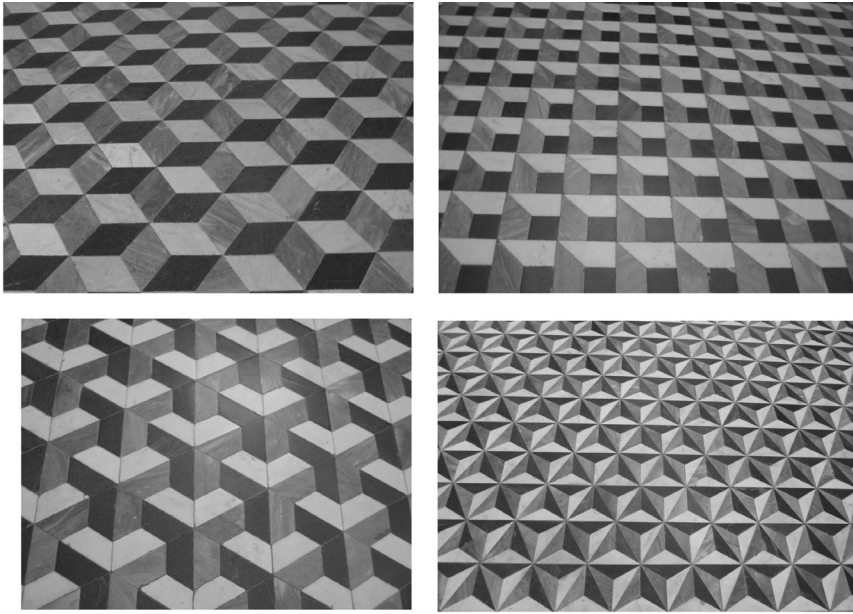
Fig. 8 Photographs of marble tiled floors from Certosa di Calci, near Pisa, showing regular patterns of tiles distinguished either by the shape or shade of the marble.

Necker's name is often associated with reversing representations of cubes and Rubin's with a vase/face figure which alternates (Wade et al, 2010). The possibilities of ambiguous interpretations of the same contours were both appreciated and manipulated by Roman mosaic artists as well as those of later periods (Piccolino & Wade, 2006a, 2007). Rubin (1915, 1921) did make a rather crude illustration of such a design (figure 9), although more elegant examples proliferated more than a century earlier. In a footnote, Rubin did remark that he had seen earlier examples of what he called this joke, both in an actual vase and in a picture. Indeed, Rubin made many references to examples of figure-ground segregation in classical art and aesthetics but he did not refer to the many examples of figural ambiguity that employed the structure with which his name is linked. The use of vase outlines to define different profiles was a popular graphical theme in the late eighteenth century, and the ambiguity was often extended to the foli-

age of trees surrounding the vase or urn. Figure 9, lower left, is by Pierre Crussaire (1749-1800) and both its title and its contents presage the simpler figures of Rubin. In fact, Rubin carried out almost all his experimental work with an alternating cross (figure 6, lower right) rather than the vase/face motif with which his name is most closely associated; the latter was presented at the conclusion of his thesis almost as an afterthought. Crussaire's mysterious urn offers not only a vase/faces motif (with different faces on each side) but he also hides profiles in the foliage of the weeping willow. Moreover, the faces so concealed were politically potent, as they represented members of the deposed royal family at a time when such allegiance was dangerous (Taws, 2007). Profiles and plants provided

Fig. 9 Upper left, Rubin's (1921) vase/faces design. Lower left, *L'urne mystérieuse* by Pierre Crussaire, printed around 1795. Right, detail of a large banner hanging in the Chiesa dei Cavalieri di Santo Stefano; the facial ambiguity and various symbolic motifs can be seen at the top of the flag, the original of which is coloured in reds and blues, as can be seen at http://www.perceptionweb.com/misc.cgi?id=p3508ed/ .

rich pickings for the artists who wished to amplify ambiguity or to conceal the identity of those so portrayed.

Designs on flags and in other heraldic figures have not been accorded the recognition in the history of visual science that they warrant. The flag shown in figure 9 right, hangs in the Chiesa dei Cavalieri di Santo Stefano, Pisa, and it provides an ambiguous example of ambiguity. The Ottoman flag was captured in a battle that took place in 1675 (see Piccolino & Wade, 2006b) and the upper part suggests two facing profiles. The facial ambiguity is surprising because the unknown artist has flown in the face of the Islamic prohibition on representing human figures in religious decorations; this would certainly have applied to flags of the Islamic army and navy. However, the restrictions were not absolute, particularly in profane art, as long as the images did not represent God or the Prophet (Burckhardt, 2001).

When the flag is viewed upside down, the parts representing profiles can also take on different appearances. The central image, between the two facial profiles, could be identified as an inverted mosque peaked by the crescent moon or an Ottoman helmet. Thus, there could have been an element of orientational as well as figural ambiguity in the design. There are some eighteenth century examples of the vase/face motif which are inverted, so that the facing faces are yet more difficult to detect. It is to orientational ambiguity that we now turn.

Orientation

A fundamental feature of Gestalt grouping that is often overlooked is orientation. Gravity provides one of the most basic frames of reference relative to which perception proceeds (Asch & Witkin, 1948; Howard, 1982; Wade & Swanston, 2012). The positioning of objects, with respect to the observer or with respect to gravity, provides a signal source of segregation and recognition. This was appreciated by Köhler who, while musing on Stratton's (1897) optical inversion experiments, noted that pictures of objects are recognised more readily in an upright orientation. This applied particularly to pictures of faces: "For this experiment I select a picture, or outline-drawing of an object, which shows a conspicuous change in appearance when it is upside down. This is the case, for instance, with photographs of known or unknown persons. They change so much that what we call facial expression disappears almost entirely in the abnormal orientation" (Köhler, 1940, 25-26). The point was amplified by Rock: "Along with printed and written words, faces represent one of the few types of material that do look different enough to impede recognition when retinally tilted by 90º or more" (1973, 59). Thus, orientation provides an essential component to combining parts into wholes – features into a configuration. This, too, was an aspect of perception examined by Roman potters. Figure 10 shows a second century Roman beaker which utilised the principle of inverted faces (see Wade, Kovács &

Vidnyánszky, 2003). A pair of eyes is shared by an upright and an inverted face modelled over the surface of the drinking vessel. The normal orientation of the beaker (shown on the left of figure 10) is obviously determined by its function. The inverted face is more difficult to discern, but it is helped in the museum by the placement of a mirror beneath it, so that the reflection can also be observed. There is even an example of a third century mosaic floor (from Pomezia, south of Rome) in which different full-face images can be seen from opposite directions; the eyes are shared by the two faces. It is clear that Roman potters and mosaic artists were struggling with similar perceptual problems to those alluded to by Köhler.


Fig. 10 A second century Roman beaker viewed in its normal (functional) orientation on the left, and inverted on the right. The eyes are common to both faces, but the inverted one is difficult to see in both instances. The red clay beaker is on display at the Budapest History Museum, and a coloured version can be found at http://www.perceptionweb.com/misc/p3201ed/.

Unlike the longevity of mosaics, few examples of such facial inversions in pottery have survived. Maybe fewer were made. The device did return in sixteenth and

seventeenth century illustrations, and the intent was similar to that for vase/face motifs – to reveal and to conceal. Revelation could be aided by verbal description, where contrary expressions – like arrogance and folly (figure 11, left) – are dependent upon the orientation of the picture. Intent could be concealed by presenting an otherwise forbidden image (like the devil) in the inverted orientation (figure 11, centre). The upright/inverted face theme was expanded upon in the seventeenth century, and an Italian artist showed that it was even possible to cross the species barrier (figure 11, right). In the case of the Roman beaker, the eyes are shared by the faces in both orientations. This is also the case for Giuseppe's man/hog, but in the other illustrations the mouth is shared by both figures: the nose in the upright version defines the chin in the inverted one, and vice versa.

In the twentieth century, the graphical technique was applied by Rex Whistler with wit and humour in his upside-down drawings of two faces in a single picture (see Wade & Nekes, 2005; Whistler & Whistler, 1946, 1978). Whistler was intrigued "by the mockery of a pompous and authoritarian figure", be it drawn from religion or royalty. Further examples of upright and inverted faces can be seen in Mannoni, Nekes & Warner (2004), Pfeiffer (1993) and Wade (2000, 2007).
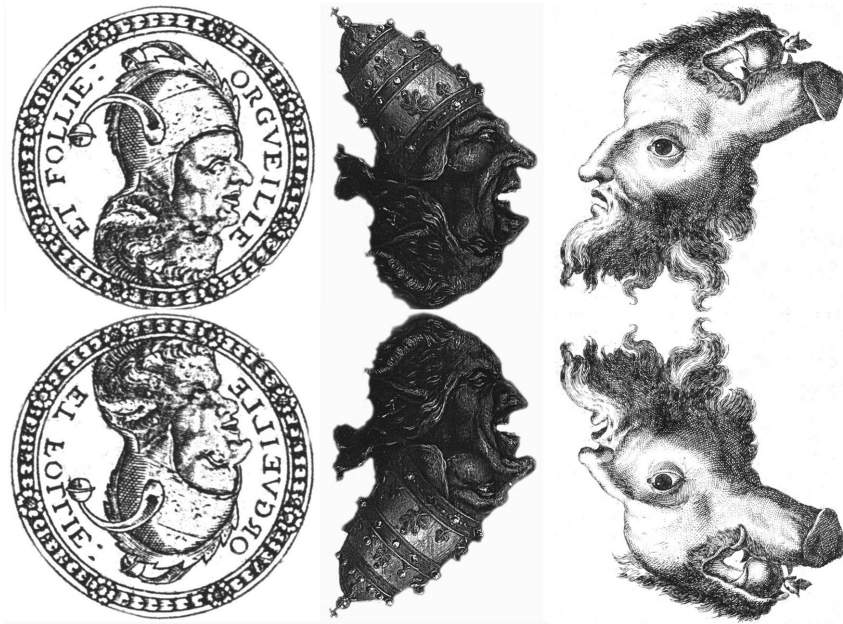
Fig. 11 Three upright and inverted images. Left, detail of a 1558 engraving by Theodor de Bry entitled *Arrogance and folly*. Centre, detail of an upright/inverted head from 1600, derived from a painting by an anonymous artist entitled *Double head of Pope and Devil*. Right, an engraving from around 1700 by an Italian artist called Giuseppe in which an animal and a human are incorporated in the same illustration. (Derived from the collection of Werner Nekes).

Conclusion

The methods for making mosaics, and the designs themselves, were maintained over several centuries, and are remarkably similar over the whole Roman Empire. We do not know the identities of the artists who made them, but we should place them in the pantheon of perception. They displayed what we now call Gestalt grouping principles with elegance and economy. Moreover, some mosaics manipulate the pictorial principles of *trompe l'oeil* with considerable skill, representing objects in low relief with cast shadows. A surviving mosaic from the House of the Tragic Poet at Pompeii depicts a chained dog with the words 'cave canem', and this theme was repeated in many later mosaics. The mosaic tradition was based on that from Greek and Roman painting, few examples of which have survived. The virtues of mosaics lie in their durability as well as in the understanding of vision they express.

Somewhat ironically, among the approaches that Wertheimer attacked were those he referred to as mosaic hypotheses:

> "*The mosaic or 'bundle' hypothesis.* – Every 'complex' consists of a sum of elementary contents or pieces (e.g. sensations). Example: If I have a_1 b_1 c_1 and b_2 c_2 are substituted for b_1 c_1, I then have a_1 b_2 c_2. We are dealing with a summative multiplicity of variously constituted components (a 'bundle') and all else is erected somehow upon this and-summation. Thus to sensations are added 'residues' of earlier perceptions, feelings, attention, comprehension, will. Also memory attaches itself to the sum of contents…. *The given is itself in various degrees 'structured' (*'gestaltet'), *it consists of more or less definitely structured wholes and whole-processes with their whole-properties and laws, characteristic whole-tendencies, and whole-determinants of parts. 'Pieces' almost always appear 'as parts' in whole processes.*" (Wertheimer, 1938b, 12 and 14, original italics).

Despite Wertheimer's use of the term 'mosaic' in this theoretical sense, mosaic artists from the past did encapsulate the essence of Gestalt grouping principles in their practical application. Moreover, despite Arnheim's statement that Gestalt psychology "had a kinship to art," it was not displayed in their appreciation of an art form that had put their principles into practice. The artists who made Roman mosaics were not so interested in innovation, but acted more like modern scientists. They followed set procedures using standard patterns and composed them to order. Wall mosaics were particularly prized and a sign of high social status. Mosaic patterns were repeatable and transportable. Mosaic artists often accompanied invading armies carrying with them templates for producing standard designs. However, there were minor innovations produced in local regions, and it is these that mosaic historians seek to explain.

Mosaics can only make their meanings evident if the elements are combined perceptually to produce the desired effect. In achieving this meaning, the mosaic artists were confronted by the same problems that Gestalt psychologists grappled

with. While the artists did not write about the procedures they adopted, their practices displayed a profound understanding of Gestalt principles of perceptual grouping.

Summary

While much has been written about the philosophical and experimental precursors of Gestalt psychology, less attention has been directed to practitioners of perception – artists. Figure-ground ambiguities and Wertheimer's Gestalt grouping principles can be seen in Roman mosaics. The tesserae were arranged to display the manner in which elements of a design can be organised perceptually to lend representational meaning but also to play upon themes of spatial ambiguity. Geometrical features were manipulated to yield the equivalents of Necker cubes in mosaics and these themes were later repeated in tile designs. Vase-face ambiguities were common in the late eighteenth century and the difficulty of recognising inverted heads, commented on by Köhler, was appreciated by Roman potters as well as by graphic artists several centuries ago. A distinction can be made between these practitioners of perceptual organisation and their interpretations by Gestalt psychologists.
Keywords: Mosaics, Gestalt grouping, ambiguity, orientation, art and science.

Zusammenfassung

Während viel über die philosophischen und experimentellen Vorläufer der Gestaltpsychologie geschrieben wurde, bekamen die "Praktiker der Wahrnehmung", nämlich die Künstler, weniger Aufmerksamkeit. Figur-Grund Mehrdeutigkeiten und Wertheimers Gestaltgruppierungs- Prinzipien sind in römischen Mosaiken zu sehen. Die Steinchen wurden so angeordnet, dass nicht nur die Elemente der Muster eine bildhafte Bedeutung bekommen, sondern auch mehrdeutige Interpretationen möglich sind. In den Mosaiken wurden geometrische Merkmale verwendet, die Necker-Würfel ähnliche Effekte hervorrufen. Vase-oder-Gesichter- Doppeldeutigkeiten waren im achtzehnten Jahrhundert verbreitet. Wolfgang Köhler beschreibt zwar die Schwierigkeit invertierte Köpfe zu erkennen, aber bereits römische Töpfer und Grafiker haben seit Jahrhunderten damit gearbeitet. Es gibt jedoch einen Unterschied zwischen der Kunst und den Interpretationen durch Gestaltpsychologen.
Schlüsselwörter: Mosaik, Gestaltgruppierung, Ambiguität, Orientierung, Kunst und Wissenschaft.

Acknowledgements

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