POINTS OF VIEW

Gestalt principles (Part 1)

Gestalt principles of perception are theories proposed by German psychologists in the 1920s to explain how people organize visual information[1]. Gestalt is a German word meaning shape or form. The principles describe the various ways we tend to visually assemble individual objects into groups or 'unified wholes'. They are highly relevant to the design of charts and graphs as well as the reports that contain them.

Gestalt is the interplay between the parts and the whole. Kurt Koffka, one of the founding fathers of Gestalt psychology, made a statement about this. He said, "The whole is 'other' than the sum of its parts." This phrase has been translated to the familiar saying, 'the whole is greater than the sum of its parts'. A classic example of subjective contour is illustrated in **Figure 1a**. We clearly see edges of a white triangle that does not exist. Koffka insisted that the emergent entity is 'other' (not greater or lesser) than the sum of the parts. By composing elements on the page according to specific principles, we can add additional layers of meaning.

In the following discussion, to be continued in next month's column, we will explore several Gestalt principles. Here we will examine the principles of similarity, proximity, connection and enclosure. The fundamental concept behind these principles is grouping; we tend to perceive objects that look alike, are placed close together, connected by lines or enclosed in a common space as belonging together. These are simple but powerful ways to build context for information.

The principle of similarity is likely familiar to many. We often use color, size and shape to organize data objects into categories. As readers, we tend to see things that are similar to be more related than things that are dissimilar (**Fig. 1b**). We can apply this observation to all elements on the page; by repeating graphical treatments including font, type size, orientation and white space, we can design elements so they appear more related.

Another quality that inclines us to make associations between objects is proximity. We tend to group objects placed close together. We can apply this principle when organizing figure panels. In a grid of evenly spaced panels, it can be unclear at first glance how one should dissect the information contained within (**Fig. 1c**). Are we to compare the panels or read them in succession? If the reader is to make two pairwise comparisons, then grouping the four panels as two pairs reinforces our natural tendency to relate proximal objects (**Fig. 1c**). If, however, we want readers to review the panels one after another, then arranging the panels in a row provides a natural order that supports reading them sequentially (**Fig. 1c**).

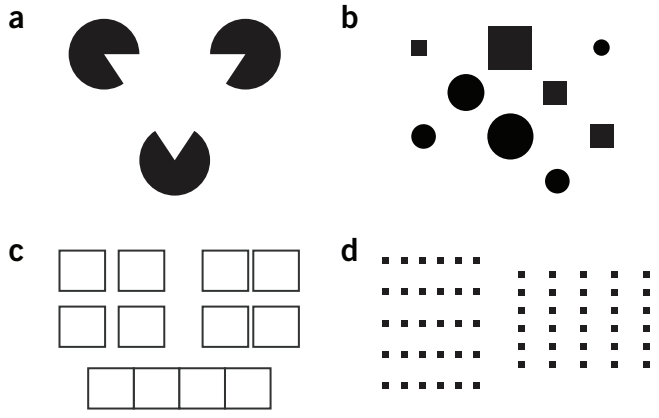


Figure 1 | Gestalt principles. (**a**) An illustration of subjective contour. (**b**) Similar objects are visually grouped. (**c**) Objects placed close to one another are seen as going together. (**d**) Relative proximity elicits vertical or horizontal correlations between objects.

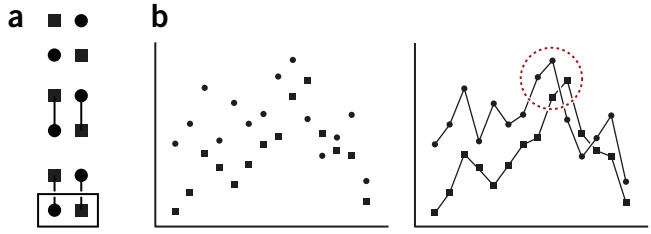


Figure 2 | Principles of grouping. (**a**) Relative strength of grouping by similarity, proximity, connection and enclosure. (**b**) Lines in graphs create clear connection. Enclosure is an effective way to draw attention to a group of objects.

Proximity could be considered a special case of grouping by similarity because of the underlying spacing between objects. Relative spacing between columns and rows can dramatically affect whether we group the components vertically or horizontally (**Fig. 1d**).

Whereas objects grouped by similarity and proximity are seen as loose confederations, grouping by connection and enclosure leads us to associate them as a unified whole. The relative strength each principle exerts on perceptual grouping is illustrated in **Figure 2a**. Lines create clear connection and bring out the overall shape of the data (**Fig. 2b**). They provide a useful method for encoding information in graphs and network diagrams. Finally, grouping by enclosure resulting in elements bounded in a common region is powerful enough to overcome similarity, proximity and connection (**Fig. 2**).

The Gestaltists described phenomena about how we organize bits and pieces of visual information into larger units. This perceptual organization is deeply ingrained in the visual experience. When we present visual information, including blocks of text projected on screen, it is helpful to arrange the elements into a meaningful structure. One framework is simply to group related information. The principles of similarity, proximity, connection and enclosure provide simple rules to draw correlations between visual elements.

Next month, we will examine the principles of visual completion and continuity, which describe our tendency to fill in missing information to perceive shapes as being complete to the greatest degree possible.

Bang Wong

1. Palmer, S.E. *Vision Science: Photons to Phenomenology* (Massachusetts Institute of Technology Press, Cambridge, Massachusetts, USA, 1999).

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POINTS OF VIEW

Gestalt principles (Part 2)

Our visual system attempts to structure what we see into patterns to make sense of information. The Gestalt principles describe different ways we organize visual data. Last month, we looked at four principles that incline us to group objects when they are made to look alike, are placed near one another, are connected by lines or are enclosed in a common space[1]. This month, we will examine the principles of visual completion and continuity. These principles are useful in page layout work and when we compose figures and slides.

Visual interpolation creates interesting illusions in which we see contours that do not actually exist. The Kanizsa triangle[2] we looked at last month is a famous example of illusory or subjective contours (**Fig. 1a**). The 'Pac-Man' shapes align to form what appears to be well-defined edges of a triangle.

Another example of visual completion is shown in **Figure 1b**. We automatically and spontaneously perceive a full circle behind the square. In reality, several shapes are possible in the occluded area. This disparity between the actual visual stimulus and what we think (or know) we should be seeing points to the psychology involved in seeing. It is likely that we complete the object behind the square as a circle because it produces a simple and familiar shape.

Because we have a strong tendency to see shapes as continuous to the greatest degree possible, we fill in voids with visual cues found elsewhere on the page. This means every element on a page affects how we perceive every other element. Visual completion enables us to forgo the extraneous lines, boxes, bullets and other graphical elements that tend to clutter our presentations.

Graphics and text can be considered shapes with vertices and edges. To construct unified compositions, align these constituent parts to form meaningful blocks of information (**Fig. 2a**). Simple geometric shapes provide a base structure on which to organize and build content (**Fig. 2b**). It is helpful to actually draw these background shapes and use them as alignment guides. I have shown examples of guides as dotted lines in **Figure 2**, which would not exist in the final figure. Placing components on the guide's path anchors the information and helps the audience identify patterns. Curvilinear guides are useful in sequencing information because they create a clear path through the material. Such alignment produces invisible lines that connect content.

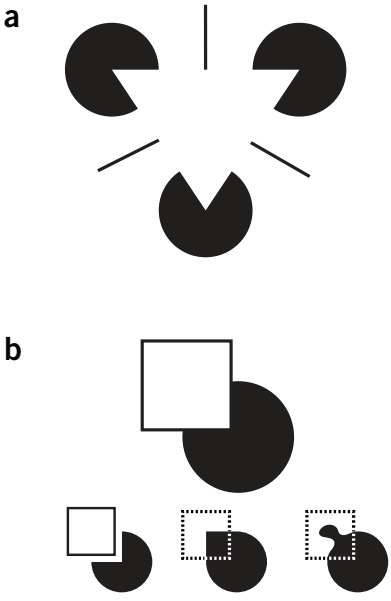


Figure 1 | Visual completion. (**a**) The Kanizsa triangle and illusory contour. (**b**) Spontaneous and automatic completion of occluded surfaces as a simple and familiar circle.

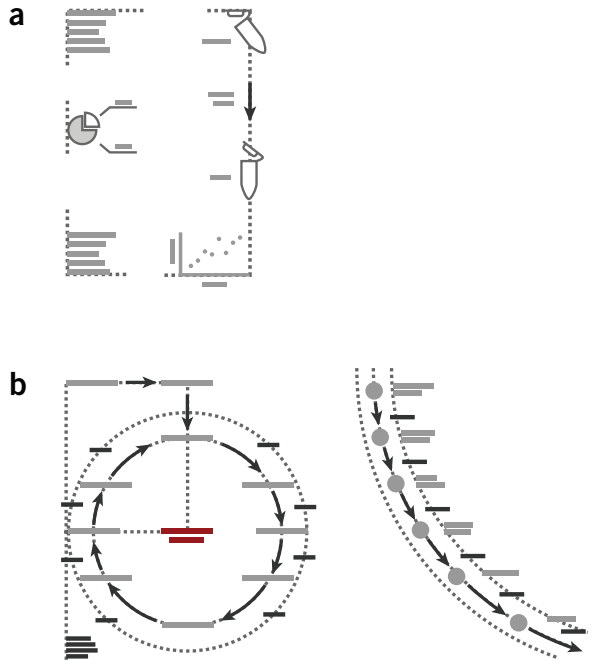


Figure 2 | Alignment. (**a**) Graphics and text used as vertices and edges of geometric shapes. (**b**) Geometric and curvilinear shapes used as flexible guides to align content.

Our eyes are acutely aware of small misalignments; compositions that use guides tend to look clean and professional. We can create different alignment guides for different information. For example, labels that describe an action can be distinguished from those for names. Moreover, we can combine alignment with the Gestalt principles of similarity, proximity, connection and enclosure to group information and structure the content. The action labels can be distinguished from the name labels with color or typographical treatment.

Our goal is to lay out information in a way that enhances its message. In structuring the components of a slide or figure, we inevitably affect the surrounding white space. White space is a vital part of design; it frames the content and gives our eyes a place to rest. Next month, we will look at 'negative space' to complete our exploration of composition.

Bang Wong

1. Wong, B. *Nat. Methods* **7**, 863 (2010).
2. Kanizsa, G. *Organization in Vision: Essays on Gestalt Perception* (Praeger Publishers, New York, 1979).

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