Our Vision is Optimized to See Structure

Early in the twentieth century, a group of German psychologists sought to explain how human visual perception works. They observed and catalogued many important visual phenomena. One of their basic findings was that human vision is holistic: our visual system automatically imposes structure on visual input and is wired to perceive whole shapes, figures, and objects rather than disconnected edges, lines, and areas. The German word for “shape” or “figure” is *Gestalt*, so these theories became known as the *Gestalt principles of visual perception*.

Today’s perceptual and cognitive psychologists regard the Gestalt theory of perception as more of a *descriptive* framework than an *explanatory* and *predictive* theory. Today’s theories of visual perception tend to be based heavily on the neurophysiology of the eyes, optic nerve, and brain (see Chapters 4–7).

Not surprisingly, the findings of neurophysiological researchers support the observations of the Gestalt psychologists. We really are—along with other animals—“wired” to perceive our surroundings in terms of whole objects (Stafford and Webb, 2005; Ware, 2008). Consequently, the Gestalt principles are still valid—if not as a fundamental explanation of visual perception, at least as a framework for describing it. They also provide a useful basis for guidelines for graphic design and user-interface design (Soegaard, 2007).

For present purposes, the most important Gestalt principles are Proximity, Similarity, Continuity, Closure, Symmetry, Figure/Ground, and Common Fate. The following sections describe each principle and provide examples from both static graphic design and user-interface design.

**GESTALT PRINCIPLE: PROXIMITY**

The Gestalt principle of *Proximity* is that the relative distance between objects in a display affects our perception of whether and how the objects are organized into
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FIGURE 2.1
Proximity: items that are closer appear grouped as rows (A) and columns (B).

FIGURE 2.2
In Outlook’s Distribution List Membership dialog box, list buttons are in a group box, separate from the control buttons.

subgroups. Objects that are near each other (relative to other objects) appear grouped, while those that are farther apart do not.

In Figure 2.1A, the stars are closer together horizontally than they are vertically, so we see three rows of stars, while the stars in Figure 2.1B are closer together vertically than they are horizontally, so we see three columns.
The Proximity principle has obvious relevance to the layout of control panels or data forms in software, Web sites, and electronic appliances. Designers often separate groups of on-screen controls and data displays by enclosing them in group boxes or by placing separator lines between groups (see Fig. 2.2).

However, according to the Proximity principle, items on a display can be visually grouped simply by spacing them closer to each other than to other controls, without group boxes or visible borders (see Fig. 2.3). Many graphic design experts recommend this approach to reduce visual clutter and code size in a user interface (Mullet and Sano, 1994).

**FIGURE 2.3**
In Mozilla Thunderbird’s Subscribe Folders dialog box, controls are grouped using the Proximity principle.

**FIGURE 2.4**
In Discreet’s Software Installer, poorly spaced radio buttons look grouped in vertical columns.
Conversely, if controls are poorly spaced (e.g., if connected controls are too far apart) people will have trouble perceiving them as related, making the software harder to learn and remember. For example, the Discreet Software Installer displays six horizontal pairs of radio buttons, each representing a two-way choice, but their spacing, due to the Proximity principle, makes them appear to be two vertical sets of radio buttons, each representing a six-way choice, at least until users try them and learn how they operate (see Fig. 2.4).

GESTALT PRINCIPLE: SIMILARITY

Another factor that affects our perception of grouping is expressed in the Gestalt principle of *Similarity*, where objects that look similar appear grouped, all other things being equal. In Figure 2.5, the slightly larger, “hollow” stars are perceived as a group.

The Page Setup dialog box in Mac OS applications uses the Similarity and Proximity principles to convey groupings (see Fig. 2.6). The three very similar and tightly spaced Orientation settings are clearly intended to appear grouped. The three menus are not so tightly spaced but look similar enough that they appear related even though that probably wasn’t intended.

Similarly, the text fields in a form at book publisher Elsevier’s Web site are organized into an upper group of eight for the name and address, a group of three split fields for phone numbers, and two single text fields. The four menus, in addition to being data fields, help separate the text field groups (see Fig. 2.7). By contrast, the labels are too far from their fields to seem connected to them.

**FIGURE 2.5**

Similarity: items appear grouped if they look more similar to each other than to other objects.
FIGURE 2.6
Mac OS Page Setup dialog box. The Similarity and Proximity principles are used to group the Orientation settings.

FIGURE 2.7
Similarity makes the text fields appear grouped in this online form at Elsevier.com.
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GESTALT PRINCIPLE: CONTINUITY

In addition to the two Gestalt principles concerning our tendency to organize objects into groups, several Gestalt principles describe our visual system's tendency to resolve ambiguity or fill in missing data in such a way as to perceive whole objects. The first such principle, the principle of *Continuity*, states that our visual perception is biased to perceive continuous forms rather than disconnected segments.

For example, in Figure 2.8A, we automatically see two crossing lines—one blue and one orange. We don’t see two separate orange segments and two separate blue ones, and we don’t see a blue-and-orange V on top of an upside-down orange-and-blue V. In Figure 2.8B, we see a sea monster in water, not three pieces of one.

A well-known example of the use of the continuity principle in graphic design is the IBM® logo. It consists of disconnected blue patches, and yet it is not at all ambiguous; it is easily seen as three bold letters, perhaps viewed through something like venetian blinds (see Fig. 2.9).

![Figure 2.8](image1.png)

**FIGURE 2.8**
Continuity: Human vision is biased to see continuous forms, even adding missing data if necessary.

![Figure 2.9](image2.png)

**FIGURE 2.9**
The IBM company logo uses the Continuity principle to form letters from disconnected patches.
Slider controls are a user-interface example of the Continuity principle. We see a slider as depicting a single range controlled by a handle that appears somewhere on the slider, not as two separate ranges separated by the handle (see Fig. 2.10A). Even displaying different colors on each side of a slider’s handle doesn’t completely “break” our perception of a slider as one continuous object, although ComponentOne’s choice of strongly contrasting colors (gray vs. red) certainly strains that perception a bit (see Fig. 2.10B).

GESTALT PRINCIPLE: CLOSURE

Related to Continuity is the Gestalt principle of Closure, which states that our visual system automatically tries to close open figures so that they are perceived as whole objects rather than separate pieces. Thus, we perceive the disconnected arcs in Figure 2.11A as a circle.

Our visual system is so strongly biased to see objects that it can even interpret a totally blank area as an object. We see the combination of shapes in Figure 2.11B as a white triangle overlapping another triangle and three black circles, even though the figure really only contains three V shapes and three black pac-men.

The Closure principle is often applied in graphical user interfaces (GUIs). For example, GUIs often represent collections of objects (e.g., documents or messages) as stacks (see Fig. 2.12). Just showing one whole object and the edges of others “behind” it is enough to make users perceive a stack of objects, all whole.
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**GESTALT PRINCIPLE: SYMMETRY**

A third fact about our tendency to see objects is captured in the Gestalt principle of *Symmetry*. It states that we tend to parse complex scenes in a way that reduces the complexity. The data in our visual field usually has more than one possible interpretation, but our vision automatically organizes and interprets the data so as to simplify it and give it symmetry.

For example, we see the complex shape on the far left of Figure 2.13 as two overlapping diamonds, not as two touching corner bricks or a pinch-waist octahedron with a square in its center. A pair of overlapping diamonds is simpler than the other two interpretations shown on the right—it has fewer sides and more symmetry than the other two interpretations.

In printed graphics and on computer screens, our visual system’s reliance on the symmetry principle can be exploited to represent three-dimensional objects on a two-dimensional display. This can be seen in a cover illustration for Paul Thagard’s book *Coherence in Thought and Action* (Thagard, 2002; see Fig. 2.14) and in a three-dimensional depiction of a cityscape (see Fig. 2.15).
The next Gestalt principle that describes how our visual system structures the data it receives is *Figure/Ground*. This principle states that our mind separates the visual field into the figure (the foreground) and ground (the background). The foreground consists of the elements of a scene that are the object of our primary attention, and the background is everything else.

The Figure/Ground principle also specifies that the visual system’s parsing of scenes into figure and ground is influenced by characteristics of the scene. For example, when a small object or color patch overlaps a larger one, we tend to perceive the smaller object as the figure and the larger object as the ground (see Fig. 2.16).

**FIGURE 2.13**
Symmetry: the human visual system tries to resolve complex scenes into combinations of simple, symmetrical shapes.

**FIGURE 2.14**
The cover of the book *Coherence in Thought and Action* (Thagard, 2002) uses the symmetry, Closure, and Continuity principles to depict a cube.
However, our perception of figure versus ground is not completely determined by scene characteristics. It also depends on the viewer’s focus of attention. Dutch artist M. C. Escher exploited this phenomenon to produce ambiguous images in which figure and ground switch roles as our attention shifts (see Fig. 2.17).

In user-interface and Web design, the Figure/Ground principle is often used to place an impression-inducing background “behind” the primary displayed content.
Gestalt principle: figure/ground

The background can convey information (e.g., the user’s current location), or it can suggest a theme, brand, or mood for interpretation of the content.

Figure/ground is also often used to pop up information over other content. Content that was formerly the figure—the focus of the users’ attention—temporarily becomes the background for new information, which appears briefly as the new
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figure (see Fig. 2.19). This approach is usually better than temporarily replacing the old information with the new information, because it provides context that helps keep people oriented regarding their place in the interaction.

GESTALT PRINCIPLE: COMMON FATE

The previous six Gestalt principles concerned perception of static (unmoving) figures and objects. One final Gestalt principle—Common Fate—concerns moving objects. The Common Fate principle is related to the Proximity and Similarity principles—like them, it affects whether we perceive objects as grouped. The Common Fate principle states that objects that move together are perceived as grouped or related.

For example, in a display showing dozens of pentagons, if seven of them wiggled in synchrony, people would see them as a related group, even if the wiggling pentagons were separated from each other and looked no different from all the other pentagons (see Fig. 2.20).

Common motion—implying common fates—is used in some animations to show relationships between entities. For example, Google's GapMinder graphs animate dots representing nations to show changes over time in various factors of economic development. Countries that move together share development histories (see Fig. 2.21).
Gestalt principles: combined

Of course, in real-world visual scenes, the Gestalt principles work in concert, not in isolation. For example, a typical Mac OS desktop usually exemplifies six of the seven principles described here, excluding Common Fate: Proximity, Similarity, Continuity, Closure, Symmetry, and Figure/Ground (see Fig. 2.22). On a typical desktop, Common Fate is used (along with similarity) when a user selects several files or folders and drags them as a group to a new location (see Fig. 2.23).
FIGURE 2.22
All of the Gestalt principles except Common Fate play a role in this portion of a Mac OS desktop.

FIGURE 2.23
Similarity and Common Fate: when users drag folders that they have selected, common highlighting and motion make the selected folders appear grouped.
With all these Gestalt principles operating at once, *unintended* visual relationships can be implied by a design. A recommended practice, after designing a display, is to view it with each of the Gestalt principles in mind—Proximity, Similarity, Continuity, Closure, Symmetry, Figure/Ground, and Common Fate—to see if the design suggests any relationships between elements that you do *not* intend.