Cognition and the Visual Arts

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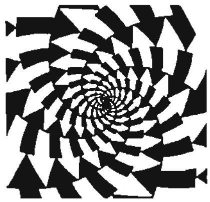
4 Visual Cognition



One may be tempted to suppose that we, who experience the world through vision, experience a very different world from the worlds experienced by bats or dolphins, who rely more on hearing, dogs or rats, who make greater use of smell, . . . or spiders or scorpions who are attuned to mechanical vibrations. But at a sufficiently abstract level, our worlds are all the same three-dimensional Euclidean world.

—*Roger Shepard*

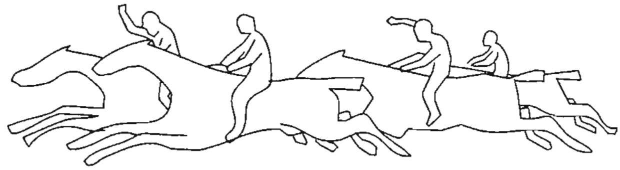
At the close of the last chapter we saw some examples of op art that are alive with movement. Those effects are largely due to differential inhibition of retinal cells. A much different sense of movement was created by Théodore Géricault, the early nineteenth-century French artist, in his *Derby at Epsom* (figure 4.1). (Ironically, Géricault died at the age of 33 after falling from his horse.) The painting is realistic in that we "feel" the movement, "hear" the thundering hoofbeats, and grasp the excitement of the moment. These sensations are based on a careful attention to reproducing the exact details of the derby. Stop reading the text and reexamine the horses and riders in this example. Do you "see" and "feel" the things mentioned above?

If we examine the anatomy of these horses, however, we find that they resemble no creature that inhabits this planet. Furthermore, the juxtaposition of horses is so pictorially planned that it is really awkward and unnatural. Indeed, the horses in this picture look more like the wooden steeds ceremoniously mounted on a merry-go-round, whose terrible expressions remain unchanged through a circular track. The entire scene might be repeated, with the same impossible horses, juxtapositions, and undulations, as the carousal makes another turn. I can almost hear the organ music. Now, look back at the *Derby at Epsom*. What do you "see"?

4.1 Théodore Gericault, *Derby at Epsom* (Musée du Louvre).

This exercise was intended to show how the same scene can be viewed from at least two different perspectives. In each case, what we "see" is, to a large degree, determined by our knowledge of what we "should" see, which is based on our previous experiences.

A much simplified sketch of Géricault's scene still captures many of the essential features of the painting. With only a few lines, it shows us familiar objects in well-known poses, which we recognize as running horses. In order for this illusion of movement to work, the observer must apply an extensive knowledge of the world to the interpretation of these few lines. The observer processes the information in what is called a top-down fashion. Consider how difficult it would be to design a computer program that would "view" the few lines in this sketch and arrive at the same conclusion as we humans do. Even very young children see immediately that this is a picture of horses being ridden by hard-driving jockeys (or wooden ponies with happy youngsters on top). Fishermen, old women, simple boys, college students, art critics, plumbers, chief executive officers, and all sorts of people accomplish this seemingly elementary task without effort. And yet all the king's horses and all the king's men can't yet design a computer program that "sees" and comprehends simple line drawings, a task we humans do every day with



lighting speed, stunning alacrity, and remarkable precision. Human vision and comprehension are among the most difficult challenges for those working in the field of artificial intelligence.

Visual Cognition

To better understand human visual cognition, we need to consider three stages of the problem.

• First, visual cognition ("seeing and understanding") involves the basic analysis of shapes, forms, colors, contours, contrasts, and movements. These primitives are sensed by the peripheral nervous system located in the eye. Electromagnetic signals in the form of physical energy are transduced to electrochemical signals and passed along the visual cortex for further processing. It is during this latter stage that visual recognition and higher-order processing takes place. (See chapters 1 and 2 for further exposition of these topics.)

• Second, primitive information is organized into fundamental forms. These fundamental forms are the basis for higher-order processing (such as the interpretation of what a form means) and are perceived mostly without prior learning or experience. An example of a fundamental form is the figure-ground pattern, in which an object (figure) stands out from the background (ground). The letters on this page (figure) stand out from the paper (ground). Psychologists who subscribe to the Gestalt (configuration) theory of cognition have studied fundamental forms in detail.

• Third, fundamental forms are given meaning through association with previous knowledge of the world stored in long-term memory (LTM). This final stage of the information processing model is sometimes called higher-order cognition, not because it is more elegant but because it occurs as the consequence of previous, "lower" stages. Furthermore, the thinking brain directs our attention to specific parts of a visual scene, giving greater notice

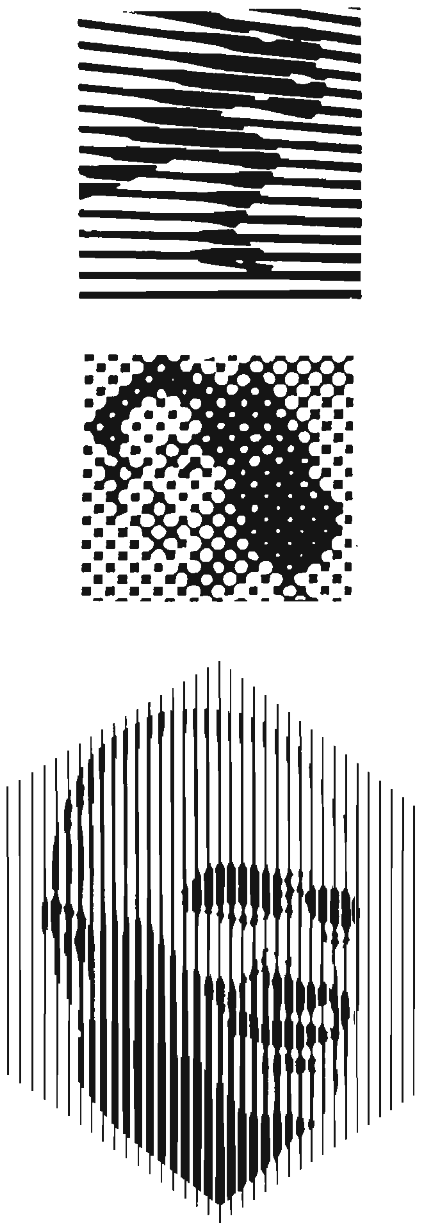
Seeing—More Than the Eye Beholds

Our mind "sees" things that the eye alone never could. Take the figure of an ice skater that was used as a symbol at a recent Olympiad. Most people recognize immediately these few lines—16 of them—as an ice skater in full stride. In the context of the Winter Olympics, the facility for correctly identifying this figure would be even faster and more accurate.

The next figure illustrates a striking example of "information" and perception. What do *you* see? If you have difficulty seeing any meaningful form, try to squint your eyes, place the figure five or six feet away, or, if you are nearsighted, remove your glasses. Do you see the brunette woman? The form was created by "information" in the form of shadings distributed over a screen, which in the present example is 22 dots high by 26 dots wide, or 572 total dots. In effect, this is a kind of "information palette" from which a meaningful image is constructed, similar to the display on a television screen, which is composed of a raster with pixels (individual light cells).

The third figure is an effort by Victor Vasarely to fashion a portrait of Georges Pompidou (for whom a modern art museum in Paris is named) out of 37 lines of varying density. As in the previous two examples, a type of paradox exists in this picture: the more it is degraded, the clearer it becomes. If you squint your eyes or look at this picture at a distance, the perceived image is actually seen more clearly. The individual contours, lines, and dots, which are sharply delineated at close range, become less clearly defined at a distance. As our perception of these separate elements is distorted, cognitive mechanisms are activated. In the present examples these mechanisms now tell us we are viewing a skater, a brunette, and a famous person.

Two perceptual/cognitive processes are at work here. (1) If the image is further degraded, the impression is more easily recognizable. The visual explanation of this effect is that information from specific contours is reduced if the contours are degraded. These specific contours are irrelevant, or even distracting, in decoding this image; therefore, their diminution enhances the perception of the object. Contours blend and the image is perceived as a whole. (2) The image is given meaning. We see people's faces and forms. These images are long familiar to each individual, and those impressions are important parts of the LTM. We are able to classify these impressions as belonging to a "class" of stored information (e.g., faces, skaters, and so on). Furthermore, we expect to see these objects because of context. We use top-down processing to assist in their recognition. Thus, someone visiting the Olympic village during the Winter Olympic games would *expect* to see an emblem of an ice skater.



4.2 Three figures, including Victor Vasarely's *Portrait of Georges Pompidou.*

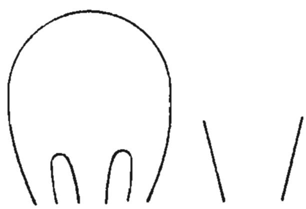
to salient features or things that are of personal interest. Finally, the brain adds information to the raw visual impressions, which gives a richness of meaning far beyond the simple stimuli it receives.

In modern cognitive terms, the first two stages initiate the process of visual cognition and are sometimes called bottom-up processing, in which the stimuli drive the workings of visual awareness. The third stage is called top-down processing because cognitive operations drive visual awareness, although at both stages elements of top-down and bottom-up processing are operating.

Both top-down and bottom-up can be illustrated in the droodle shown in figure 4.3. Try to guess what these few lines "mean." (For the "answer" see the end of this chapter.) Each of the three stages through which visual processing takes place can be identified for this figure. During the first, information from the simple line drawing is received by the photoreceptors in the eye and begins its voyage to the brain. Fundamental distinctions are made between basic contours, and specific neurons are stimulated in the visual cortex. In the second stage certain features of the figure are perceived as belonging together and others as belonging to other groupings. One might perceive the three features on the left side of the figure as belonging to one grouping and the two features on the right to another. Finally, all of the features are integrated into a meaningful whole—a process called *redintegration*. At this stage we "see" the object as it was intended to be seen. This stage is dependent on our vast world knowledge, and possibly on additional information provided (see answer). Without knowledge, the meaning (at least the "intended" meaning) is lost. Let us examine in some detail the second and third stages as they apply to the perception of art.

Painting must not be exclusively visual or retinal.

—*Marcel Duchamp*



4.3 What do you see?

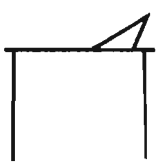
Direct or Indirect Perception?

A central question in the science of sensory/perceptual psychology that pertains to the perception of art is whether visual forms are perceived "directly" or "indirectly." Those who subscribe to the "direct" theory hold that sensory information in and of itself is sufficient for a person to perceive the world accurately. This notion, most closely associated with the late James Gibson of Cornell University, is sometimes called an "ecologically valid" theory (see Gibson 1979), as it holds that the study of perception ought to be conducted under real world conditions. Under these conditions, real objects are perceived accurately by people; it is only under artificial or "ecologically invalid" conditions, such as might be experienced under laboratory conditions of illusions and other unnatural stimuli, that indirect perception occurs.

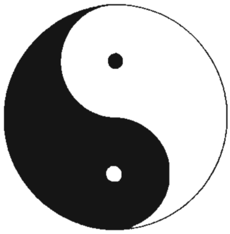
The original theory of indirect perception was suggested by Helmholtz (and others) during the last century. It proposes that most of our perceptions are constructed from inferences about the real world. If we know what to look for in a figure, then we are likely to see it. The indirect perception is related to top-down processing of visual stimuli, in which perception is driven by our expectations of how the world should look.

Rather than choosing one theory and discarding the other, we might do better to consider both theories as valid but as dealing with different parts of the sensory process. It is certainly believable that complex objects are sensed as primitive figures—detected by the eye and initially processed by the visual cortex. It is also true that the brain is an enormously complex thinking device, rich in memory associations and adept at solving problems requiring insight and imagination. We see things through the eyes, but we understand things with the mind.

The perception of art has struggled with similar questions, and the same answer seems relevant. When we study a piece of art, the complex object is initially sensed as a series of primitive light signals. These signals are integrated into a composite picture, in which the mind adds interpretation. The final perception is the result of these two factors working together.



4.4 Carracci trick drawing. As early as 1600 artists drew sketches similar to what we now call droodles but were then known as "trick figures." This is a modern redrawing of a trick figure by one of the Carracci. It shows "a Capuchin preacher asleep in his pulpit," but we are only likely to see it if we already know what to look for.

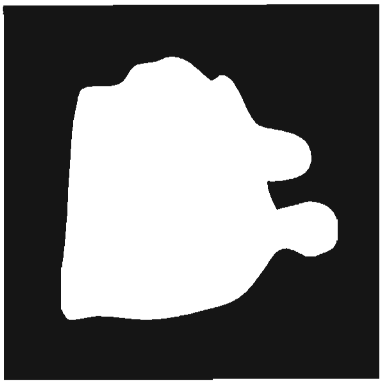


Fundamental Forms

Stimuli that are commonly organized into a pattern or basic configuration are called fundamental forms. As mentioned, our eye and brain naturally divide visual patterns into figure and ground. In this section we encounter several types of fundamental forms that serve as the building blocks for more complex images, including art.

Why is the perception of fundamental forms so important to the human observer? To cast this discussion in a broader context, consider the purpose of visual perception among members of our species and other animals. It is likely that primitive sense organs capable of perceiving light energy evolved very early in the history of multicellular creatures for the purpose of finding food, heat (or cold), and light (or dark) and avoiding harm. As mentioned in chapter 1, fossilized remains indicate that the Paleozoic trilobites had primitive eyes capable of seeing. Some fossil eyes date back to 500 million years ago, and it is likely that some forms of photosensitive devices are older than that. Primitive invertebrates, jellyfish for example, have photosensitive cells. Even echinoderms (e.g., starfish and sea urchins) have eyespots found at the end of a tentacle. More elegant seeing instruments developed when photosensitive regions became indented and were protected by a transparent layer of cells that later developed into what we now know as the lens. This enclosed photoreceptive instrument became more complex and a profusion of cells within it evolved into the areas of the retina. Other refinements of the visual sensing apparatus developed over millions of years until the eye, as we presently know it, emerged.

From our discussion of the survival properties of vision (chapter 2), recall the three important things that vision tells us:



4.5 Figure and ground illustration. Even though we cannot tell what it is, this figure is seen as standing out from its background. We naturally separate figure from ground—an important step in form perception.

- What is an object?
- Where is it?
- What is it doing?

It is hardly coincidental that the topics of *form perception, depth perception,* and the *perception of movement* are three major areas of visual research and theory. All three of these topics are important for the perception of art. The first will be considered here and the others later.

What is an object? First of all, an object must be a thing distinguishable from other things. A rowboat made invisible by a dense fog is not an object, at least not an object we can see. Something must differentiate an object from its context, and a commonly perceived demarcation is achieved through figure-ground separation, as shown in figure 4.5. This seemingly meaningless white blob is clearly seen as separate from its background: everyone with normal vision sees it this way. This process is one of the most elementary in object perception. (Keep in mind that complex forms, as expressed in two-dimensional art, are composed of elementary forms.) Look again at the blob. Notice that the contour, the transition between one level of reflected light and another, is more a part of the figure than it is of the ground. We see the figure as resting on top of the black ground and infer that the black background continues beneath the white form. (We can reverse this illusion by imagining the white portion to be a hole cut out of a black card.) A further

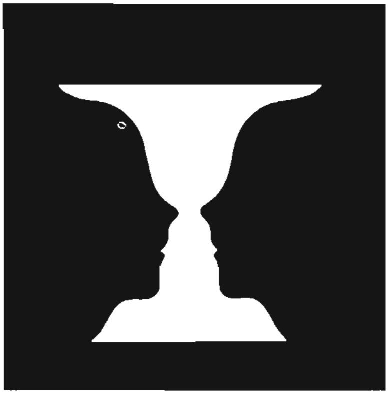
4.6 Do you recognize this famous couple? (See figure 8.14.)

aspect of visual perception is illustrated in this figure: the role played by orientation and top-down processing. Rotate the figure 90 degrees counterclockwise. Now what do you see?

Our ability to distinguish figure from ground is, in part, due to the intensities of light reflected from an object. In figures 4.5 and 4.6 the amount of light reflected from the white surfaces is about 80 percent of the light falling on them, while the black surfaces reflect only about 4 or 5 percent of the light falling on them. The ratio of reflected light from the white (figure) and black (ground) is approximately 20 to 1! That gets our attention. To put this concept in a slightly different context, consider the printed type on this page and the background of the paper upon which it is printed. Here the ratio of the light reflected from the white paper and from the black type is about 16 to 1. That is, about 16 times

The first painting was just a line that surrounded the shadow of a man projected by the light of the sun on the ground.

—Robert Delaunay

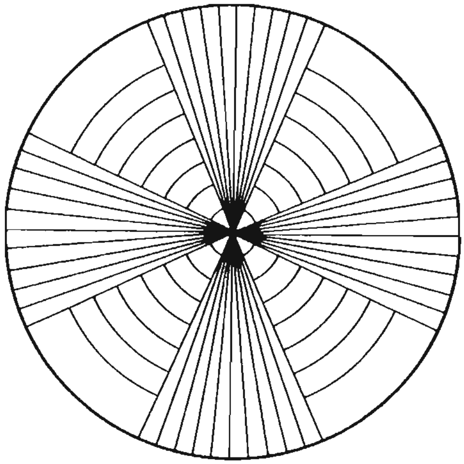


4.7 A reversible figure-ground form in which either two profiles or a white chalice can be seen. From Gleitman (1981).

as many quanta per second of electromagnetic energy are being absorbed by the neurons in your retina from the white background as from the black type. However, the *ratio* of light reflected from figure and from ground remains reasonably stable over a wide range of ambient light conditions—a phenomenon aptly called brightness constancy. Brightness constancy is one of several important cues that allow us to recognize a black cat regardless of whether it is seen in a darkened room or lighted room. A cat in a dark room reflects less light, but then so do the other objects in the dark room. Our ability to recognize a cat under a wide range of viewing conditions is one of the most spectacular of visual wonders, one we routinely take for granted. This important principle of perception is crucial in the viewing of art: within a fairly wide range of illumination, the balance between figure and ground remains constant.

Another type of figure-ground illustration, interesting to perceptual psychologists, is one in which the figure can be seen as the ground and the ground can be seen as the figure (so-called reversible figures). A well-known example is shown in figure 4.7, in which the viewer may exercise some control over which part of the illustration is the ground and which is the figure. Note that the contour "belongs" to the figure. It can belong to the white vase or to the two profiles, but when part of one figure it is not part of the other. A reversible figure in which figure-ground difference is not based on large black and white regions is shown in figure 4.9. This figure has

4.8 Queen Elizabeth and Prince Philip can be seen in this commemorative vase in a figure and ground representation.

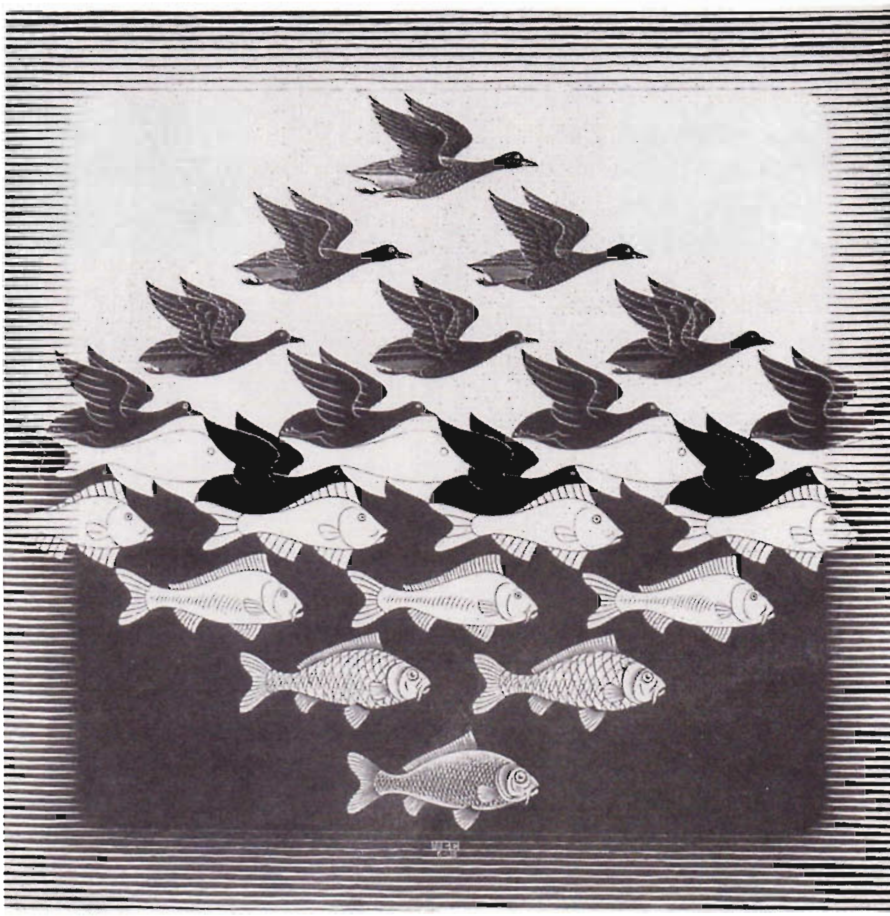


4.9 A figure-ground illusion in which the figures are of nearly equal light intensity.

two equally intense features (circular lines and radiating straight lines), each of which can be seen as figure or ground. Sometimes it is difficult to alternate between the figure and ground (as illustrated in figure 4.9), but, if you have difficulty, continue to look at the object. Sometimes if you squint your eyes, the figure will suddenly switch. Some people get better at switching with practice, while others never seem to get the knack of it. I am mystified by these individual differences and suspect it may have something to do with right hemisphere brain functioning. This illustration is interesting in another regard; when the figure is the straight lines, the ground (the curved lines) appears to continue behind the figure. However, when the figure and ground are reversed, no illusion is experienced of additional straight lines emanating from the center and falling behind the curved lines.

Some artists have incorporated reversible figure-ground illusions in their paintings, with engaging results. Among the most intriguing is the inventive M. C. Escher, whose *Sky and Water I* is shown in figure 4.10.

In the following two figures, two well-known modern artists have used figure-ground motifs in strikingly different ways, one in stark black and white, the other rich in detail. Victor Vasarely uses figure-ground interplay in an illustration of two lovers embracing each other (figure 4.11). This figure is confusing to many people because, if one object is the figure (say the white form), then the other (the black part) is seen as the background. However,



4.10 M. C. Escher, *Sky and Water I* (© 1938 M. C. Escher Foundation). The figure-ground separation process changes from top to bottom, as birds change to fish.

in order for this painting to work (to be seen as two lovers), both figures must be conceptualized as "figures" simultaneously—a difficult perceptual task. But then, perhaps this was exactly what the artist intended: to create an ambiguous painting that requires some effort on the part of the viewer. Or perhaps the artist intended that the two figures be seen to alternate rapidly—with first one and then the other appearing as the featured figure, much as happens to our ears when we hear a musical fugue. Or (alas) we might see

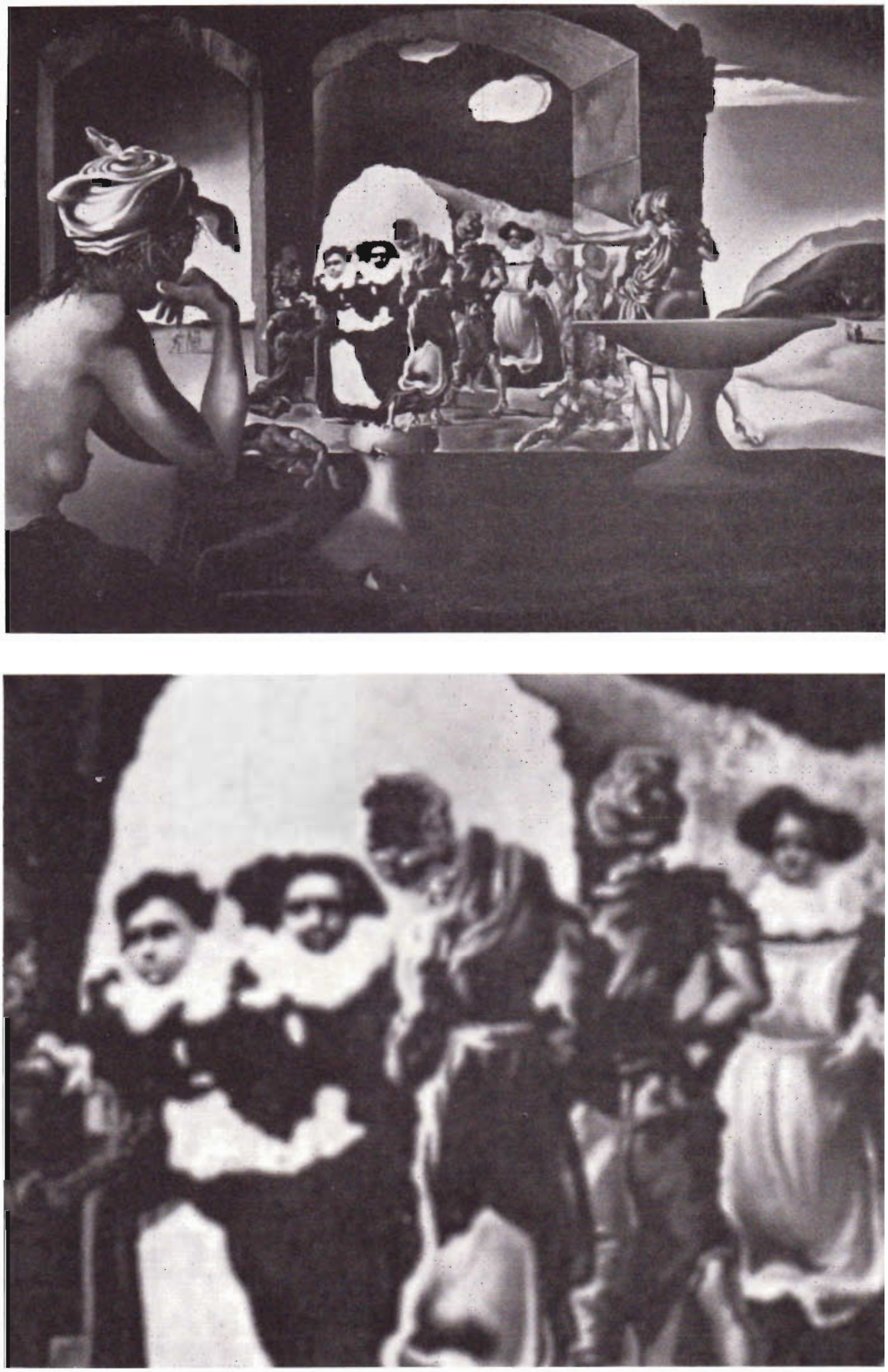
4.11 Figure-ground reversal by Victor Vasarely. Two lovers are shown embracing; either can be seen as figure or ground.

an attraction/aversion "fugue," such as we often experience in the capricious nature of amorous relationships. Even if such an elaborate stratagem was not planned, the piece invites critical cognitive analysis and serves to illustrate some interesting principles of perception.

In Salvador Dalí's *Slave Market with Disappearing Bust of Voltaire* (figure 4.12), the bust of Voltaire predominates in most people's interpretation, especially when the painting is reproduced at small scale. However, when viewed at close range (or when this detail is enlarged), the two nuns predominate. As with Vasarely's lovers, it is nearly impossible to see both Voltaire and the nuns at the same time, but one can see each clearly if it is taken as the figure.

Perceptual Organization and Gestalt Psychology

A very interesting episode in the history of psychology was the proposal by a group of German scholars—notably Max Wertheimer, Kurt Koffka, and Wolfgang Köhler—that *form* is the primitive unit of perception.[1] The Gestalt psychologists, as they were called (taking their name from the German word that is close to the English word "configuration"), believed that the key to understanding perception—and thereby the larger domain of all



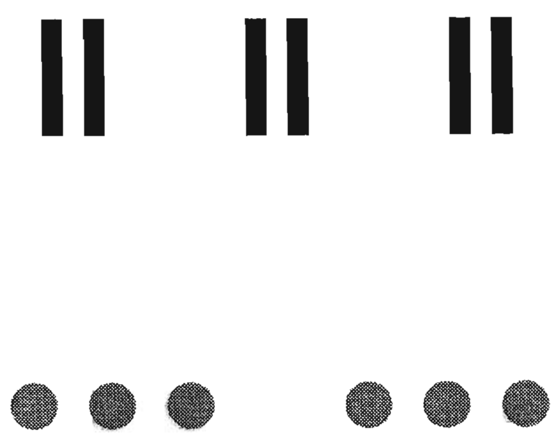
4.12 Salvador Dalí, *The Slave Market with Disappearing Bust of Voltaire,* with detail below. The two nuns standing in the archway at left-center reverse to form a bust of Voltaire.

psychology—was to be found by studying the way the brain organizes basic stimuli. Furthermore, they postulated that the organization of patterns is an inherent property of humans; knowledge of these organizing phenomena would elucidate the way the brain functions. From the Gestaltists' laboratory dazzling geometric patterns were created, some of which produced visual illusions and others of which showed how the brain naturally organizes visual stimuli—all under the rubric of perceptual organization.

Because perceptual organization is so common to the human observer, we tend to think of the process as being uninteresting, uncomplicated, or routine. Yet, many believe, the way the brain organizes incoming visual patters is fundamental to our understanding of both psychology and art. Several principles of perceptual organization are discussed below.

Proximity

If like objects are located near each other in the physical world, we tend to group them together perceptually. Similar features are grouped together as shown in figure 4.13, in which six vertical lines are perceived not as six independent, unorganized lines but as three sets of two. The six small circles are likewise seen as two sets of three circles. We tend to organize proximal stimuli, if they are similar in shape, color, form, or lines, into patterns. Think of any art piece you have seen, either in this book or in a gallery, and analyze it in terms of proximity (see figure 4.16). It is likely that many images rely



4.13 Grouping by proximity.

on proximity, which compels the viewer to "see" the world in a certain predetermined way.

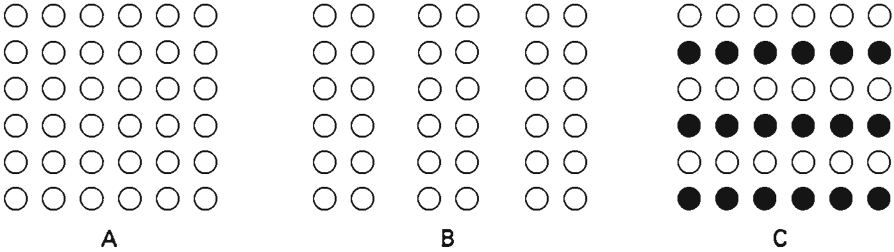
Interestingly, the same principle seems to apply to other sensory stimuli, notably sound and music. When we hear music we naturally organize it into rhythms or beats, so that "six toots on a trumpet" may be heard as three sets of two toots (or two sets of three toots, or one toot and five toots, and so on). What the mind's ear hears is a pattern of information, *just as the mind's eye sees a pattern of information* in the visual display presented in figure 4.13. And what *we* hear and see is basically very much what people have experienced for millennia.

This universal mode of seeing (and hearing, tasting, smelling, and feeling) seems to be an integral, evolved component of the human nervous system—its main purpose being to usefully represent the physical world to a thinking creature. The creatures that performed these operations successfully were presumably more adaptive and more likely to procreate than those that didn't.

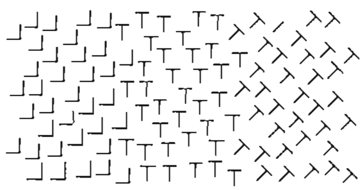
Perhaps you have now made the connection between the way the brain organizes visual and auditory stimuli and the Kandinsky painting *Pictures at an Exhibition* (and its relation to Mussorgsky's music; see figure 3.5). There are many parallels in the ways the sensory systems (vision and audition, for example) process information. These include the perception and processing of rudimentary stimuli such as visual gratings and auditory cadence. Perhaps, at a sufficiently abstract level, the physical world is known to us through a sensory system that is attuned to a limited number of elementary patterns. These patterns are collected by the peripheral sensory systems and sent on to a brain that is evolutionarily predisposed to receive and process them. If this reasoning is valid, and considerable evidence from both the behavioral and neurological sciences supports such a notion, then the seeing of complex visual forms, as when we view art, is a matter of sensing basic shapes, passing them along to a receptive brain, and combining the impression with our vast knowledge of the world from which inferences are fashioned.

Similarity

Similar elements, shapes, sizes, and colors tend to be grouped together, as shown in figure 4.14. The inclination to see similar elements as belonging to the same class is so compelling that we interpret this illustration as three columns of two circles, or three lines of solid circles and three lines of open



4.14 Grouping by similarity. We tend to organize the circles in *A* as three columns of two circles.

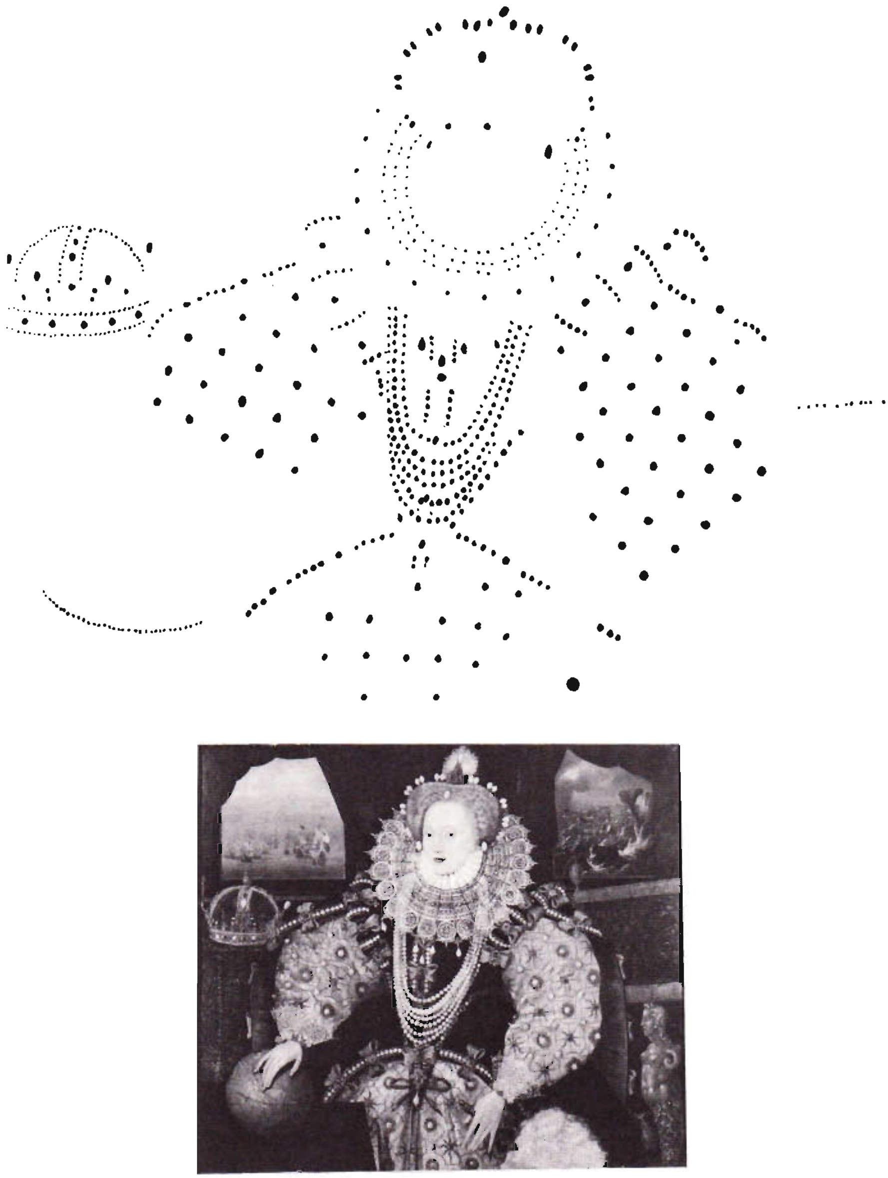


4.15 Grouping by similarity. The T's in the center are perceived as belonging to a different class of objects. From Beck (1966).

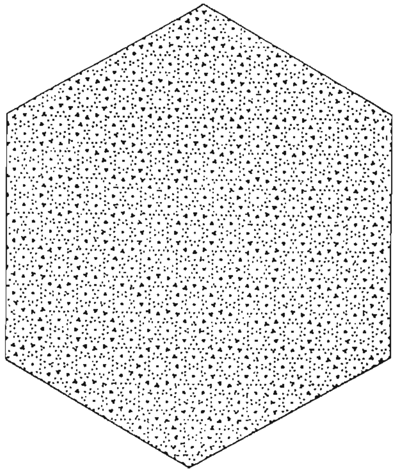
circles—although the latter impression is far less salient due to the solid circles being seen as figure. Many other common examples of **grouping by similarity** can be found in everyday life—such as the above boldface type, which seems to belong together while the remaining type belongs to another category.

A slightly more complex example of the ability of the perceptual system to organize stimuli by similarity is shown in figure 4.15, in which the group of T's in the center stand out from the rest—even though the physical energy reaching the retina is nearly identical for each of the three sets of information.

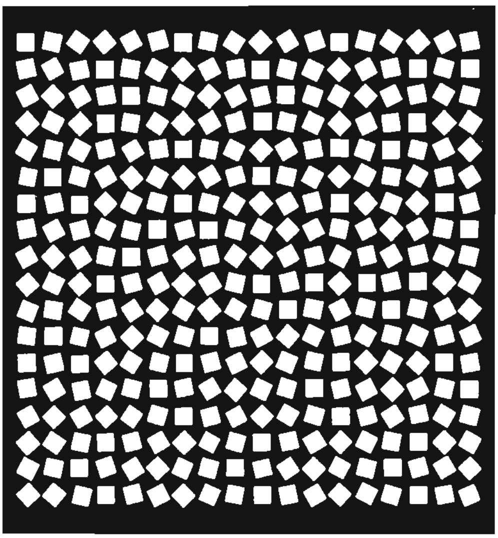
Similar patterns have also been used in art to organize a viewer's perception of an object. One such example is shown in figure 4.16, a portrait of Queen Elizabeth I, in which the artist (perhaps unconsciously) uses grouping by similar pattern to focus the viewer's attention. Take a moment and look at the small portrait. Notice how you naturally tend to organize the features of the subject's collar into a circular pattern. The similar qualities in Elizabeth's hair are grouped in pairs, and the pairs are organized into a larger pattern surrounding her face. All of these organizational patterns accentuate



4.16 The Armada portrait of Queen Elizabeth I. The use of similar objects, beads, jewels, and collar material compels the viewer to organize these common features. Schematic drawing from Malins (1980).



4.17 Rival organization of patterns. The tendency to see unstable circles is caused by features being parts of more than a single organizational scheme. From Marr (1982).



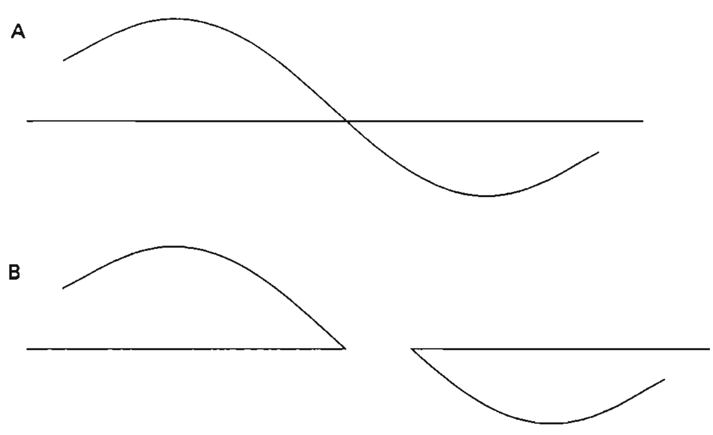
4.18 Another example of conflicting organizational patterns. As you look at this figure you will notice that once you establish one pattern of circles, another circle captures some of the elements of the first circle. This continual visual competition makes for a dynamic and (to many) interesting piece of art. (Design by Leonard Kitts.)

the features of the face—the focal point of the painting. Other examples of grouping by similarities are shown in the diagram above the painting.

A more complex visual example is shown in figure 4.17, in which rival organizations compete for our attention. There is a strong inducement to see a number of circles formed by certain common elements; but then some of these elements are parts of other circles as well. The psychological effect, in which the object becomes "alive" with changing formations, is a result of perceptual rivalry between two natural organizational patterns (circles). The object has a dynamic tension that makes it difficult to see a stable form. Many types of op art, discussed earlier, and geometric clothing patterns take advantage of the tendency to organize ambiguous features in one direction and then to see the same features as part of another pattern.

Continuation

Objects that flow "naturally" in one direction are likely to be seen as belonging together. Our eyes seem to go with the flow. An example of continuation is shown in figure 4.19A. What do you see? It is probable that you see this figure as a straight line through which a curved line has been drawn, rather than as two "awkward" figures (B). It may be that this strong visual tendency (and the related principle of "common fate") is related to the physics of moving objects. We see things in motion as, more or less, keeping on course rather than making oblique angular changes in midcourse. Indeed, living in



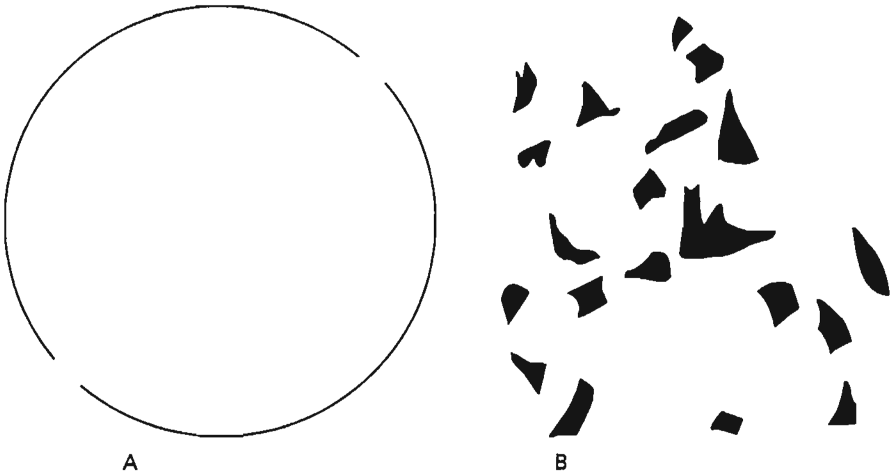
4.19 Continuation. We see two continuous lines (*A*) rather than two "awkward" lines (*B*).

a three-dimensional, potentially dangerous world, governed by laws of the physical universe (e.g., gravity, conservation of momentum), it is vital that we be able to predict trajectories (on which the law of continuation seems to be partially based) in order to avoid falling branches, spears, and left hooks. It seems that we now use those ancient abilities to hit a baseball, avoid fast-moving cars on the freeway, and predict the location of a golf ball badly hooked.

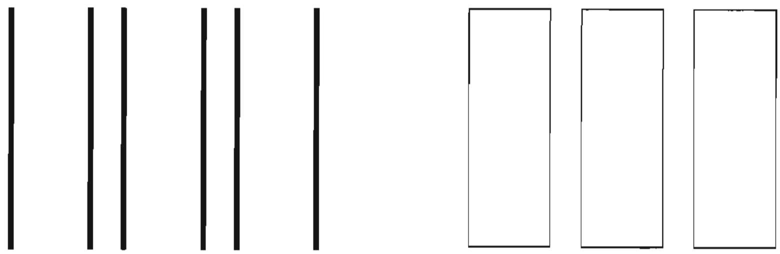
Closure

Related to the law of continuation is closure—or the tendency to see figures as unitary, enclosed wholes. In figure 4.20A we "see" a figure of a circle. Technically, a circle is an *enclosed* round figure. This figure is not exactly a circle, and yet, if we saw this object momentarily projected (as in a tachistoscopic presentation), we would be certain that it was a true circle. And, generally speaking, in informal usage we commonly consider a wide class of visual objects "circles" if they are close to being circles.

In figure 4.20B we may be able to "see" the composite figure of a knight and his horse, not a series of unconnected shapes. Yet any one of these shapes



4.20 Closure. We see a circle (*A*) even though technically it is two separate lines. In *B* we may see a whole pattern of a knight and horse, not unassociated black dabs. Psychological tests of mental ability and organic brain damage have been devised using lacunary stimuli such as these.



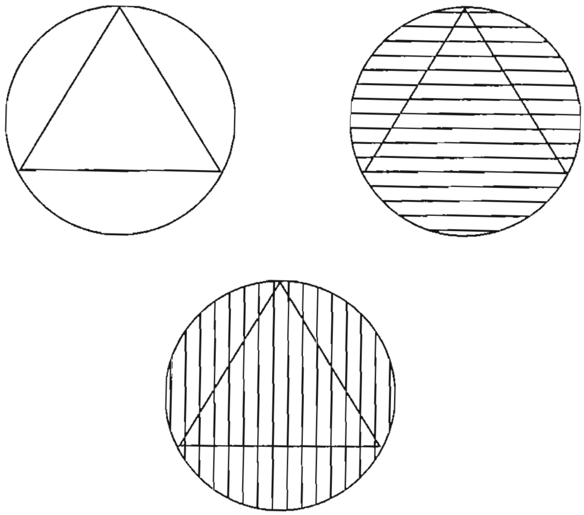
4.21 "Weak" and "strong" forms.

alone is empty of meaning. Only when we gain closure is the object recognizable and its components become an integral part of the whole.

Another example of closure and its psychological impact is seen in figure 4.21. Here we see six vertical lines on the left; at right, with the addition of top and bottom lines, we see a much different form. Such closed figures seem somehow to be "better" or "stronger." In general, the more basic the closed figure, the more psychologically salient it is (a topic closely related to *Prägnanz*). Thus, a rectangle is more "significant" than open lines, a square more "significant" than a rectangle, and a circle more "significant" than a square.

Prägnanz

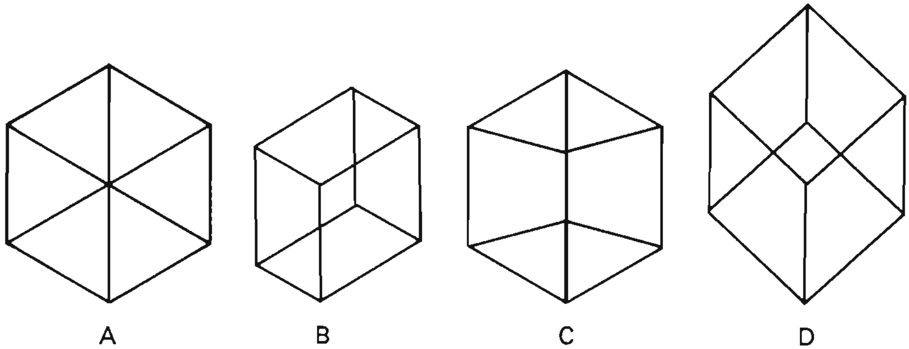
The German word *Prägnanz* translates into English as "pregnant with meaning," and is one of the more controversial aspects of Gestalt theory. Figures with *Prägnanz* are said to have "good shapes." This somewhat slippery concept (e.g., good to whom?) is applied to typical, geometrically regular configurations, such as a circle, square, triangle, or hexagon. The psychological implication of *Prägnanz* is that our mind seeks stable, regular figures in the environment and that we may feel uneasy if unable to find such objects, frequently without knowing the source of our discomfort. Artists and film makers capitalize on this tendency by creating scenes pregnant with "bad" (unstable) gestalts that are visually factious and crave stability. A similar phenomenon is found in music, in which unresolved musical patterns cry out for resolution. During the 1960s, folk singers would frequently end a tune with an open chord or unresolved chord, poignantly positing a type of musical question, "What?, Why?, Where?, When?" "What have they done to the rain?" A geometric example of conflicting "good" forms is shown in figure



4.22 Competing stable forms.

4.22, in which an equilateral triangle is shown on the left and then embedded in a circle with parallel lines on the right. The stronger tendency is to see the parallel lines here and not the triangle. If the competition between the two stable forms is removed, as in the bottom figure, the triangle becomes visible.

Yet another way to understand the notion of *Prägnanz* is to consider the figures in figure 4.23. Spend a few moments looking at object *A*. What do you see? It is possible to see a three-dimensional figure, but it is likely that you see a two-dimensional hexagon. As a matter of fact, once you see the three-dimensional cube in this figure, it is hard to hold it; the tendency is to slip back to a two-dimensional figure. Now, consider the remaining figures. Objects *B* and *D* seem to be three-dimensional—it is difficult to see two-dimensional forms in these examples—while object *C* switches between two- and three-dimensionality. In all these examples, our perception of these ambiguous figures reverts to the most stable forms (those with *Prägnanz*). You might try this observation with a friend by exposing each of the four figures independently for about 30 seconds. (Cover up the other figures and show one form at a time.) While the observer looks at each figure, record whether he or she experiences two dimensions or three dimensions. (The observer could indicate his or her perception by holding up two or three fingers.)

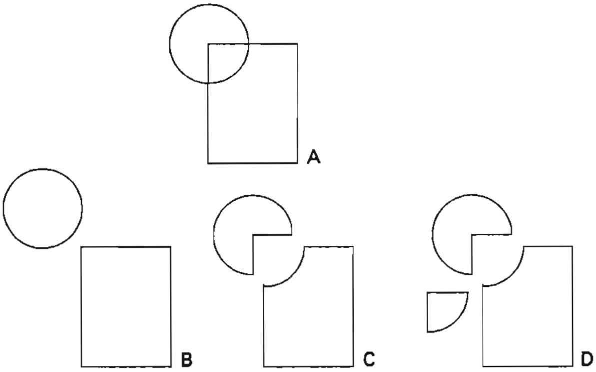


4.23 Two- and three-dimensional-appearing figures that seek stability or *Prägnanz*.

Typically, people see *A* and *C* as more two-dimensional and *B* and *D* as three-dimensional. There is a strong tendency for each of us to see stable forms in these objects, whether the stable form is expressed in two or three dimensions.

Finally, we see an example of *Prägnanz* in figure 4.24, in which a compound object (*A*) can be decomposed and explained in several ways. It could be that it is composed of two overlapping independent forms, as shown in *B* (and this is the "best" *Prägnanz*), or it could be that there are two nonoverlapping figures, as shown in *C*, or that three forms are used, as shown in *D*. The most parsimonious explanation is that there are two overlapping forms, and this explanation seems most "natural." We have an inclination to find more fundamental explanations for percepts, rather than "unnatural" interpretations.

To many cognitive psychologists (including your author), the work of the early perceptual psychologists is significant for two reasons. First, they identified fundamental forms that are processed similarly by all human observers; and second, they advocated a doctrine that was at odds with the environmentally determinist approach that dominated psychological theory during this period. The idea that objects, forms, and shapes were "naturally" processed in similar ways by all members of the same species was anathema to many academic psychologists during the early part of this century. While these Gestalt concepts are now important parts of cognitive psychology, the influence of radical behaviorism, as expressed by John Watson and others, has been sharply reduced. Presently, cognitive psychologists are searching for universal laws and principles of how the mind perceives reality, stores infor-



4.24 Overlapping figures or three objects combined to make one: an illustration of *Prägnanz*.

mation, and reacts to environmental forces. Curiously, the perception of simple forms is now seen as an important link in the chain of knowledge, which—in its idealized form—is expressed in a unified theory of cognition. At present such megatheories are immature, but serious efforts are being made to develop them.

The Gestalt laws of perceptual organization were fertile ground in which the aspirations of modern cognitive psychologists could grow. Other psychologists, notably perceptual psychologists, suggested that other laws of perceptual organization, which are generally simpler, less subjective, and more demonstrable empirically, could better account for the perception of forms. There is little disagreement, however, that the patterns of perceptual organization discussed in this chapter are major factors in determining how objects are perceived. And, for the purpose of understanding the perception of art, I would propose that the comprehension of complex visual stimuli, such as those exhibited in art, begins by distinguishing salient featural components that are then recombined in the mind's eye. The aesthetic experience is greater than the sum of the parts, but it begins with parts.

*The droodle in figure 4.3 is either "Casper the Ghost watching TV" or "A view of a scrubwoman and her pail."