The Legacy of Gestalt Psychology

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The Legacy of Gestalt Psychology

Since its inception early in this century, Gestalt theory has made significant contributions to the study of perception, learning and social psychology. These contributions remain influential today

by Irvin Rock and Stephen Palmer

Like many important movements in science, Gestalt psychology was born of a revolt against the intellectual establishment of its time. Today several concepts that Gestalt theorists proposed early in this century have been incorporated into modern understanding of perception, learning and thought—indeed into our very language and culture. Many people have heard the phrase "the whole Gestalt" or have seen pictures that demonstrate Gestalt principles, such as the one that looks now like a vase, now like two profiles face to face. But few outside of academic psychology know what the movement was about or what has happened to the ideas on which it was based.

Gestalt psychology started in Germany, but after the rise of Nazism its founders—Max Wertheimer, Wolfgang Köhler and Kurt Koffka—moved to the U.S., where some of their students remain active. The Gestaltists contributed more to the study of perception than to other areas of psychology—*Gestalt* is German for "pattern" or "shape," although "configuration" comes closer to its intended meaning—but they also made important advances in education, learning, thinking and social psychology. Some of their ideas have not survived, but others continue to influence the work of modern psychologists.

IRVIN ROCK and STEPHEN PALMER, both at the University of California, Berkeley, collaborate on studies of visual perception. Despite their different backgrounds, they share an interest in many phenomena uncovered by Gestalt psychologists. Rock received his training at the New School for Social Research under students of the founding fathers of Gestalt, including Solomon Asch, Hans Wallach, Mary Henle and Martin Scheerer. He completed his Ph.D. there in 1952. Palmer was trained at the University of California, San Diego, in the more modern tradition of information processing, under the guidance of Donald Norman and David Rumelhart. His doctoral dissertation, completed in 1975, attempted to investigate Gestalt ideas in terms of information processing. Rock and Palmer are currently pursuing several research projects that extend and revise Gestalt theories of perceptual grouping and frame of reference.

Gestalt psychology was launched in 1912 when Wertheimer, then at the Institute of Psychology in Frankfurt am Main, published a paper on a visual illusion called apparent motion. Apparent motion is the perception of movement that results from viewing a rapid sequence of stationary images, as in the movies [*see illustration on page 86*]. This phenomenon indicated to Wertheimer that the perception of the whole (movement) was radically different from the perception of its components (static images).

The idea that the whole is different from the sum of its parts—the central tenet of Gestalt psychology—challenged the then prevailing theory of Structuralism. In particular, the Gestaltists rejected elementarism, a basic Structuralist assumption that complex perceptions could be understood by identifying the elementary parts of experience. Structuralists believed a trained observer could break down the fundamental elements of perception into primitive sensations, such as the points that make a square or the particular pitches in a melody. They maintained that a square was just the experience of a particular set of points stimulating the retina; a melody was just the experience of a sequence of distinct tones that became associated with one another in the listener's mind. Their view has been described as "mental chemistry" because it assumes that perceptions can be analyzed component by component, much as molecules can be broken down into atoms.

The Gestaltists attacked this theory. What people perceived, they held, is not merely a sum or sequence of sensations but the whole configuration of which they are part. The location or size of a square's image can be altered so that entirely different retinal sensations are produced, yet the perception is still that of a square. How else could people experience the same melody when it is transposed in key? All the corresponding pitches are now different, yet only a few musicians with perfect pitch would notice any change.

Gestalt theorists maintained that the parts of a square—or the tones of a melody—interact with one another and in so doing produce a perceived whole that is distinct from the sum of its parts. Shape and melody are examples of what they called emergent properties: overall qualities of an experience that are not inherent in its components. Emergent properties are not unique to mental phenomena, however. The properties of table salt, for instance, are very different from those of its constituents, sodium (a corrosive metal) and chlorine (a poisonous gas). Even the characteristics of a society are distinct from those of the individuals who compose it.

Emergent quality illustrates one meaning of the Gestalt concept of organization. The Gestaltists also believed organization was necessary to explain why human beings see the world as

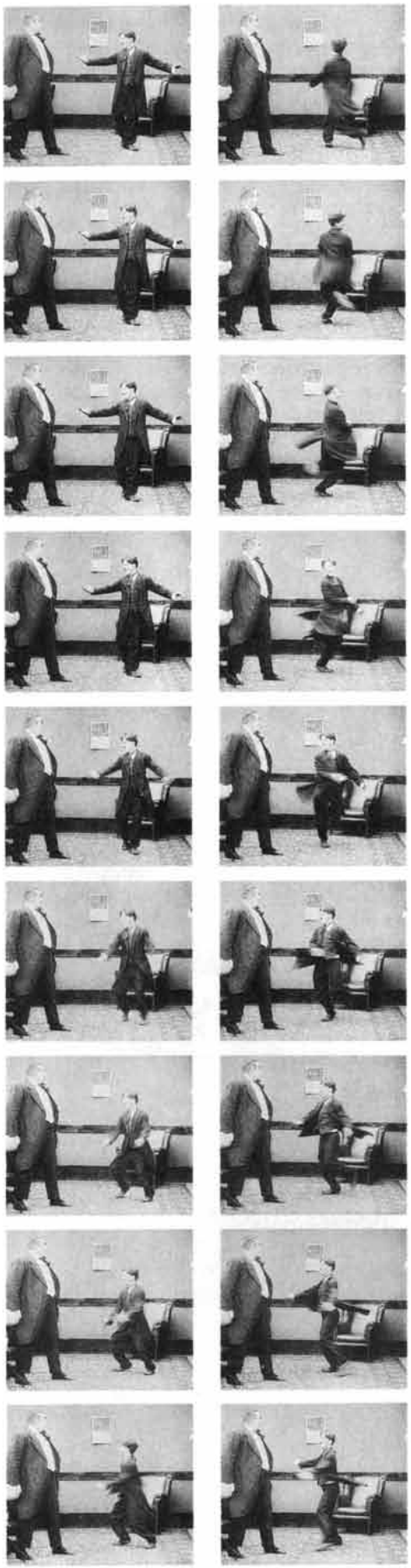
NATURAL CAMOUFLAGE shows how the laws of grouping, such as similarity, proximity and connectedness, can conceal animals. The ponies cannot easily be distinguished from the background.

composed of distinct objects. They pointed out that because the retinal image is nothing but an array of varying intensities and frequencies of light, the rays coming from different parts of the same object have no more affinity for one another than those coming from two different objects. It follows that the ability to perceive objects—such as stones, trees and houses—must be an organization achieved by the nervous system. The realization that the perception of separate objects was not achieved solely by the "picture" focused on the retina was one of the Gestaltists' most important contributions.

To explain how perceptions of individual objects are formed, Wertheimer proposed that the visual system organizes parts into wholes based on laws of grouping. Elements tend to be grouped perceptually if they are close together, similar to one another, form a closed contour or move in the same direction [*see illustration on page 89*]. Most often these laws lead to an accurate representation of the objects in a scene, but they can also lead to inaccurate ones, as in the case of camouflage.

Another important aspect of organization, called figure-ground perception, was discovered in 1921 by Danish psychologist Edgar Rubin. Rubin pointed out that even if all the parts of a connected region are grouped together properly, it can be interpreted either as an object (figure) or as the surface behind it (ground) [*see lower illustration on page 87*]. He formulated a set of laws that describe the conditions under which a region would tend to be seen as figure rather than as ground.

The Gestaltists further discovered that certain structures determine a frame of reference with respect to which other objects are perceived. Many people have reported experiencing an instance of this phenomenon, called induced motion, when a neighboring train slowly pulls out of the station, producing the impression that one's own train has begun to move in the opposite direction, although it is actually stationary. Another example of this phenomenon occurs when an observer is inside a tilted room. The walls of the room define the vertical and horizontal axes of the frame, causing a chandelier to look strangely askew and



MOVIE FRAMES of Charlie Chaplin illustrate how the illusion of apparent movement is created. The still frames give the impression of motion if they are viewed successively at rapid speed.

the observer's own body to feel tilted, despite the fact that both are perfectly aligned with gravity. In each case, the visual system takes a large, surrounding structure to define the perceptual standard—stillness or uprightness—and construes other objects, including one's self, in terms of these standards.

A final aspect of the Gestalt concept of organization deals with what they called the principle of *Prägnanz,* which states that when stimuli are ambiguous, the perception will be as "good" (meaning simple, regular and symmetric) as the "prevailing conditions" allow. The prevailing conditions refer to the information being registered by the retina. Obviously, the visual system does not convert any pattern into the simplest shape. An irregular triangle, for example, is not seen as a circle, because perception must account for the nature of the retinal image. But in cases where the image is ambiguous, such as a partly hidden figure [*see lower illustration on page 88*], the viewer tends to perceive the simplest shape consistent with the information available.

Gestalt theorists sought to understand these and other perceptual phenomena in physiologic terms. They posited a very direct connection between experience and physiology in their doctrine of isomorphism, which states that a subjective experience and its underlying neural event have similar structures. Wertheimer's analysis of apparent movement illustrates this idea. When two lights in nearby locations are turned on and off at the proper alternation rate, the observer sees a single light moving back and forth [see "The Illusion of Movement," by Paul A. Kolers; SCIENTIFIC AMERICAN, October, 1964]. Wertheimer argued that this perception was caused by electric energy in the brain flowing between the two locations stimulated by the lights—in other words, the physiological event had the same structure as the perception it gave rise to.

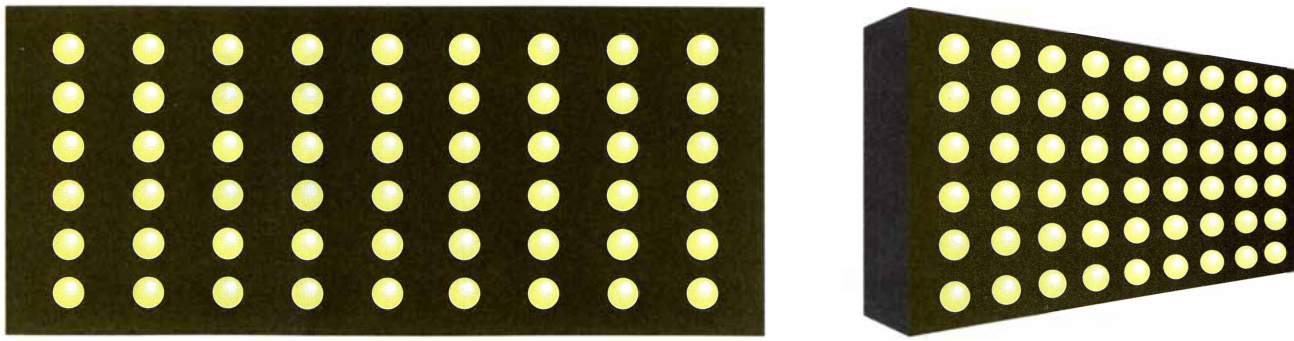
The flowing of electric energy in the brain did not refer to the transmission of electric signals along individual neurons, as dictated by the standard view of neurophysiology. Such a neuronal system did not seem capable of explaining the kind of interaction and organization Gestalt theorists had in mind, so they suggested that direct current flowed through brain tissue. They held that stimuli created electric fields in the brain that interacted with one another and converged toward a state of minimum energy. Köhler, who was well versed in the physics of the day, argued that the brain was only one example of many physical systems—which he called physical *Gestalten*—that evolve toward a state of equilibrium. Soap bubbles, for instance, start out in various shapes, but they always change over time into perfect spheres because that is the minimum energy state for a soap film.

Consistent with their doctrine of isomorphism, the Gestaltists believed that the convergence of electric brain fields toward a minimum energy state provided the mechanism for *Prägnanz:* perceptions were simplified when the underlying brain event reached a state of equilibrium.

Although Köhler's theory of electric brain fields is no longer taken seriously, many other ideas that emerged from Gestalt psychology continue to influence today's perception theorists. In some cases, Gestalt views have been extended and in others revised, but one cannot read a contemporary perception textbook without finding a wealth of ideas that originated with the Gestalt movement.

Wertheimer's laws of grouping have withstood the test of time. In fact, not one of them has been refuted, and no new ones have been added to his original list, until our own recent proposals. One of us (Palmer) suggested a law of enclosure, or common region, referring to an observer's tendency to group elements that are located within the same perceived region [*see illustration on page 89*]. The second law, connectedness, which we postulated jointly, may be the most fundamental principle of grouping yet uncovered. Connectedness refers to the powerful tendency of the visual system to perceive any uniform, connected region—such as a spot, line or more extended area—as a single unit. Connectedness is a particularly good candidate for a law of grouping because it is perhaps the most diagnostic property of objects in the environment. We suspect Wertheimer missed this important principle because he failed to realize that an explanation was required for why each element in his configurations was itself perceived as a single entity.

Although the validity of the laws of grouping has not been seriously challenged, the stage at which they operate in the visual system is being reassessed. The Gestalt position implic-



LATTICE OF GLOWING BEADS is organized vertically into columns (*left panel*). When it is tilted backward (*right panel*), observers still perceive columns even though the retinal images of the beads are now closer together horizontally.

itly assumes that grouping must occur early in visual processing. So when Wertheimer discussed principles such as proximity, he presumably referred to retinal proximity: how close the stimuli were to one another on the retina. It is possible, however, that these grouping principles operate later in visual processing, after depth and lighting conditions have been perceived.

To disentangle these two hypotheses, one of us (Rock) performed an experiment with Leonard Brosgole some years ago. Luminous beads were strung on parallel strings and suspended in the dark so that they appeared as a lattice of glowing dots. Because the beads were closer to one another vertically than horizontally, observers saw them as organized into columns [*see illustration above*]. We then tilted the display backward so that the retinal images of the beads were closer together horizontally, although the beads themselves of course remained closer vertically. When observers viewed this display, they continued to see the beads in columns, indicating that grouping was based on perceived proximity in three-dimensional space rather than on actual proximity on the retina. Grouping by proximity must therefore occur after depth perception. We have reached similar conclusions for the principles of common region and connectedness, as well as for similarity grouping by lightness.

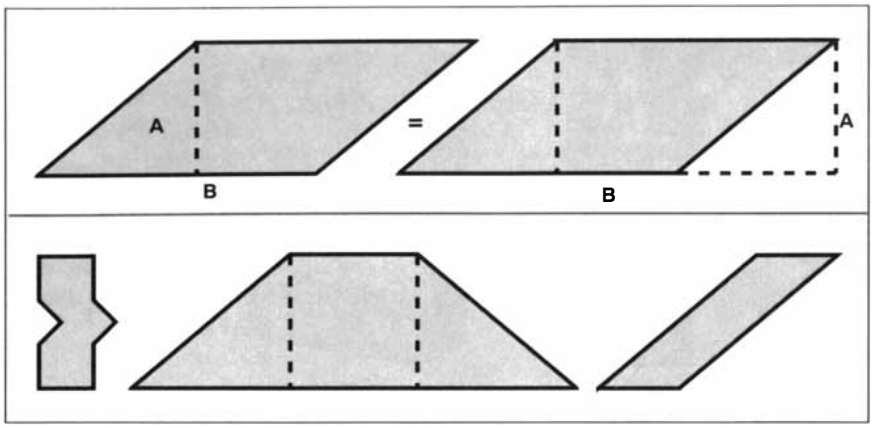
New experimental methods have further advanced the understanding of grouping and have also suggested links to the underlying physiology. Jacob Beck of the University of Oregon pioneered the study of texture segregation, a form of grouping elements by similarity when they are perceived as a pattern rather than as individual forms. In one experiment he presented observers with a field of three different types of elements side by side: L's (or reversed L's), T's and tilted T's [*see top illustration on page 90*]. The observers were to say at which boundary there was a more natural break in the pattern.

Beck found that the boundary between the upright and tilted T's was much more evident than the one between the L's and the T's. This reveals—somewhat surprisingly from the Gestalt point of view—that the orientation of the elements is a more powerful factor than their overall shape. These and related findings have forged theoretical connections between the separation of textures and the activity of cells in the visual cortex that respond strongly to differences in the orientation of component lines and edges [see "Brain Mechanisms of Vision," by David H. Hubel and Torsten N. Wiesel; SCIENTIFIC AMERICAN, September, 1979].

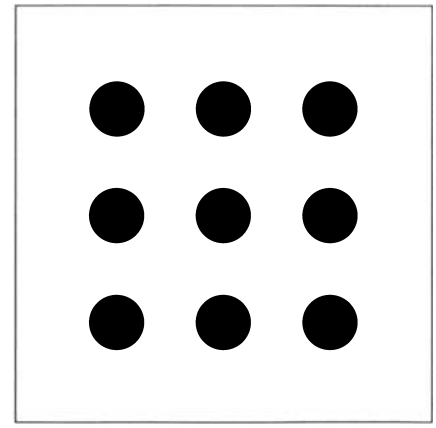
Other techniques have provided ways of testing the Gestalt idea that wholes are perceptually dominant. David Navon, now at the University of Haifa in Israel, performed a study to determine whether wholes are perceived before parts, or vice versa. Using large letters composed of small letters, he measured the time observers needed to identify the large (global) or small (local) letters [*see middle illustration on page 90*]. In some cases, the large and small letters were the same (consistent); in others, they were different (conflicting).

If whole figures are perceptually primary, as the Gestaltists held, global letters should be identified faster than local ones; if parts are primary, as others believe, the reverse should be true. Another prediction of the Gestalt view-

FIGURE-GROUND ORGANIZATION is fundamental to perception. Either side of the pattern on the left can be perceived as figure or as ground. Although the two shapes on the right share the same contour, they seem very different.



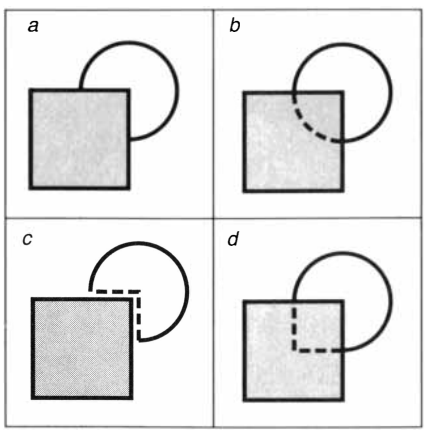
UNDERSTANDING that a parallelogram's area is equivalent to that of a rectangle's (*top panel*) makes finding the areas of other shapes (*bottom panel*) easier. Learning by understanding allows insights to be transferred to analogous situations.



CONNECT the dots by drawing four straight lines without lifting pencil from paper. (Solution on page 90, at bottom.)

point is that if the whole is perceived first, conflicting local letters should not affect the naming of the global ones, but conflicting letters at the global level should slow naming of the local ones. Again, part-to-whole theorists predict the opposite. Navon's results supported the Gestalt predictions on both counts. Later investigators have found these results to be less pervasive than Gestalt theory would suggest by showing that responses depend on factors like the absolute and relative size of the letters.

Another concept of Gestalt theory that is very much alive is the principle of *Prägnanz*—the idea that the visual system converges on the most regular and symmetric perception consistent with sensory information. The vague Gestalt notion of "goodness" has now been clarified. Emanuel Leeuwenberg and Hans Buffart, then at the University of Nijmegen, advanced a theory that specifies the amount of information in various perceptions—"good" ones contain little information, and "bad" ones contain a lot—and have predicted how people will perceive partly hidden figures, among other phenomena. Wendell R. Garner of Yale University has shown that good patterns can be matched more quickly, remembered better and described more succinctly than bad ones.



OBSCURED FIGURE illustrates the idea of *Prägnanz*. Given an ambiguous pattern (*a*), observers perceive simple shapes (*b*) instead of complex ones (*c, d*).

In contrast to their theories of perception, Gestaltists' ideas about electric fields in the brain have been resoundingly rejected by modern physiologists. Concepts similar to Köhler's notions about physical *Gestalten,* however, have resurfaced under the guise of neural networks. According to neural-network theorists, mental processes result from the dynamic behavior of many interconnected computing units, which can be thought of as neurons. Each unit's behavior can be characterized by its state of activation—much like a neuron's firing rate—and units affect one another by excitatory or inhibitory connections—much like synapses. The entire system is initially activated by an external stimulus that affects some subset of the units. Activation then propagates through the network until it reaches an equilibrium state of minimum energy [see "Collective Computation in Neuronlike Circuits," by David W. Tank and John J. Hopfield; SCIENTIFIC AMERICAN, December, 1987]. In short, these networks can be thought of as examples of physical *Gestalten.* Although this work is still in its infancy, neural-network models of perception promise to open a whole new chapter of Gestalt theory.

Beyond revolutionizing the study of perception, Gestalt theorists enriched the fields of learning, memory and thinking—with important implications for education—and social psychology. Early Gestalt ideas about thinking clashed with those of the emerging Behaviorist movement. A forerunner of that school, Edward L. Thorndike, concluded from his studies that animals solved problems by trial and error rather than by thought or understanding. In one now famous experiment, he placed a cat in a cage from which it could escape by pulling a hanging string that opened the door latch. In the process of thrashing about, the cat would inadvertently tug the string and be released. After many such trials, it would pull the string the moment it was returned to the cage. Thorndike concluded that the cat did not use intelligence but gradually developed an association.

Gestalt theorists vehemently denounced this kind of experiment and the conclusions drawn from it. They objected that the situation actually prevented any display of intelligence in problem solving because the cat could hardly be expected to understand the hidden mechanism that related tugging on the string to opening the door. In contrast, Köhler performed experiments with chimpanzees while he was isolated on the island of Tenerife during World War I in which both the requirements for a solution and the means to achieve it were perceptually evident. Köhler observed chimps discovering how to retrieve bananas from outside their cage with a stick.

These findings conflicted with Behaviorist dogma in at least two important ways. First, the chimps arrived at the solution suddenly, in a flash of "insight," rather than gradually. This was possible, Köhler argued, because the nature of the problem was perceptually apparent, unlike the string-latch mechanism. Second, the errors made by the

chimps were not random, as predicted by Behaviorist theory, but displayed intelligence and comprehension.

Although no one has explained how insight occurs, the Gestaltists did illuminate certain aspects of how understanding could be achieved. One way humans can do it, unlike animals, is by having something explained to them. Mere listening is not enough, of course, for the listener must achieve the same cognitive structure as the explainer in order to become aware of the essential connections among the relevant facts. Listeners do not have to go through the same creative process as did the original problem solver to arrive at the solution, but their final state of comprehension must be similar.

The educational implications of achieving insight through explanation cannot be overestimated. Not only is it satisfying to grasp the solution to a problem, but it is far less likely to be forgotten than rote memorization, and it can be readily transferred to related new problems. Wertheimer showed, for instance, that once children realize why the area of a parallelogram equals its base times its altitude [*see upper left illustration on opposite page*], they can find the areas of other geometric figures without having to memorize the formulas. Many modern educators critical of rote learning advocate teaching students to think creatively to achieve insight. Few realize that these "revolutionary" ideas about education originated with Gestalt psychologists.

Gestalt theorists also struggled to describe the creative process through which a person achieves original insight in everyday life. They proposed that problems have certain demands that are readily grasped, which lead people to attempt nonrandom solutions [see "Problem-Solving," by Martin Scheerer; SCIENTIFIC AMERICAN, April, 1963]. Becoming fixated on one hypothesis or one function of an object—often without realizing it [*see upper right illustration on opposite page*]—is the chief obstacle to insight. When people let go of implicit assumptions, their understanding of a problem is sometimes dramatically reorganized, enabling them suddenly to "see" the solution, complete with the accompanying "aha!" experience.

Modern researchers on human problem solving have not yet explained insight, but they have abandoned the Behaviorist idea of blind trial and error in favor of one more consistent with Gestalt ideas about the value of comprehension. One promising focus of recent research has been the use of analogies in problem solving: those who understand one topic can apply this knowledge elsewhere through analogy.

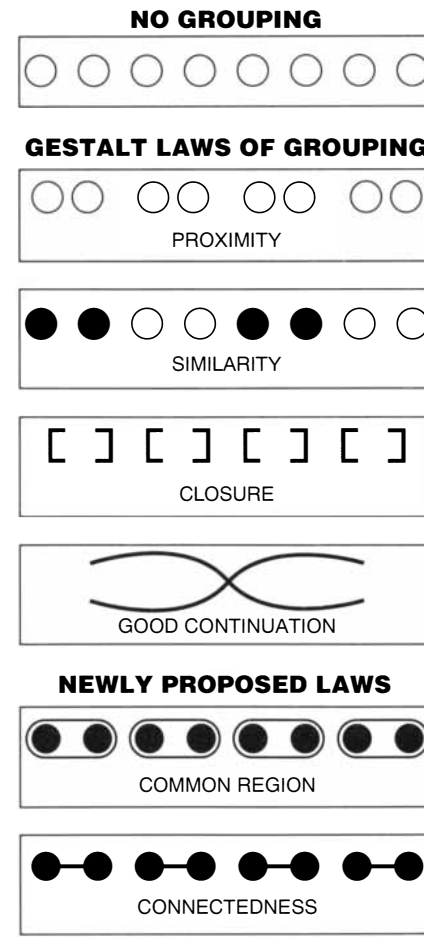
The Gestaltists made further inroads against the Behaviorist approach in the realm of social psychology. Beginning in the late 1930s, three investigators—Kurt Lewin, Fritz Heider and Solomon E. Asch—rejected the idea that social behavior could be explained solely as a response conditioned by societal rewards, such as approval or praise. Rather, they argued, people make sense of the behavior of others by attributing to them feelings, perception, goals, beliefs and intentions—a view known as attribution theory. As obvious as this idea sounds, it was a radical departure from the prevailing Behaviorist approach, which minimized or denied subjective states of mind. Attribution theory has since displaced Behaviorism as the dominant view in social psychology.

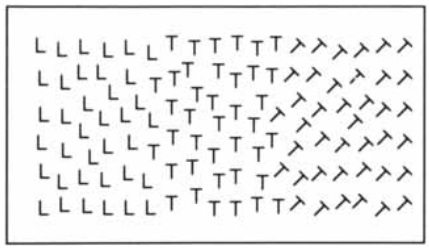
Few of Lewin's ideas have survived in contemporary psychology, but the work of Heider and Asch has had lasting influence. Heider applied Gestalt ideas about object perception to the perception of others. One cornerstone of his theory was the idea of attribution: that people try to account for one another's behavior in terms of deeper causal explanations, such as motives and intentions, using context and behavioral consistencies. Heider also developed the concept of balance: the idea that individuals prefer harmonious cognitive relations. For instance, if Jane likes person *X* and thinks *X* likes person *Y,* then the system of beliefs will be balanced if Jane also likes *Y*—and imbalanced if she does not. This idea echoes the principle of *Prägnanz:* the tendency to achieve the best or most basic organization.

Heider's seminal work on balance theory is related to the late Leon Festinger's theory of cognitive dissonance. Because Festinger believed people seek to reduce inconsistencies in their beliefs, feelings and behavior, he studied how people's choices affect their subsequent beliefs and attitudes. He reasoned that when a rejected alternative (say, a sporty but temperamental car) is in many ways more desirable than the chosen one (a staid but reliable car), the fact that it was not chosen will produce an inner state of disharmony—or dissonance, as Festinger called it—which produces pressure toward eliminating it. One way to reduce dissonance is to reevaluate the relative attractiveness of the alternatives, such as devaluing the unchosen one (sporty cars are too dangerous anyway), thereby enhancing the chosen one.

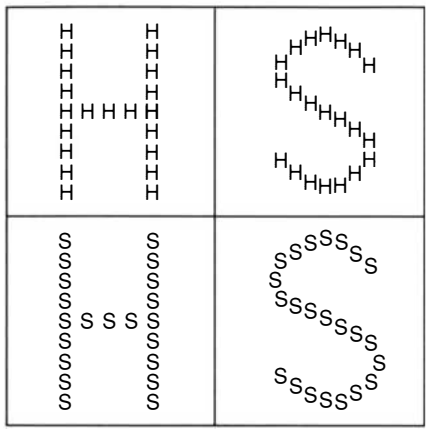
Asch, who worked with Wertheimer at the New School for Social Research, directly extended Gestalt theory to social psychology. He contended that attitudes are rooted in beliefs, that beliefs are rooted in information and that beliefs tend to be rational rather than molded by "suggestion," as early social psychologists thought. His emphasis on human rationality conflicted with the seeming irrationality of phenomena such as racial prejudice. Asch argued, however, that even prejudice can be understood as being reasonable and rooted in information, albeit misinformation. For example, if children depend on parents and other respected adults and have little reason to mistrust them, accepting adult opinions about an ethnic or racial group is a reasonable thing to do. Moreover, children get little if any information from other sources to contradict what they have been told by their parents.

Asch also challenged the Behaviorist assumption that beliefs and attitudes result from suggestions based on the prestige of the source. For instance, American college students were known to change their opinion of a statement depending on who they believed had made it. When told Thomas Jefferson

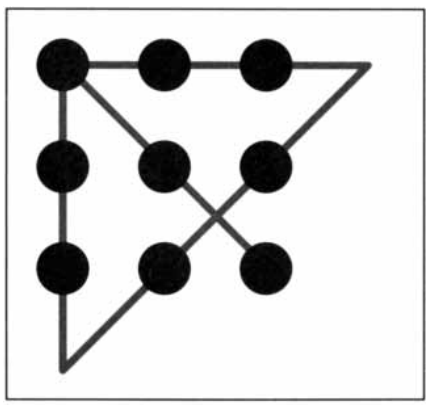




TEXTURE SEGREGATION is based on the dissimilarity of elements. The boundary between upright and tilted T's is clearer than between upright T's and L's.



GLOBAL PRECEDENCE allows larger letters to be recognized more rapidly than smaller ones, whether or not the latter are consistent. Identifying small letters, in contrast, takes longer when they conflict with the global letter.



DOTS can be connected by extending the lines beyond them. People assume incorrectly that they may not do this.

had said "a little rebellion, now and then, is a good thing, and as necessary in the political world as storms in the physical," they often strongly agreed. If the same statement was attributed to Lenin, their agreement with the statement diminished considerably.

These results superficially support the idea that the acceptability of the source strongly influences a person's opinions. But Asch believed there was a rational basis for such decisions. He proposed that people understood the statement differently depending on who was thought to have said it. Indeed, Asch found that students who attributed the statement to Lenin interpreted "rebellion" to mean the complete overthrow of the socioeconomic system. Those who attributed it to Jefferson usually had a less violent interpretation, such as moderate social or political reform [see "Opinions and Social Pressure," by Solomon E. Asch; SCIENTIFIC AMERICAN, November, 1955].

This aspect of Asch's work represents an extension of the Gestalt concept of part-whole contextual effects that was developed to explain perceptual phenomena. The part in this case was the statement, which had different meanings when embedded within the whole (all that one knows about the author, be he Jefferson or Lenin). The idea of the whole resulting from the organization of parts is illustrated by Asch's experiment on how people form impressions of personalities from lists of traits. Asch found that when people arrive at a unified impression of a person, certain traits are pivotal: substituting one for the other in a list of otherwise identical traits would entirely change the overall impression. Even the same trait will be perceived differently as a function of another trait. Thus, the meaning of being "determined" in a warm person is not quite the same as being "determined" in a cold person.

In some ways, the Gestalt movement, despite its acknowledged impact on several areas of psychology, has always been regarded rather skeptically by the scientific establishment. This opinion was certainly true in the 1920s and 1930s when the dominant theories were Structuralism and Behaviorism, schools that the Gestaltists attacked vehemently—and successfully. Yet such skepticism persists today for several reasons. First, Gestalt psychology sought to investigate subjective experience, as in perception, which Behaviorists rejected as an improper subject for scientific inquiry. Second, although Gestaltists did perform many well-controlled experiments, their best-known phenomena were often presented as straightforward demonstrations, such as the figures illustrating the laws of grouping. Third, their theories were usually expressed qualitatively and fell short of current standards of precision. Moreover, their views about brain function have been largely discredited by modern neurophysiologists. And last, but certainly not least, the theoretical approach they advocated seems to deny one of the most basic tenets of the scientific method—that wholes can be understood by reducing them to a set of parts.

These formidable obstacles to the acceptance of Gestalt ideas should be weighed against their considerable accomplishments. The list of major perceptual phenomena they elucidated—grouping, figure-ground organization, frames of reference, figural goodness and apparent motion, just to name the ones mentioned in this article—is impressive. Although it is logically possible that these discoveries could have been made independently of their methods and theoretical beliefs, it seems unlikely. The Gestalt attack against Structuralism was devastatingly effective.

In addition, the Gestaltists were victorious over the Behaviorists in their clash regarding the nature of learning, thinking and social psychology. Although behavioral methods are adhered to by modern psychologists, Behaviorist theory has been abandoned in favor of a cognitive approach more in line with Gestalt thinking. The theoretical problems they raised about perceptual organization, insight, learning and human rationality remain among the deepest and most complex in psychology.

Even though Gestalt ideas about electric brain fields were erroneous, the more general proposal that the brain is a dynamic system converging toward equilibrium in an energy function—physical *Gestalten* in Köhler's terminology—may turn out to be correct. The remarkable surge of interest in neural-network models attests to the fact that Gestalt theories are very much alive today and that their place in psychological history is assured.

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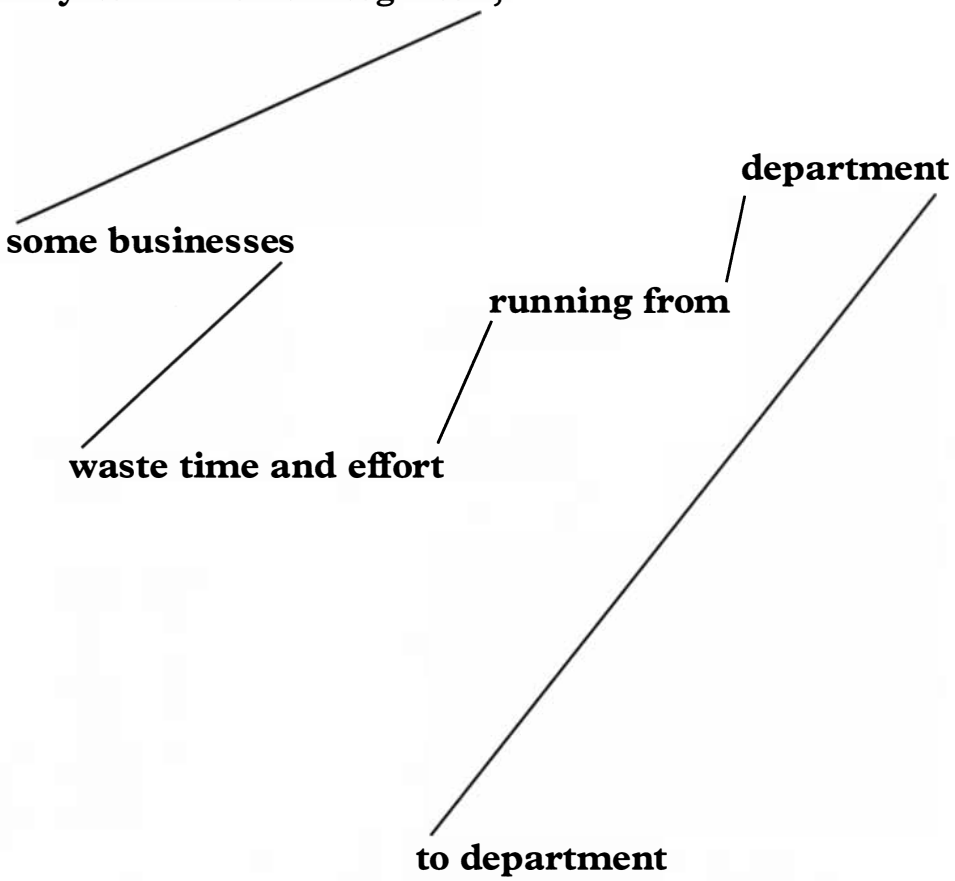
When their systems aren't integrated,



until finally they learn to integrate their systems the Intelligent way.

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