How the Blind Draw

Blind and sighted people use many of the same devices in sketching their surroundings, suggesting that vision and touch are closely linked

by John M. Kennedy

ABRAHAM MENASHE

BLIND ARTISTS, such as Tracy (*above*), rely on their sense of touch to render familiar objects. Tracy lost all sight to retinal cancer at the age of two, but by feeling the glass, she determines its shape. By rubbing the paper, placed on a piece of felt, she knows where her pen has scored the page and left a mark. Because the lines in most simple drawings reveal surface edges—features that are discerned by touching as readily as they are by sight—drawings by the blind are easily recognized by sighted people.

I first met Betty, a blind teenager in Toronto, as I was interviewing participants for an upcoming study of mine on touch perception in 1973. Betty had lost her sight at age two, when she was too young to have learned how to draw. So I was astonished when she told me that she liked to draw profiles of her family members. Before I began working with the blind, I had always thought of pictures as copies of the visible world. After all, we do not draw sounds, tastes or smells; we draw what we see. Thus, I had assumed that blind people would have little interest or talent in creating images. But as Betty's comments revealed that day, I was very wrong. Relying on her imagination and sense of touch, Betty enjoyed tracing out the distinctive shape of an individual's face on paper.

I was so intrigued by Betty's ability that I wanted to find out if other blind people could readily make useful illustrations—and if these drawings would be anything like the pictures sighted individuals use. In addition, I hoped to discover whether the blind could interpret the symbols commonly used by sighted people. To bring the blind into the flat, graphical world of the sighted, I turned to a number of tools, including models, wire displays and, most often, raised-line drawing kits, made available by the Swedish Organization for the Blind. These kits are basically stiff boards covered with a layer of rubber and a thin plastic sheet. The pressure from any ballpoint pen produces a raised line on the plastic sheet.

Thanks to this equipment, my colleagues and I have made some remarkable findings over the past 20 years, and this information has revised our understanding of sensory perception. Most significantly, we have learned that blind and sighted people share a form of pictorial shorthand. That is, they adopt many of the same devices in sketching their surroundings: for example, both groups use lines to represent the edges of surfaces. Both employ foreshortened shapes and converging lines to convey depth. Both typically portray scenes from a single vantage point. Both render extended or irregular lines to connote motion. And both use shapes that are symbolic, though not always visually correct, such as a heart or a star, to relay abstract messages. In sum, our work shows that even very basic pictures reflect far more than meets the eye.

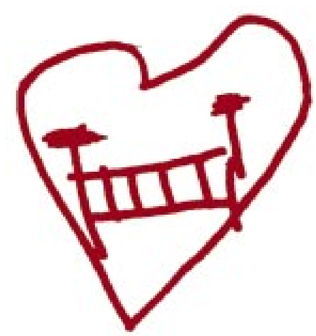
Outlines

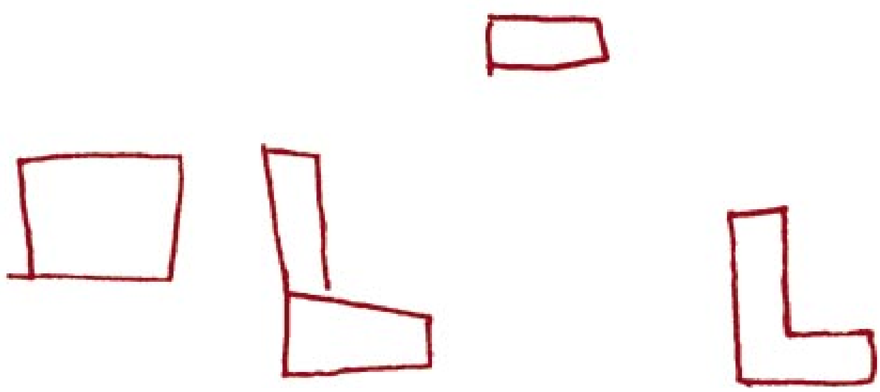
After meeting Betty, I wondered whether all blind people could appreciate facial profiles shown in outline. Over the years, I asked blind volunteers in North America and Europe to draw profiles of several kinds of objects. Most recently, I undertook a series of studies with Yvonne Eriksson of Linköping University and the Swedish Library of Talking Books and Braille. In 1993 we tested nine adults from Stockholm—three men and six women. Four were congenitally blind, three had lost their sight after the age of three, and two had minimal vision. Each subject examined four raised profiles, which Hans-Joergen Andersen, an undergraduate psychology student at Aarhus University in Denmark, made by gluing thin, plastic-coated wires to a flat metal board [*see upper illustration on next page*].

Eriksson and I asked the volunteers to describe the most prominent feature on each display using one of four labels: smile, curly hair, beard or large nose. Five of them—including one man who had been totally blind since birth—correctly identified all four pictures. Only one participant recognized none. On average, the group labeled 2.8 of the four outlines accurately. In comparison, when 18 sighted undergraduates in Toronto were blindfolded and given the same raised-line profiles, they scored only slightly better, matching up a mean of 3.1 out of four displays.

Many investigators in the U.S., Japan, Norway, Sweden, Spain and the U.K. have reported similar results, leaving little doubt that blind people can recognize the outline shape of familiar objects. At first, it may seem odd that even those who have never had any vision whatsoever possess some intuitive sense of how faces and other objects appear. But with further thought, the finding makes perfect sense. The lines in most simple drawings show one of two things: where two surfaces overlap, called an occluding edge, or where two surfaces meet in a corner. Neither feature need be seen to be perceived. Both can be discerned by touching.

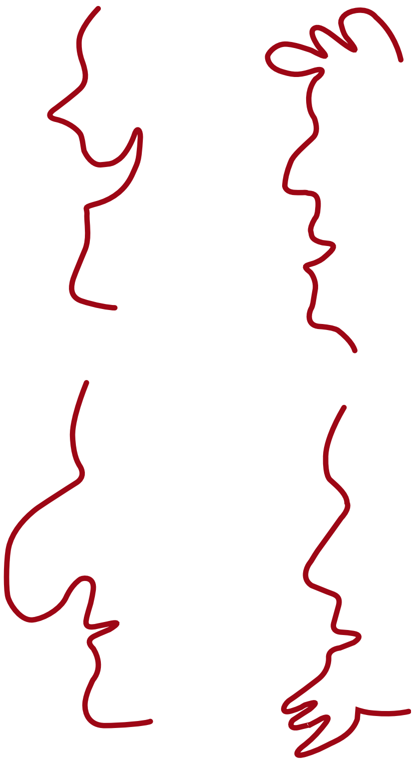
Not all blind people read raised-line drawings equally well, and these individual discrepancies can reflect the age at which someone lost his or her sight.





OUTLINE DRAWINGS, made by Kathy, totally blind since age three, demonstrate that blind artists use many of the same devices as sighted illustrators do. They use lines to represent surfaces, as Kathy's picture of the eagle on her charm bracelet shows (*top*). Blind people portray objects, such as a house, from a single vantage point (*at right*). Blind artists use shapes to convey abstract messages: Kathy drew a heart surrounding a crib to describe the love surrounding a child (*at right*). And they use foreshortening to suggest perspective: Kathy drew the L-shaped block and the cube to be the same size when they were side by side but made the cube smaller when it was placed farther away from her (*bottom*).

DRAWINGS COURTESY OF JOHN M. KENNEDY



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PROFILES, made from plastic-coated wires mounted on a thin metal board, were given to nine blind subjects in Stockholm. The subjects were asked to describe each display using one of four labels: smile, curly hair, beard or large nose. On average, the group described 2.8 of the four displays accurately, showing that blind people often recognize the outline of simple objects. Blindfolded, sighted control subjects given the same task did only slightly better.

For example, people who have been blind from birth or infancy—termed the early blind—sometimes find raised-line drawings challenging. But in 1993 Yatuka Shimizu of Tsukuba College of Technology in Japan, with colleagues Shinya Saida and Hiroshi Shimura, found that 60 percent of the early-blind subjects they studied could recognize the outline of common objects, such as a fish or a bottle. Recognition rates were somewhat higher for sighted, blindfolded subjects, who are more familiar with pictures in general.

Interestingly, subjects who lose vision later in life—called the later blind—frequently interpret raised outlines more readily than either sighted or early-blind individuals do, according to Morton Heller of Winston-Salem University. One likely explanation is that the later blind have a double advantage in these tasks: they are typically more familiar with pictures than are the early blind, and they have much better tactile skills than do the sighted.

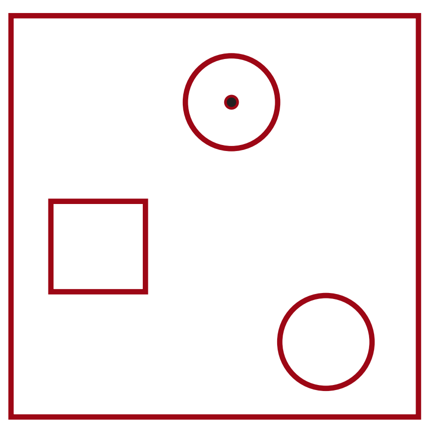
Perspective

Just as Betty prompted me to study whether the blind appreciate profiles in outline, another amateur artist, Kathy from Ottawa, led me to investigate a different question. Kathy first participated in my studies when she was 30 years old. Because of retinal cancer detected during her first year of life, Kathy had been totally blind since age three and had never had detailed vision. Even so, she was quite good at making raised-line drawings. On one occasion Kathy sketched several different arrangements of a cube and an L-shaped block that I used to test how relative distances appear in line art. When the blocks sat side by side, she made them the same size—as they were in actuality. But when the cube was farther from her than the other block, she made it smaller in her drawing.

This second drawing revealed a fundamental principle of perspective—namely, that as an object becomes more distant, it subtends a smaller angle. (Think about viewing a picket fence at an angle and how its posts appear shorter closer to the horizon.) Kathy's use of this basic rule suggested that some aspects of perspective might be readily understood by the blind. Again the proposition seemed reasonable, given some consideration. Just as we see objects from a particular vantage point, so, too, do we reach out for them from a certain spot. For proof of the theory, I designed a study with Paul Gabias of Okanagan University College in British Columbia, who was then at New York University.

We prepared five raised-line drawings: one of a table and four of a cube [*see upper illustration on opposite page*]. We showed the drawings to 24 congenitally blind volunteers and asked them a series of questions. The table drawing had a central square and four legs, one protruding from each corner. The subjects were told that a blind person had drawn the table and had explained, "I've drawn it this way to show that it is symmetrical on all four sides." They were then told that another blind person had drawn an identical table but had offered a different explanation: "I've shown it from underneath in order to show the shape of the top and all four legs. If you show the table from above or from the side, you can't really show the top and all four legs, too."

Next we asked our volunteers to pick out the cube drawing that had most likely been made by the person who drew the table from below. To answer consistently, they needed to understand what strategy had been used in drawing the table and each cube. One cube resembled a foldout of a box, showing the front face of the cube in the middle, surrounded by its top, bottom, left and right faces. Another drawing showed



SOLIDS—a sphere, a cone and a cube—arranged on a table are commonly used to test spatial ability. The arrangement is shown from overhead at the far right. Which drawing at the near right shows the solids from the edge of the table facing the bottom of the page? Which drawing shows them from the opposite edge? From the edge facing left? Facing right? Blind and sighted individuals do equally well on this task, proving that the blind can determine how objects appear from particular vantage points.

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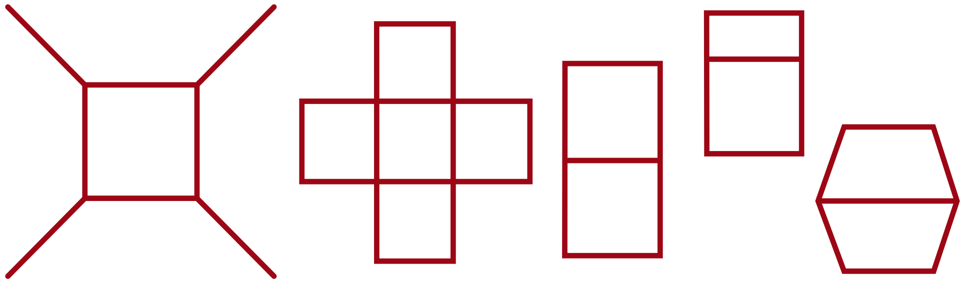

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PERSPECTIVE is readily understood by the blind. To prove this point, the author and Paul Gabias of Okanagan University College asked 24 congenitally blind volunteers to examine a drawing of a table (*far left*) and four drawings of a cube. They were told that one blind person drew the table in a star shape to show how it appeared from underneath and that another blind person drew an identical table, intending to show its symmetry instead. The subjects were then asked which cube was most likely drawn by the person who drew the table from underneath. Most chose the cube composed of two trapeziums (*far right*), the one that made the most sophisticated use of perspective.

two squares, representing the front and top of the cube. A third picture depicted the front of the cube as a square and the top as a rectangle—foreshortened because it was receding away from the observer. A fourth illustrated two trapeziums joined along the longest line; the extra length of this line revealed that it was the edge nearest to the observer.

Which cube do you think was drawn by the person who intended to show the table from below? Most of the blind volunteers chose the drawing that showed two trapeziums. That is, they selected the illustration that made the most sophisticated use of perspective. Accordingly, they picked as the least likely match the flat "foldout" drawing—the one that used no perspective whatsoever. The foldout drawing was also the one they judged most likely to have been made by the person who, in drawing the table, had hoped to highlight its symmetry.

Heller and I joined forces to prepare another task for demonstrating that the blind understood the use of perspective. (You might like to try it, too; it appears at the bottom of the opposite page.) We arranged three solids—a sphere, a cone and a cube—on a rectangular tabletop. Our blind subjects sat on one side. We asked them to draw the objects from where they were sitting and then to imagine four different views: from the other three sides of the table and from directly above as well. (Swiss child psychologist Jean Piaget called this exercise the perspective-taking, or "three mountains," task.) Many adults and children find this problem quite difficult. On average, however, our blind subjects performed as well as sighted control subjects, drawing 3.4 of the five images correctly.

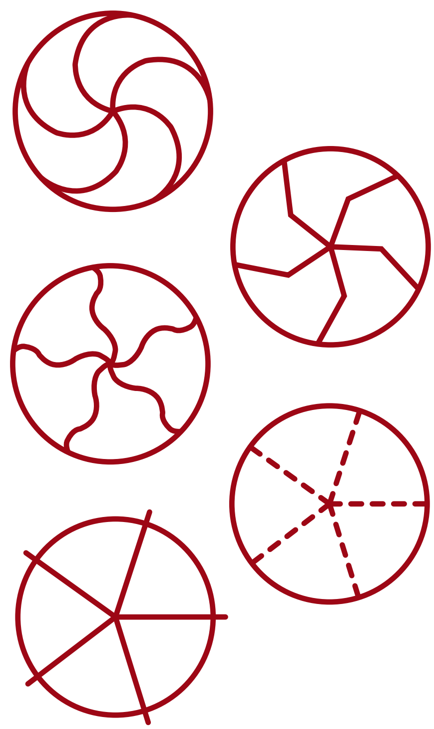
Next, we asked our subjects to name the vantage point used in five separate drawings of the three objects. We presented the drawings to them twice, in random order, so that the highest possible score was 10 correct. Of that total, the blind subjects named an average of 6.7 correctly. Sighted subjects scored only a little higher, giving 7.5 correct answers on average. The nine later-blind subjects in the study fared slightly better than the congenitally blind and the sighted, scoring 4.2 on the drawing task and 8.3 on the recognition task. Again, the later blind probably scored so well because they have a familiarity with pictures and enhanced tactile skills.

Metaphor

From the studies described above, it is clear that blind people can appreciate the use of outlines and perspective to describe the arrangement of objects and other surfaces in space. But pictures are more than literal representations. This fact was drawn to my attention dramatically when a blind woman in one of my investigations decided on her own initiative to draw a wheel as it was spinning. To show this motion, she traced a curve inside the circle. I was taken aback. Lines of motion, such as the one she used, are a very recent invention in the history of illustration. Indeed, as art scholar David Kunzle notes, Wilhelm Busch, a trendsetting 19th-century cartoonist, used virtually no motion lines in his popular figures until about 1877.

When I asked several other blind study subjects to draw a spinning wheel, one particularly clever rendition appeared repeatedly: several subjects showed the wheel's spokes as curved lines. When asked about these curves, they all described them as metaphorical ways of suggesting motion. Majority rule would argue that this device somehow indicated motion very well. But was it a better indicator than, say, broken or wavy lines—or any other kind of line, for that matter? The answer was not clear. So I decided to test whether various lines of motion were apt ways of showing movement or if they were merely idiosyncratic marks. Moreover, I wanted to discover whether there were differences in how the blind and the sighted interpreted lines of motion.

To search out these answers, Gabias and I created raised-line drawings of five different wheels, depicting spokes



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MOTION can be suggested by irregular lines. When blind and sighted volunteers were shown five diagrams of moving wheels (*right*), they generally interpreted them in the same way. Most guessed that the curved spokes indicated that the wheel was spinning steadily; the wavy spokes, they thought, suggested that the wheel was wobbling; and the bent spokes were taken as a sign that the wheel was jerking. Subjects assumed that spokes extending beyond the wheel's perimeter signified that the wheel had its brakes on and that dashed spokes indicated that the wheel was spinning quickly.

WORDS ASSOCIATED WITH CIRCLE-SQUARE	AGREEMENT AMONG SUBJECTS (PERCENT)
SOFT-HARD	100
MOTHER-FATHER	94
HAPPY-SAD	94
GOOD-EVIL	89
LOVE-HATE	89
ALIVE-DEAD	87
BRIGHT-DARK	87
LIGHT-HEAVY	85
WARM-COLD	81
SUMMER-WINTER	81
WEAK-STRONG	79
FAST-SLOW	79
CAT-DOG	74
SPRING-FALL	74
QUIET-LOUD	62
WALKING-STANDING	62
ODD-EVEN	57
FAR-NEAR	53
PLANT-ANIMAL	53
DEEP-SHALLOW	51

WORD PAIRS were used to test the symbolism in abstract shapes—and whether blind and sighted people perceived such meanings in the same way. Subjects were told that in each pair of words, one fit best with circle and the other with square. For example, which shape better describes soft? According to the number given after the soft-hard word pair, everyone thought a circle did. These percentages show the level of consensus among sighted subjects. Blind volunteers made similar choices.

with lines that curved, bent, waved, dashed and extended beyond the perimeter of the wheel. We then asked 18 blind volunteers to assign one of the following motions to each wheel: wobbling, spinning fast, spinning steadily, jerking or braking. Which wheel do you think fits with each motion? Our control group consisted of 18 sighted undergraduates from the University of Toronto.

All but one of the blind subjects assigned distinctive motions to each wheel. In addition, the favored description for the sighted was the favored description for the blind in every instance. What is more, the consensus among the sighted was barely higher than that among the blind. Because motion devices are unfamiliar to the blind, the task we gave them involved some problem solving. Evidently, however, the blind not only figured out meanings for each line of motion, but as a group they generally came up with the same meaning—at least as frequently as did sighted subjects.

We have found that the blind understand other kinds of visual metaphors as well. Kathy once drew a child's crib inside a heart—choosing that symbol, she said, to show that love surrounded the child. With Chang Hong Liu, a doctoral student from China, I have begun exploring how well blind people understand the symbolism behind shapes such as hearts, which do not directly represent their meaning. We gave a list of 20 pairs of words to sighted subjects and asked them to pick from each pair the term that best related to a circle and the term that best related to a square. (If you wish to try this yourself, the list of words can be found at the left.) For example, we asked: What goes with soft? A circle or a square? Which shape goes with hard?

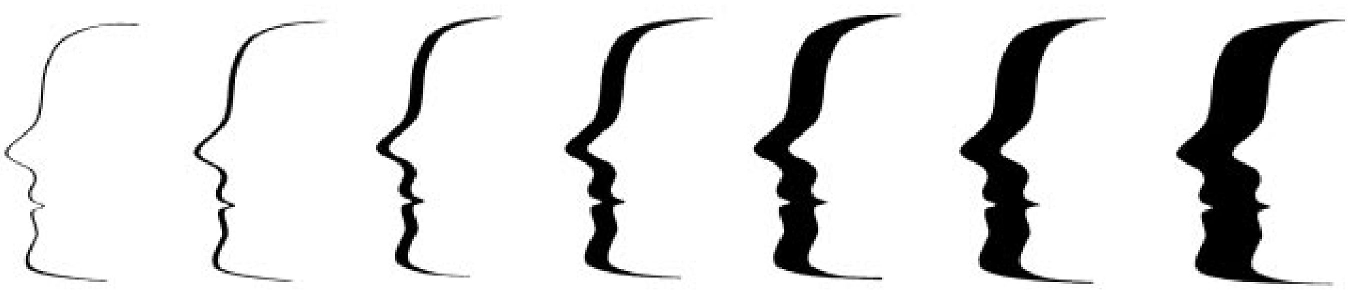
All our subjects deemed the circle soft and the square hard. A full 94 percent ascribed happy to the circle, instead of sad. But other pairs revealed less agreement: 79 percent matched fast and slow to circle and square, respectively. And only 51 percent linked deep to circle and shallow to square. When we tested four totally blind volunteers using the same list, we found that their choices closely resembled those made by the sighted subjects. One man, who had been blind since birth, scored extremely well. He made only one match differing from the consensus, assigning "far" to square and "near" to circle. In fact, only a small majority of sighted subjects—53 percent—had paired far and near to the opposite partners. Thus, we concluded that the blind interpret abstract shapes as sighted people do.

Perception

We typically think of sight as the perceptual system by which shapes and surfaces speak to the mind. But as the empirical evidence discussed above demonstrates, touch can relay much of the same information. In some ways, this finding is not so surprising. When we see something, we know more or less how it will feel to the touch, and vice versa. Even so, touch and sight are two very different senses: one receives input in the form of pressure, and one responds to changes in light. How is it that they can then interpret something as simple as a line in exactly the same way? To answer this question, we must consider what kind of information it is that outlines impart to our senses.

The most obvious theory is that each border in a basic drawing represents one physical boundary around some surface or shape. But it is not that simple, because all lines, no matter how thin, have two sides or contours—an inside and an outside border, if you will. As a result, thick lines are perceived quite differently from thin ones. Consider a thick line tracing a profile. If it is thick enough, it appears to show two profiles, one per edge, gazing in the same direction [*see illustration below*]. When the line is thin and its two borders are close together, though, an observer perceives only one

THICKNESS of these outlines determines whether their two contours are viewed as one profile or two. The same ambiguity occurs with touch. Blind subjects interpret raised edges placed near each other as a single surface boundary and those placed farther apart as two.



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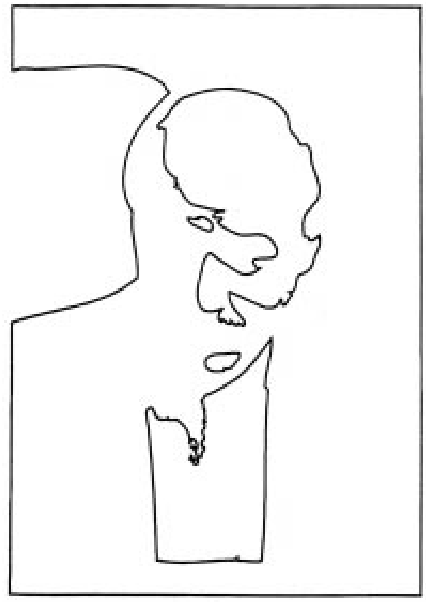
face. As it turns out, touch produces a similar effect. I prepared a series of profile drawings in which both edges of the defining line were raised. When the edges were only 0.1 centimeter apart, my blind volunteer, Sanne, a student at Aarhus University, said they showed one face. When they were 0.8 centimeter apart, she reported that they showed two faces.

Another theory of outline drawings suggests that lines substitute for any perceptible boundary, including those that are not tangible, such as shadows. But this theory, too, fails in a very telling fashion. Look at the illustration at the right, which shows two pictures of the author. In one image, shadow patterns, defined by a single contour separating light and dark areas, cross my face. In the second image, a dark line having two contours traces the same shadow patterns. Despite the fact that the shapes in the second picture are identical to those in the first, the perceptual results are vividly different. The first is easily recognized as a face; the second is not.

Again, this example shows that our visual system, like our tactile system, does not read two contours of a line in the same way as it interprets a single contour. The implication is that the brain region responsible for interpreting contours in sensory input from busy environments is a general surface-perception system. As such, it does not discriminate on the basis of purely visual matters, such as brightness and color. Rather it takes the two contours of a dark line and treats them as indicators for the location of a single edge of some surface. Whereas sighted individuals treat brightness borders as indicators of surface edges, the blind treat pressure borders in the same way.



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SHADOWS, and other intangible boundaries, are not recognizable in outline—explaining in part why the blind can understand most line drawings made by sighted people. In the picture of the author on the left, a single contour separates light and dark areas of his face. In the picture on the right, a line, having two contours, makes the same division. Note that although the shapes are identical in both images, the perceptual results are quite different. Only the image on the left clearly resembles a face.

Because the principles at work here are not just visual, the brain region that performs them could be called multimodal or, as it is more commonly termed, amodal. In one account, which I have discussed in my book on drawings by the blind, such an amodal system receives input from both vision and touch. The system considers the input as information about such features as occlusion, foreground and background, flat and curved surfaces, and vantage points. In the case of the sighted, visual and tactile signals are coordinated by this amodal system.

As we have found, the ability to interpret surface edges functions even when it does not receive any visual signals. It is for this very reason that the blind so readily appreciate line drawings and other graphic symbols. Knowing this fact should encourage scholars and educators to prepare materials for the blind that make vital use of pictures. Several groups around the world are doing just that. For instance, Art Education for the Blind, an organization associated with the Whitney Museum of American Art and the Museum of Modern Art in New York City, has prepared raised-line versions of Henri Matisse paintings and of cave art. It may not be long before raised pictures for the blind are as well known as Braille texts. SA

The Author

JOHN M. KENNEDY was born in Belfast in 1942 and was raised in one of the few Unitarian families in Northern Ireland. He attended the Royal Belfast Academical Institution and Queen's University of Belfast, where his interests included fencing and theater. He completed his Ph.D. in perception at Cornell University and began his research with the blind shortly thereafter as an assistant professor at Harvard University. He currently lectures at the University of Toronto, Scarborough College, where he won his college's teaching prize in 1994. Notes from his courses on perception are available through the university's World Wide Web site at http://citd.scar.utoronto.ca/Psychology/PSYC54/PSYC54.html

Further Reading

PICTURE AND PATTERN PERCEPTION IN THE SIGHTED AND THE BLIND: THE ADVANTAGE OF THE LATE BLIND. M. A. Heller in *Perception,* Vol. 18, No. 3, pages 379–389; 1989.

DRAWING AND THE BLIND: PICTURES TO TOUCH. J. M. Kennedy. Yale University Press, 1993.

PROFILES AND ORIENTATION OF TACTILE PICTURES. J. M. Kennedy and Y. Eriksson. Paper presented at the meeting of the European Psychology Society, Tampere, July 2–5, 1993.

SYMBOLIC FORMS AND COGNITION. C. H. Liu and J. M. Kennedy in *Psyke & Logos,* Vol. 14, No. 2, pages 441–456; 1993.

TACTILE PATTERN RECOGNITION BY GRAPHIC DISPLAY: IMPORTANCE OF 3-D INFORMATION FOR HAPTIC PERCEPTION OF FAMILIAR OBJECTS. Y. Shimizu, S. Saida and H. Shimura in *Perception and Psychophysics,* Vol. 53, No. 1, pages 43–48; January 1993.

