DOCUMENT RESUME

ED 259 539 EC 180 275

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TITLE	What Can We Learn about Pictures from the Blind?.
PUB DATE	83
NOTE	9p.
PUB TYPE	Journal Articles (080) -- Inform tion Analyses (070) -- Viewpoints (120)
JOURNAL CIT	American Scientist; v71 p19-26 Jan-Feb 1983
ELRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Blindness; Communications; Elementary Secondary Education; *Freehand Drawing; *Tactile Adaptation; Tactual Perception

ABSTRACT

A series of studies on tangible pictures and their application to blind persons are reviewed and possible explanations for the suggestion of depth offered by outline drawings are discussed. Findings from ancient cave and rock art, together with drawings made by blind children and adults suggest that outline drawings contain some elements that are universal, independent of culture and of the faculty of vision. Illustrations of some of the blind individuals' drawings demonstrate marked similarities to the development of drawing in sighted children. Studies featuring recognition of tactile pictures and devices used to depict movement and abstract concepts are reviewed. Conclusions center on the blind individual's innate pictorial abilities and the usefulness of encouraging blind persons to experience others' pictures and make their own as well. (CL)

John M. Kennedy

What Can We Learn about Pictures from the Blind?

Blind people unfamiliar with pictures can draw in a universally recognizable outline style

Outline pictures represent objects and ideas by employing lines in many different kinds of configurations, and by communicating metaphorically as well as literally. In the last decade, studies of ancient cave and rock art, of a contemporary society devoid of pictures, and of drawings made by blind children and adults have suggested that outline drawings contain some elements that are universal, independent of culture and of the faculty of vision.

The studies contribute to our understanding of tactile perception, the perception of shape by the blind, and the general human capacity to use pictures; further, they have a practical value. Just as Braille's work made literature available to touch, research on tangible pictures has the potential to make the world of pictures useful to the blind.

As with most research, this had a modest beginning, in the form of a question. Gibson (1966, 1979) points out that all visible objects are composed of a small set of features that create a pattern in the light coming to our eyes. These features are flat and curved surfaces and their boundaries, shadow, highlight, and color markings on a surface. Outline sketches concentrate on only a few of the features that pattern light: the ones created by the boundaries of surfaces. The other features—which we may collectively call chiaroscuro—are omitted. Why, I wondered.

The difference between surface boundaries and chiaroscuro features is readily apparent in a comparison between Figure 1 and Figures 2 and 3. In Figure 1 are lines showing edges that occlude the background, and lines showing the rounded occluding boundaries of hills whose visible fronts curve around to invisible backs. Other lines simply show a change of slant at corners, which may be either concave, enfolding the observer like the corner of a room, or convex, protruding toward the observer like the corner of a building.

An artist might try to draw shadow, highlight, color markings, and even texture boundaries in outline drawings, but the results would have very instructive limits. A drawing showing color change on a flat surface might portray, for example, the half-moons on fingernails (as in Fig. 2), the colors on flags, or the color patches in the plumage of a bird. No matter how familiar the object is to the viewer, when it is shown in outline some of the lines will actually *depict* and some will only *suggest* their referent. Lines that stand for changes in depth and slant depict their referent, in the sense that the depth and slant are *seen*. In a drawing of a wire cube, for instance, effects of depth and slant draw attention to themselves, refusing to remain stable and often reversing in orientation.

By contrast, in Figure 3—a drawing of a parrot—color patches are only suggested, not seen. Even when we draw a well-known flag, the outline drawing may seem to wave in depth, but will not wave in the familiar colors.

Why is a line drawing capable of showing change of depth but not change of color or shade? One's first impulse may be to say that there are no differences of color or brightness on either side of a line. But there are no differences of depth or slant either, and yet these features are able to appear in our perception of outline sketches.

A second possible explanation would be that there is information for depth but no information for chiaroscuro in the outline sketch; however, this account, too, is inadequate. Information is present whenever a light pattern is specific to its origin, and the natural and artificial examples of colored patterns mentioned above are all specific. As another instance, it is perfectly easy to draw a recognizable shadow in an outline drawing. The information is there, but the perceptual darkening is not, unless we actually shade the drawing. Furthermore, since we can see depth around the edges of very simple line forms, even ones that are ambiguous and reversible in terms of depth, lines must be able to stand for depth in the absence of any specifying information. Thus this explanation fails on two counts.

A third explanation holds that as adults we have long been familiar with line drawings showing depth, whereas we have seen few line drawings that show shadows, color markings, and so on. But which came first? Does our ability to see depth in flat outline drawings emerge from familiarity, or is it because of a preexisting ability to interpret depth from flat lines that we make outline drawings? Developmental psychology and cross-cultural evidence are needed to settle the question.

The familiarity theory holds that any feature of the environment that creates divisions in light, giving rise

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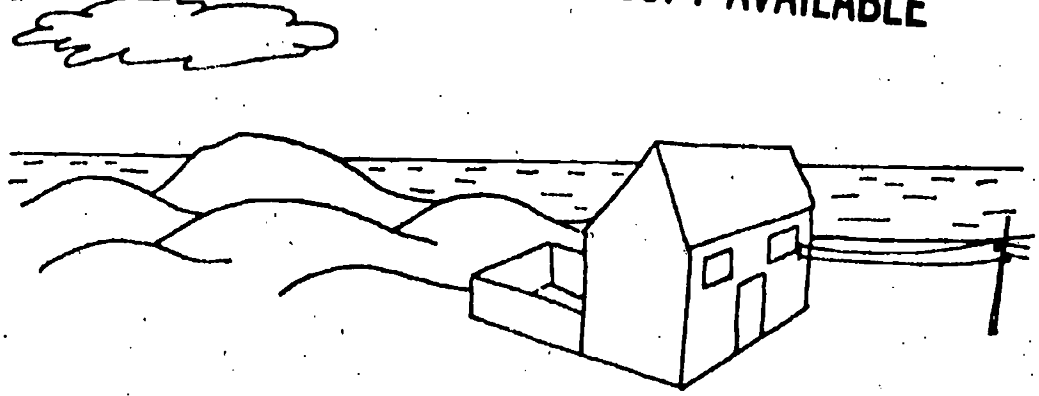


Figure 1. The uses of line demonstrated in this drawing seem to be universally recognizable by the human observer. Lines can stand for a surface edge, with the corresponding change in depth. Corners, whether convex or concave, indicate a change in slant. A single line can also be used to show some features, such as a wire or a crack, in which the edges are close together, parallel, and far from the observer's vantage point.

to optical patterns, can be depicted by a line, and that our society has simply made one use of a line powerful through making it common. A more extreme form of this idea, the convention theory, would state that all aspects of depiction are simply matters of education and custom. The most extreme convention theory is unable to account for a study by Hochberg and Brooks (1962), who showed that a child of 20 months, who learned his vocabulary with reference only to real objects, could name objects in pictures (including outline drawings). A more subtle version of the familiarity theory maintains that the ability to see depth in flat pictures is actually a skill that arises from years of practice with pictures. On our first inspection of an outline picture, depth, color markings, and shadow would be on an equal footing—all weakly suggested and none actually seen. This more plausible version of the familiarity theory can be tested, and found wanting, against evidence from ancient as well as contemporary cultures.

Silvers and I (1974) analyzed 657 outline pictures found on rock faces and cave walls in Europe, Africa, North America, and Australasia to determine whether the representational elements deployed in modern illustrations were also used in the ancient sites. Every region we sampled contained unambiguous depictions of the flora and fauna of the locality; an example is the turtle shown in Figure 4. The uses of line included depiction of depth and slant change in abundance. Indeed, 650 of the rock pictures contained lines showing occluding bounds of rounded surfaces, and 434 contained lines standing for parallel features such as strings and cracks. There were only five cases in which a line stands for a color division. In no case did we find lines depicting the chiaroscuro of illumination and shadow.

Thus the first drawings, although widely separated geographically, had much in common, and we can infer that a line can represent a change of depth to the universal eye. However, to be sure that the overwhelming emphasis in rock art on line depiction of surface edges is rooted in perception and not simply in custom or preference, it is necessary to take the research a step further, to test pictures that reflect both this and other possible uses of line. The people on whom to test these pictures should come from a culture without pictures; only if the subjects of the experiment are unfamiliar with the outline style of drawing should it be possible to determine which uses of line make immediate sense to the naive eye.

For the period of one year Ross, a psychologist, lived in Papua New Guinea with a small tribe of 200 people known as the Songe. During this year none of the Songe possessed any form of picture or was observed so much as to doodle a picture in the earth. Fascinating symmetrical geometric patterns are created on bark cloth, to be used in the chief Songe art form, the dance, but to all appearances the patterns are meant and used as designs and are not depictions of objects. Ross found no indication of a use of line that might make the Songe familiar with one particular depicting function of line rather than another.

Despite their unfamiliarity with pictures, the Songe were able to recognize outline drawings with little difficulty (Kennedy and Ross 1975).

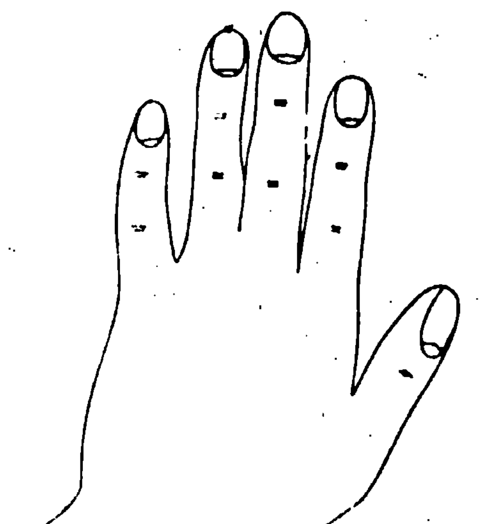


Figure 2. In this outline drawing, the half-moon delineated on each fingernail is intended to represent the change of color commonly found at that point on the nail. Such a use of line — to indicate a change of color rather than a change of depth — is not universally recognizable. When this picture was shown to the Songe, a contemporary people of Papua New Guinea whose culture includes no pictorial representation, the subjects were puzzled by the half-moon lines. (From Kennedy and Ross 1975.)

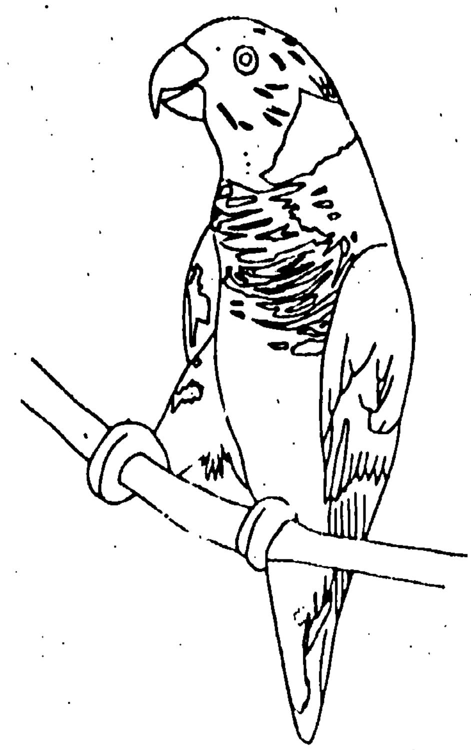


Figure 3. Although the lines indicating areas of color change in this drawing actually correspond closely to the markings on parrots inhabiting the Songe territory, Songe observers did not interpret the lines in this way. Instead, they created an unexpected depth referent for them, suggesting that the parrot had been cut repeatedly in the places marked. (From Kennedy and Ross 1975.)

The 38 subjects, ranging in age from 10 to over 50, were tested with more than 20 drawings and were clearly able to recognize outline drawings and to say what each line stood for, even though many of the drawings were extremely schematic and simplified. When shown a simple perspective overlap drawing containing two human figures, all the subjects correctly pointed out which figure was nearer and which was farther away.

In contrast, when examining drawings in which lines stood for edges of familiar color markings, the Songe were puzzled. They even went so far as to invent unusual depth referents for the lines. Given a picture of a hand with half-moons on the fingernails (see Fig. 2), they took the half-moons to be due to damage to the hand, with new nails growing in. When shown a drawing of a parrot (Fig. 3), they thought the parrot must have been cut repeatedly, although the lines drawn on the parrot's breast actually correspond closely to the color markings on parrots common in the Songe territory.

Evidently, there is a human faculty to perceive lines as standing for features of depth; the faculty is not conferred by familiarity with outline drawings but develops largely from innate influences, and it is far more effective than the problematic mere suggestion conveyed by lines drawn to indicate color differences. Where then is the faculty that accepts the line as a substitute for surface edges? On consideration, it appears to lie outside vision per se, beyond the purely visual channels. Because the uniquely visual features—highlight, shadow, and color differences—are not pictured effectively in outline drawings, drawings of surface edges presumably work their effects at some level of analysis apart from that of purely visual features. Surface edges are common to both visual and tactile channels, and they are the one thing that lines readily depict for vision. The fact that lines do not depict what is purely visual, and do depict surface edges—a feature that is also perceived by touch—suggests that the faculty that transforms flat lines into vehicles for depiction may lie in some perceptual pathway common to vision and touch.

Such was the reasoning that led me to research with blind people. If the faculty of outline depiction is not restricted to vision but can be brought into action by pictures shown to a nonpictorial people such as the Songe, presumably the same faculty can be awakened by *tangible* outline pictures given to congenitally blind people, who have had little or no familiarity with depiction. Presumably, too, the blind person can make a drawing, provided, of course, that he can feel the line being left by his stylus.

Tactile pictures

In an early study (Kennedy 1974; Kennedy and Fox 1977) I presented eight raised-line drawings to 15 blind adults. The raised-outline drawings, 10 cm high, represented such things as a hand, a fork, a cup, and a human figure with arms crossed and they were explored by the blind subjects by hand, one drawing at a time. I tested recognition of the pictures in two ways: first without any aids, and then with a caption of a word or short phrase such as "cup" or "man with arms crossed." In a total of 120 trials, the subjects identified the displays 22 times without aid. This rather low result of 18% indicates that identifying pictures by touch is not easy, as confirmed by a sample of 34 blindfolded sighted people, who identified only 30% of the pictures correctly. However, when given a caption, all the blind subjects identified all the pictures, describing the orientation and the parts of each picture.

Two positive features of the results stand out. First, there were some encouraging signs when the blind people were attempting to identify the drawings without captions. A few drawings were recognized, and the guesses that were wrong often still made sense: for example, the fork was guessed as "an ice-cream cone with a funny bottom" and "a flower on a thick stem." Second, the blind subjects did not find the pictures abstruse once they had been given a caption. Thus, the pictures were not like ideographs, whose parts are still meaningless even when the referent is pointed out.

It is also illuminating to consider an individual case, such as that of R, aged 12 (Kennedy 1980a). Congeni-

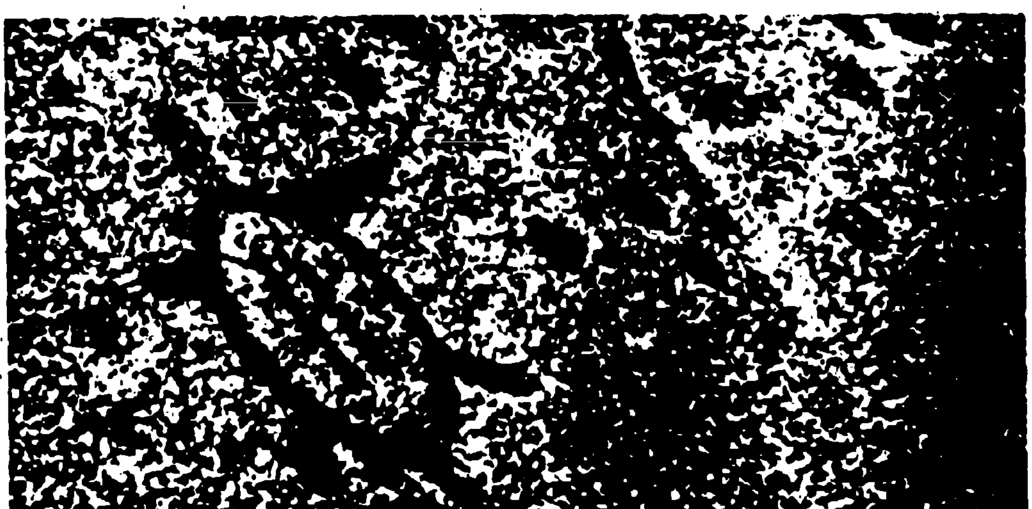


Figure 4. An ancient example of outline drawing, from a rock face in Peterborough, Ontario, is immediately comprehensible to the modern eye. With the use of line to represent features of depth, in much the same style as shown in Figure 1, the rock painting shows an easily recognizable turtle. The oval shapes below are thought to represent eggs. (Photo by M. Latta.)

tally blind, R can detect light but not shapes. He has not made pictures before, as far as could be ascertained, and his contact with displays has included only maps, geometrical shapes, and string displays. In this experiment, R made 12 pictures, using a kit that causes a raised line to appear when the user draws on a flat plastic sheet with a ballpoint pen.

R began with a coat hanger, shown in Figure 5 (*top*). Next he drew a ring. To show thickness, he suggested that one could draw a line of closely packed zigzags, but he then went on to draw two concentric lines, with the outer line standing for a region slightly in from the outer perimeter of the ring, and the other line standing for a region of the ring somewhat larger than the inner perimeter. Thus the drawing is not in normal outline style but does contain a definite idea of thickness. R drew with some accuracy the face of a cubic box, and also the face of a hexagonal box, shown in Figure 5 (*bottom*). To show a man running, R drew legs with a kink in them, explaining, "It's just to show that his leg is bent." He also added a hurdle at the bottom of the picture. The drawing appears on the cover of this issue.

R identified raised-line drawings as well. When he was given a drawing of a duck that presented a side view with only one wing, he said that the second wing was "on the other side" (with a laugh, touching the reverse of the page) and was "just imaginary." What we can learn from R is that for him lines can stand for occluding edges of boxes, occluding bounds of rounded objects, and the set of parallel features constituted by a wire. Thus, three basic uses of outline make immediate sense to him.

Among the rewards of this research were the surprise and pleasure that the blind children and adults took in their own unsuspected abilities. They often experimented with the drawing materials, volunteering to sketch snowmen, boats, dogs, beach scenes, and so on. Some of these drawings indicated that the blind use the concept of a vantage point. Figure 6 (*top*), for example, a drawing by M, a congenitally blind woman, shows two fingers as overlapping; the lower digit is shown by lines for the sides of the finger that are not obscured from the vantage point.

An unusual mixture of styles is shown in Figure 6 (*bottom*), a drawing of a glass by L, a congenitally blind woman (Kennedy 1980b). The circular forms stand for the top and bottom of the glass, two outer lines are the walls, and the central line is the front body of the glass. Here, lines that stand for an edge, a corner, or a tangent to a vantage point are outlines. But there is also a line for the rounded front surface of the glass, which is not standard outline style. Violations of outline style were remarkably rare in the drawings studied, and L's example—like R's ring—is a curious one.

The vast majority of our drawings by the blind follow principles of drawing that are thought to be universal in sighted children (Willats 1981; Winner 1982). In a configuration used by some blind children, for example, the relative location and shape of each feature is correct, but the connections between the features are not shown. In a more advanced configuration, used by both adults and children, the features are shown in outline and are connected, but there is no point of view governing

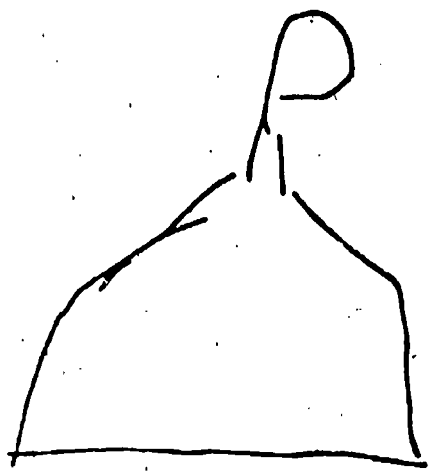


Figure 5. The first drawings of a 12-year-old boy, congenitally blind, show a coat hanger (*top*) and the face of a hexagonal box (*bottom*). Presented with a kit that creates a raised line on a plastic sheet with the use of a ballpoint pen, the boy was speedily able to demonstrate his fundamental grasp of pictorial outline style. (From Kennedy 1980a.)

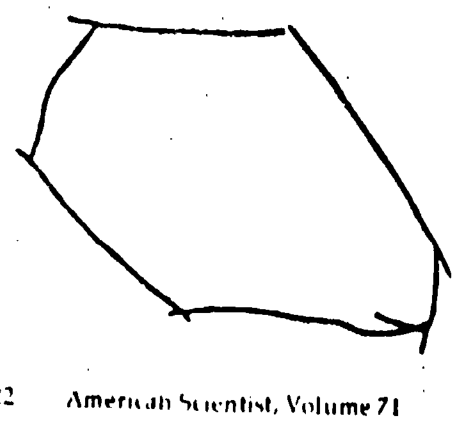
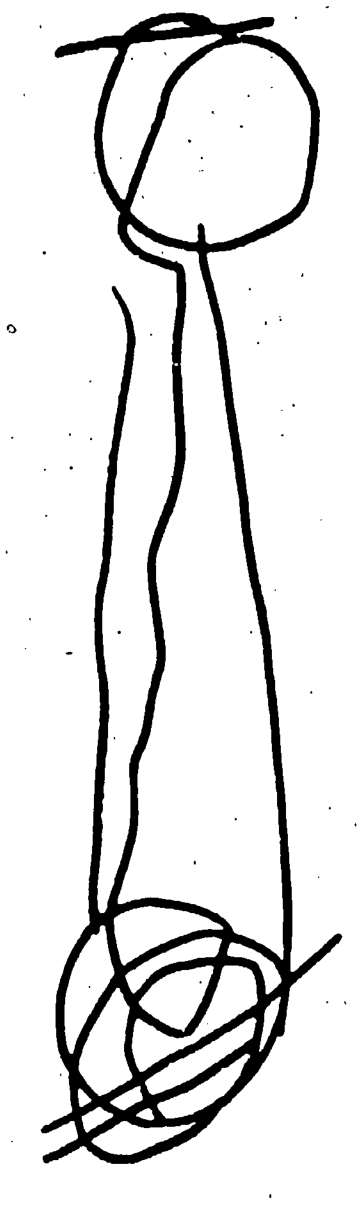


Figure 6. An appreciation and use of the vantage point are often apparent in raised-line drawings by the blind. A drawing of crossed fingers shows the fingers as overlapping (*top*), with the overlapped portion of a finger being hidden from the vantage point of the observer. In a drawing of a tumbler (*bottom*), two circles stand for the top and bottom rims and two vertical lines represent the sides of the glass, which are tangents to a vantage point; the third vertical line, in an unusual device, indicates the front wall of the glass. (From Kennedy 1980b)



the order and direction of the connections. Each individual connection is appropriate—for instance, a table leg is shown meeting a corner of the table—but the set of table legs is arranged in a way that has nothing to do with an overall vantage point. In a third, more elaborate configuration, used mostly by blind adults, not only is each feature drawn in outline and each connection made appropriately, but the arrangement follows from a single vantage point. Figure 7 illustrates these types of configurations with drawings of tables by three subjects. There seems no doubt that blind adults have a well-developed appreciation of the vantage point, as illustrated especially in the bottom drawing, which shows a table from above, from the side, and from below (Kennedy 1980b).

Related to the vantage point is the important pictorial feature of depth at an edge—that is, the relation between foreground and background. A reversal of the foreground and background can sometimes be disorienting enough to render the picture unrecognizable; this effect was first demonstrated in 1914 by Edgar Rubin, a Danish psychologist (see Gibson 1951; Zusne 1970). A familiar example of the effect is the type of outline drawing that can be seen either as a human profile looking to the left or as a human profile looking to the right, as shown in Figure 9. Domander and I (1982) tested a small sample of 6 blind children (aged 8 to 13) with raised-line drawings of this kind and found results similar to those from sighted people. When the children first interpreted the profile as looking to the right and next took it as looking to the left, they did not recognize the profile on its second appearance as a drawing that they had examined only a minute before. The important implication of this study is that, like the sighted, blind people have pictorial impressions that can modify their perception of unchanging forms. They seem to have something akin to a sighted person's perception of pictured foreground and background. Our hypothesis is that just as depth at an edge in an outline drawing is visually perceived by sighted people, it is tactually perceived by blind people.

Further, blind adults sometimes use the feature of convergence in their drawings: for example, by

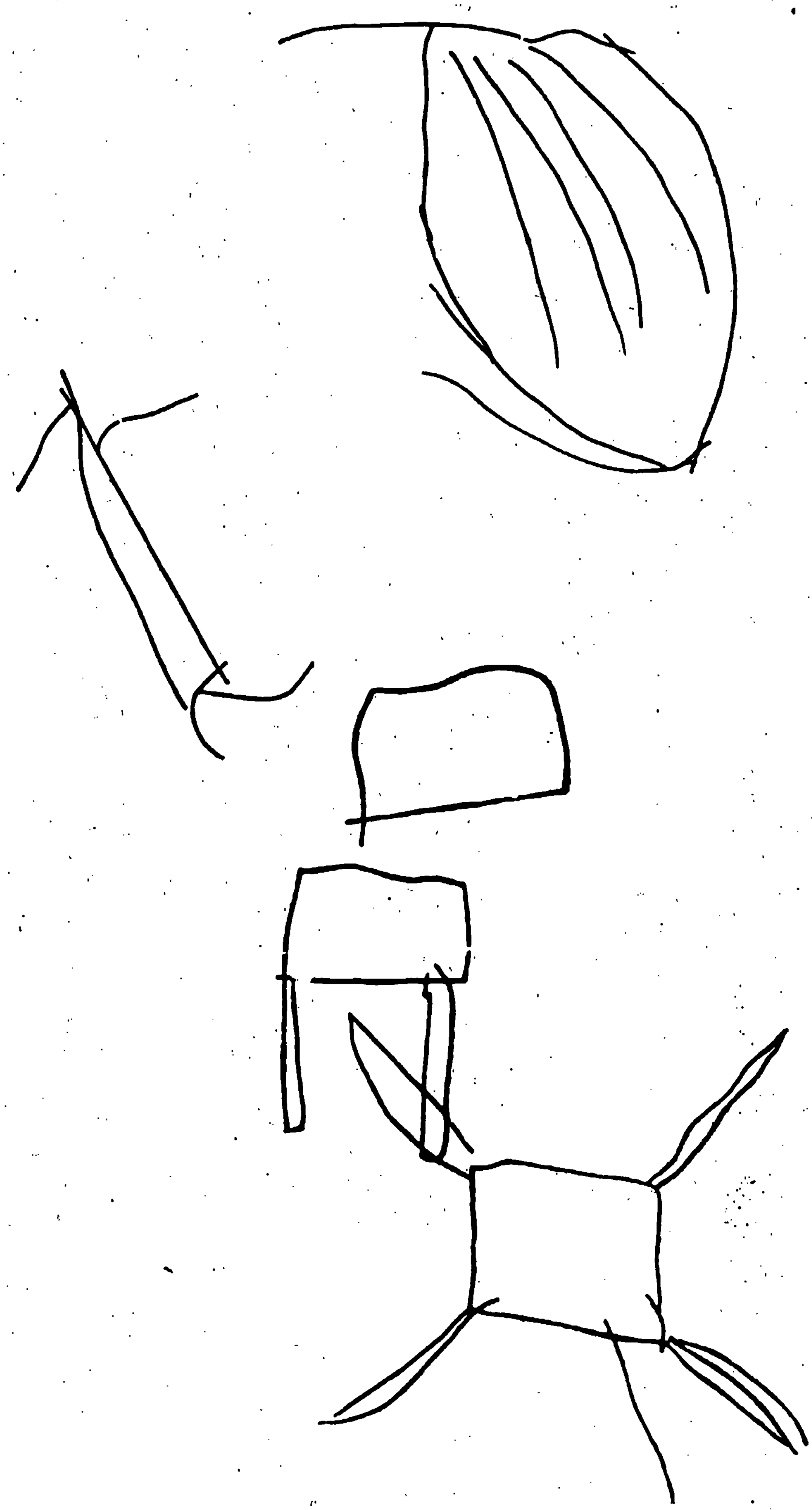


Figure 7. Three kinds of outline configuration – here, all depicting tables – represent different levels of sophistication that can enter into a drawing. In one type of configuration (*top*), each feature of the object is shown in outline, but the features are not shown as connected. Another type (*middle*) shows each feature and the connections among them, but is not presented from any single vantage point. In a third type, not only are all features shown, together with their connections to other features, but the drawing as a whole shows a perspective – that is, the use of a unifying vantage point. Here a set of drawings (*bottom*) shows a table from above, from the side, and from below.

drawing a progressively narrowing shape to show a surface as slanting or, in an unusual approach, by depicting the near edge of a surface with a thick line and the far edge with a thin line.

A moment's thought reveals a possible connection between tactile experience and perspective. The geometry of perspective is the set of rules governing direction. It matters not, for the sake of perspective, whether the direction is coming inward (as with light rays) or going outward (as with a pointing finger). Hence, blind people should have an intuitive sense that as things recede into the distance, they subtend a narrower angle. Campbell and I tested this with children aged 5 to 15 (Kennedy 1982). The children were made familiar with the extent of a wall in a small room by being taken from one of its corners to the other. Then they were asked to point to the corners—each arm outstretched, the left arm pointing to one corner and the right arm to the other corner—from near (one step from the wall) and from far away (4 m from the wall). In every case, the children pointed with a narrower angle from the farther position.

In another convergence study for Campbell's doctoral thesis, blind adults were led to a pair of stands 2.4 m apart, with a string connecting the stand 1 m above the ground. The subjects were walked backward at right angles to the string and asked to point to the two stands. In all cases the subjects made a smaller angle in pointing from a far site (2.4 m away from the string) than in pointing from a nearer site (0.7 m away). The degree of difference between the two angles varied with the individual being tested, ranging from 3% to 46%; however, all the subjects unquestionably demonstrated an understanding of the principle of convergence.

Campbell and I found that the convergence principle works for the blind in the horizontal and vertical dimension, and for small scales (15 cm) as well as large scales (4 m). It may be this comprehension which helps blind people make and understand outline drawings from a fixed vantage point.

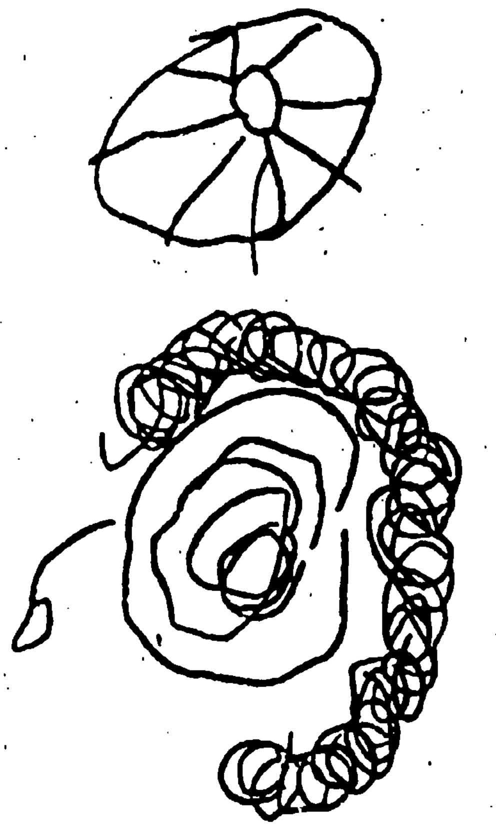


Figure 8. When asked to illustrate movement by drawing a revolving wheel, blind subjects met the challenge with an array of metaphoric devices: an oblong outer shape with some spokes short and some long, a dense spiral outside the wheel with concentric circles inside it, curved spokes, and a series of arcs with dots for the center. (From Kennedy 1980a.)

Pictorial devices

Next we turned to the depiction of movement (Kennedy 1982). Thirteen adults and 34 children were asked to draw rolling wheels, fast-moving cars, and men running. They produced many different devices for showing movement, which can be divided into three types. One type is a postural device, such as showing a man in a position that would be adopted in running; an example is the cover illustration, R's drawing of a man with knees bent. Another device is the use of context: for example, showing a wheel being pushed along by a man, a context that would force it to move. The hurdle at the bottom of the cover drawing is a contextual device, reinforcing the idea that the man is running. In a third type of device, a metaphoric type, something not literally accurate is shown to convey the abstract idea. One metaphoric device was to show the spokes of the wheel as curved, as in Figure 8 (*bottom left*); others were to give the wheel an elliptical shape or to show the wheel surrounded by a dense spiral (*top left and middle left*). More elaborately, in Figure 8 (*right*), a rolling wheel was drawn with a single straight line for the hub, dots for the center, and multiple arcs for the edge.

Metaphoric devices for showing that a man is running included a line trailing behind one foot and, in a different approach, inclusion of the intended footsteps in the drawing. One adult, blind from birth, drew a princess at a spinning wheel. She included a single curving line inside the wheel, and drew two perimeters (Kennedy 1980b).

With these devices, our subjects seem to be relying on everyone's intuitive knowledge of what is correct and literal to introduce special variations that they expect the observer to understand are not literal. Everyone knows that rolling wheels are not elliptical and do not have spirals around them or arcs within them. The orthodox features depicted by line are sufficiently understood by the blind, and are expected by them to be sufficiently understood by others, that unusual uses will stand out and force the observer to seek a nonliteral referent.

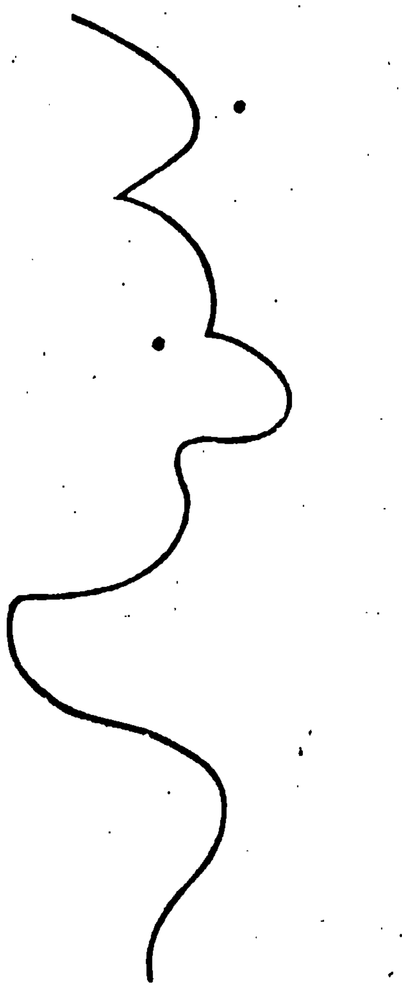


Figure 9. Reversible pictures show us that the relation of foreground to background depth is an important factor in recognizing a drawing. This depiction of a human profile can be seen either as looking to the right or as looking to the left (in either case, the eye is a dot slightly to the side of the profile line); it can look so different, depending on which orientation is seen, that sighted people often fail to recognize it when seeing it with the changed orientation. In a pioneering experiment, a raised-line version of this drawing was presented to blind subjects, who showed the same effects of change of orientation as those of the sighted subjects. This was the first evidence that the blind may have an appreciation of pictorial foreground and background depth, and can be strongly guided by the perception. (From Kennedy and Domander 1982.)

In a follow-up study (Kennedy and Domander 1981), 15 blind adults and teenagers were asked to draw even more challenging topics, including pain, wind, and noise. They were also asked to explain every device as they drew it; this made it possible to classify the devices as "intended to be literal" (e.g., the tangible edges of a stream of air), "intended to be metaphoric" (imaginary tracks made by the wind in the air), or "intended to be diagrammatic" (an arrowhead for direction). The devices could also be classified in terms of whether they showed the object itself or its context.

The topics were a person shouting, the wind, a hand in pain, a hammer hitting a table and making a loud noise, and bad-smelling garbage. Of the 185 separate devices produced for showing these topics, 51 devices were judged to be intended metaphorically (40 of these depicting the object itself and 11 depicting its context). The majority of the devices (122) were literal depictions of the context of the object; another 12 devices were judged as intended to be diagrammatic.

Because the majority of devices were literal depictions of the referent's context, it appears that when asked to show a topic that is not in the normal range of outline depiction, the blind subjects tested tended to draw a helpful, tell-tale context. But the subjects (those who had been blinded early as well as those blinded late) clearly have the capacity to devise metaphoric ways of showing abstract topics. One subject said of a line he had drawn that it was "just imaginary." Three subjects said that their metaphoric lines might not be understood by other people; another common observation was that the referents could be felt but could not readily be drawn. These comments show that the blind distinguish between what can be drawn and what is difficult to draw, and they perceive that lines standing for what cannot readily be drawn are somehow different from lines standing for ordinary drawing topics. Little wonder that the usual resort is to depict literally the context of the referent!

It is difficult to be sure what a child is doing and expecting to be understood when he draws an unorthodox device. But there may be an important lesson to learn from a drawing by S, aged six and blind from birth (Kennedy 1980a). S began by drawing a man standing; then, when asked to show the man running, he extended the legs to make them "real lo-o-ong." Amused, he went on to make the man's arms "real lo-o-ong" too to show how strong he was and how fast he was running. Finally, to emphasize how very fast the man was running, S turned impishly to the man's ears and made them, too, "real lo-o-ong!" The finished drawing is shown in Figure 10. Perhaps there is a lead for future re-

Figure 10. Metaphoric devices abound in this drawing of a man running, by a blind boy. After setting out to portray a man standing still, the 6-year-old artist extended the legs, to show that the man was running. Next he made the arms long too, to show how strong the man was and how fast he was running; to top it off, the boy made the man's ears unusually long as well.

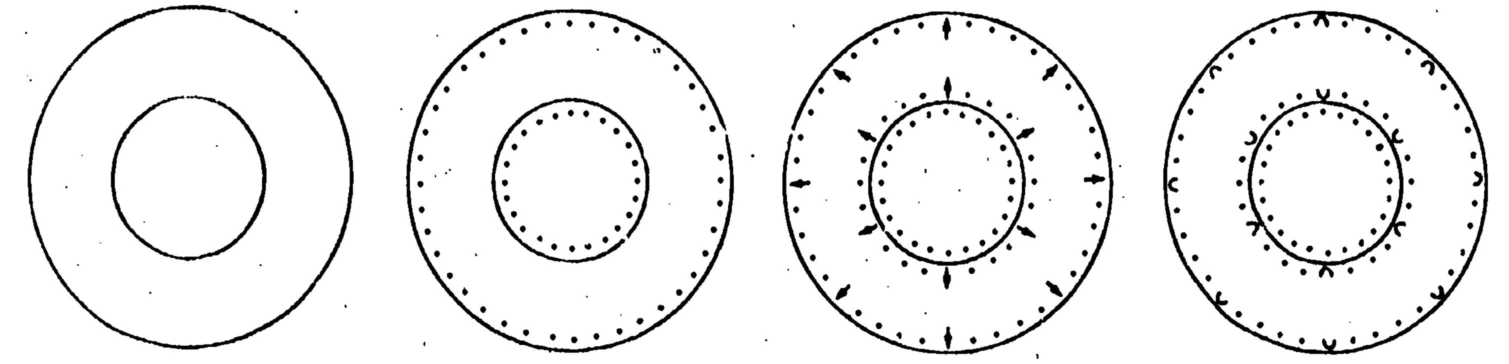


Figure 11. A pictorial code could be used in raised-outline illustrations for the blind as a guide to interpretation. For example, dots on one side of a line might indicate the foreground, arrows could represent slant, and arcs could stand for curvature. The drawing at left is of course ambiguous; the remaining drawings, according to this code, would portray a penny on a plate (two flat surfaces), a bucket (flat interior and slanting sides), and a bowl (flat interior and curved sides).

search in these indications that children find it easy to use metaphor when they are also able to use humor.

Clearly, the blind have considerable innate pictorial abilities. As we have seen earlier in this paper, these abilities can be boosted by captions; another boost might be a code for removing ambiguity from a picture. As demonstrated in Figure 11, a pictorial code can be used in several different ways to make one basic design stand for a penny on a plate, a bucket, or a bowl. Codes that have marks along the basic outline can quickly be learned and used by the blind (Schiff and Foulke 1982).

The abilities shown by the blind—particularly those who have had no previous exposure to pictures—confirm the lessons from early rock art and the Songe. Depiction by line is successful with no previous training, provided that the line stands for edges of surfaces: occluding edges, corners, occluding bounds, and parallel features (wires, cracks, and so on). Further, there are many possible systems for combining the lines on the flat surface of a picture, the convergent perspective system is only one of these, and the naive viewer finds other systems acceptable. Nevertheless, there is reason to suppose that perspective is not entirely a matter of convention and that it has an intuitive basis in picture-making. Although only one of several systems, it is not an artificial one, since it governs direction and applies to both optics and pointing.

The perception of pictures is directed not only by systems such as perspective but also by the observer's capacity to take the intention of the artist into account; we use pictures to communicate, not merely to represent. In using metaphoric devices, the artist deliberately breaks the rules to show something beyond the power of the rules: what is literally wrong can act to amplify the range of the medium (Kennedy, in press a; in press b). Depiction is a system accessible through vision or touch, in which we play off one factor against another to go beyond the power of any one factor.

The theory is intriguing, but what must draw attention immediately is its practical application. With the advanced embossing and depositing techniques now available to printers, Braille texts, guidebooks, craft manuals, and even children's stories could all be made more useful to the blind by the addition of raised illustrations. A few such books exist now, and they should be the standard shortly. To learn from pictures made by others and to communicate by making one's own pictures—these opportunities for the blind should be encouraged.

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