Esref Armagan and perspective in tactile pictures

John M. Kennedy and Igor Juricevic

University of Toronto

Contact author address:

John M. Kennedy

Department of Psychology

University of Toronto, Scarborough

1265, Military Trail

Toronto, Ontario M1C 1A4

Canada

email: kennedy@utsc.utoronto.ca

Tel : 416--287--7435

Fax : 416--287—7642

Word count 4,268

Abstract

Both touch and vision deal with the directions of objects from the observer. Therefore perspective pictures can be tactile as well as visual. Indeed, outline pictures stand for surface features facing the observer's vantage point in touch and vision and freehand perspective appears in drawings by the blind and sighted.

Introduction

The conjecture we present here is that perspective matters a great deal to tactile pictures.

From cave art times to the present, vision had a monopoly on pictures, particularly ones that used perspective. But no longer. The monopoly is broken by the finding that blind people can draw and interpret raised line pictures. Laoutari-Gritzala (2006) presents pictures from blind children from Greece, Saudi Arabia, Argentina, Latvia, and Canada, for example. The children's drawings show a horse (page 43), a house and trees (page 51), a bird (page 52), people (page 57), a hedgehog (page 66), a bicycle (page 67 and 88), flowers and a train (page 72). Julia (age 9, from Germany) drew items from a picnic using many of the same forms as a sighted child of the same age e.g. the fringed rug is drawn as a rectangle (page 232). Julia may be using parallel projection. Patryk (from Poland, aged 15) drew a chair using converging lines for the chair's seat, and T-junctions to depict the rear legs being occluded by the front edge of the seat (page 230). Patryk may be using one-point perspective.

Many educators suggest that the experiences of blind children and adults are incorporated into their drawings, the drawings have intense tactile qualities and artmaking is taught, as children become members of their culture (Laoutari-Gritzala, 2006, page 82). As perception and developmental psychologists, we may have much to offer to go beyond these worthy conceptions. Specifically, we theorize that the surfaces of the perceptible world are tangible as well as visual, that drawing development has a similar course in the sighted and the blind, and perspective plays a role in touch as well as vision.

The break in the ages-old visual monopoly on pictures is profound if perspective is truly alive and well in touch and tactile pictures (Kennedy & Juricevic, 2006). The break allows us to overturn common assumptions about art history and pictures (Hopkins, 2000; Lopes, 1997). The heart of the matter, we argue here, is that touch brings unexpected strengths to pictures, including the ability to group dotted lines into forms governed by perspective, and vision is dogged by many illusions and peculiarities, as well as undoubted abilities with perspective (Sedgwick, 2003). The reason touch makes use of perspective is that perspective is very much a matter of direction. Touch reveals direction just as vividly as vision detects depth.

Drawings by blind adults

When she lead an art class for blind adults in Colorado, Ann Cunningham, author of the tactile book “Sadie can count”(Cunningham, 2006), requested a drawing of a cube. Four of the results are in Figure 1.

-- -------------------------------

Insert Figure 1 about here

---------- -----------------------

The drawings show a single aspect of a cube, a foldout drawing of a cube, a foldout drawing emphasizing the left side of the cube with oblique lines to join the top, left side and bottom of the cube, and a drawing in which the front and one side are shown, with the side drawn using converging lines. This is the developmental sequence for drawings of cubes by sighted children from age 5 to 12 (Nicholls and Kennedy, 1992). Cunningham’s findings illustrate the hypothesis that the sequence unfolds for the blind as well as the sighted. First the form of one part of a target object is shown, then multiple parts, then parts facing a vantage point with some indication that they are all joined, then some indication of foreshortening of receding sides. In freehand drawings the amount of foreshortening is quite variable. Indeed the method for calculating the foreshortening was first devised in the early 1400s by Brunelleschi, the architect.

Figure 1 has a drawing with converging sides. In freehand linear perspective, this reflects the fact that if an object recedes it subtends a smaller angle at the observer's vantage point. Since only one side is converging, the cube is drawn in one-point linear perspective. The convergence of receding parallel sides is often thought to be distinctively visual, but in fact there are exact parallels in touch because touch deals with direction.

Direction and touch

Figure 2 shows direction being used in touch. Two poles are in front of an observer. From nearby, anyone reaching out to the poles would put their arms wide apart. Step back, and the arms converge. The angle between the arms is smaller. For both vision and touch, directions to the poles from the observer have come closer. Each step back shrinks the angle between the two directions (Kennedy, 1993).

-- --------------------------------

Insert Figure 2 about here

--- --------------------------------

For each step back, using linear perspective geometry we can calculate the shrinking of the angle between the two directions. Thereby, projections of distant tiles on a piazza are foreshortened. The closer they are to the vanishing point the higher they are in elevation, and the more they are foreshortened. To a fair degree, vision appreciates that a nearby tile and a middle-distance foreshortened tile are similar in shape. This indicates vision works with a fair approximation to linear perspective (Juricevic & Kennedy, 2006). The approximation takes account of two factors, one, the position of the tile with respect to the vanishing point, and, two, the angles subtended by the tile's length and breadth. Vision adds the two factors to arrive at its impression of the true shape of the distant tile. That is, the two combine linearly. Since square tiles tend to look more and more stubby in the far distance, the approximation's shrinkage rate as the tile recedes is a tad short of the correct rate. Likewise in touch, if we close our eyes and point to the centres of tiles on a path stretching directly away from us, we underestimate the rate of change of direction, our pilot studies suggest.

Perspective and illusion on a picture's surface

Figure 3 is a drawing of three cubes in one point perspective. All the parallels receding in depth are shown by oblique lines in the picture converging to one point.

------------------------- ------------------

Insert Figure 3 about here

-------------- ----------------------------

If sighted people estimate the lengths of the obliques by eye, they are quite mislead by perspective (Segwick, 2003). Consider the figure on the left. The baseline of the square is connected to an oblique depicting the receding side of the cube. The oblique appears longer than the baseline, but in fact it is slightly shorter. This error in reading the lines on the picture surface is partly due to the foreshortening of the faces. In Figure 4, the cubes are drawn in parallel perspective, so all the obliques are parallel and do not converge. The remaining perspective feature, once convergence is removed, is that the sides are foreshortened. The baseline of the front face of the cube on the left appears much longer than the oblique attached to it. In fact, they are equal. Evidently foreshortening can create visual illusions. This is one of the factors that makes it hard for sighted people to control their perspective drawings. They may try to draw equal lines on the page, but as soon as perspective features are added, their judgments turn awry. The appearance of equality is lost.

------------------- --------------

Insert Figure 4

------------------ -------------------

Drawings by Esref with perspective features

Foreshortening and convergence appear in drawings by blind people who have drawn a great deal. Esref Armagan, a congenitally totally blind man from Turkey was aged in his 40s and early 50s when we interviewed him, with translations by Joan Eroncel. He has been interested in pictures since he was a child, and makes pictures several times a week. We asked Esref to draw cubes, and he drew Figure 5, in which both foreshortening and convergence are evident.

------------------ ---------------------------------

Insert Figure 5

--------------- -------------------------------------

The drawing numbered 1 shows a wire cube in a well-known form, known as a Necker cube. Was this drawing taught to Esref, and not truly understood by him? To determine if he fundamentally understood his drawing he was asked to draw a cube perched on one of its vertices, with another vertex directly in front of him. The result is numbered 2. He reported this was a novel task, and therefore this is a good test of his ability to modify Figure 1 to fit instructions about 3D. Then he was asked to draw a cube showing its front face at head height but with the cube moved to the left. He drew drawing number 3. In it, side faces are foreshortened compared to the front face. Also, the lines for the top and bottom sides converge (are “narrowed,” in his terms).

Esref’s drawings are highly accomplished. The drawing with a receding side converging and foreshortened is adept. The drawing of a cube balanced on a point also uses foreshortening with the astute result that Vs at the corners of the top quadrilateral on the picture surface form obtuse and acute angles. Remarkably, just as the lengths of lines in Figures 3 and 4 are illusory, the angles in these Vs are seriously misread by vision. To a casual inspection, they appear close to right angles. The top and bottom Vs are actually quite obtuse (over 110 degrees), and the left and right throughly acute (about 65 degrees). The acute and obtuse Vs are about 45 degrees different, but vision, influenced by the indications of perspective in the picture, takes them to be close to right angles, and almost equal. Esref has used foreshortening to such good effect that sighted observers suffer an illusion in looking at this figure (Hammad et al., in press).

The angle shrinkage that is required in pointing to a succession of tiles in a path is the kind of experience that Esref can rely on to understand the need for convergence and foreshortening in a 2D picture. Esref has drawn a great deal, and his development is advanced. We hypothesize that his drawing development followed the same course as drawing in the sighted, and Esref’s striking achievements in perspective drawing are a result largely of his own persistence, practice, problem solving and motivation. We must stress that some of his progress is surely due to living in a culture in which aspects of drawing and pictures are freely discussed. Some is due to Esref asking acquaintances direct questions. But Esref has learned more than how to draw a cube in rote fashion and has gained a general grasp of 3D space and the observer's vantage point. This permits him to create novel projections onto an imaginary projection surface between the object and the vantage point, we suggest.

Figure 6 shows a drawing of a model house, by Esref. He was asked to draw the house from above one of the house's corners. The result shows three surfaces. The roof is drawn with parallel lines, suggesting parallel projection, in keeping with many drawings by the blind (Eriksson, 1998). The long side wall is drawn with converging lines. The end wall is drawn with a longer line for the near corner than for the far corner, and thus employs convergence. As a result, the drawing converges to the left and the right. Ergo, the picture uses two-point perspective for the side and end walls (Juricevic & Kennedy, 2006), but is inconsistent in providing parallel lines for the roof. At first glance, viewers readily take the picture as being entirely in parallel perspective, but in fact the near corner is about 25% longer than either the far corner of the long side wall or the far corner of the end wall. A moment's inspection reveals the difference, though probably even with steady attention to the picture many viewers end with an illusory impression that the difference is closer to 10%. Despite the inconsistency, the drawing is sophisticated, and few sighted subjects would produce its equal, our experience with undergraduates given similar tasks suggests.

Esref takes great pride in his ability to tackle drawing tasks, and to consider objects from novel vantage points. Figure 6 reinforces the claim that in drawing objects, Esref can entertain novel locations in any of the possible 3D locations around an object.

-------------------- ---------------------

Insert Figure 6 about here

------------- ----------------------------

Esref's skill with form and vantage points were tested by asking him to draw a dog, an insect and a person, without specifying the observer's vantage point. He drew the dog from the front, the insect from above and the person from the side (Figure 7). He said he drew John Kennedy, one of the authors, and added the name John, in Turkish. The dog's muzzle, eyes, ears, haunches, legs and paws are shown. The insect's body, legs, head, eyes and antenna are depicted. John's head, body, clothing and pointing arm are shown. John is drawn as if sitting on a cube. Two faces of the cube are shown, forming a corner. Both may be shown with converging lines, though the one on the right is merely one line slanted upwards. Hence this drawing has features of two-point perspective (Kennedy & Juricevic, 2006).

Enough features are present in Figure 7, in excellent proportion, to make the forms recognizable. Enough information is provided to define the directions of the parts from the observer's vantage point. The selection of features is consistent with the vantage points.

-------------------- ---------------------

Insert Figure 7 about here

------------- ----------------------------

Perspective and grouping

Esref draws in a highly advanced way. He uses proportions of parts accurately. He may be using parallel, one- and two-point linear perspective. He is a living example of goals and achievements to which the blind can aspire. His drawings deserve to be in the major museums of the world because they are key to a revolution in scholarship about perception and depiction. Esref is a leader whose basic abilities are not unique. He shows abilities blind people can harness. He shows what is possible. What Esref does today, many blind people will do in the future. He has used resources present in the blind, applying them to the problems of 2D drawing that naturally arise in a 3D world. Blind people perceive object form, and the direction of the object from the observer. Blind people appreciate the directions of parts of a scene. Like sighted people, they have a rough sense of perspective. Ask them to point to the base of a distant column on a plain and they will point higher than for the base of a nearby column. The sighted and the blind sitting at a desk find the clutter on the desktop is defined by the shapes of keyboards and telephones resting on the desk, their depths from the observer and in addition – most important for the present thesis -- their directions in the left-right (x) and vertical (y) dimensions.

The illusions for sighted people due to depth information in Esref's drawings are striking. Inaccuracy in touch may be less to do with depth information than vision, and more to do with grouping areas in 2D. Heller (2003) reports many tactile illusions for the blind, but no effects that can with certainty be ascribed to pictorial depth information. In contrast, studying grouping, Heller et al (2003) found flat forms embedded in larger forms hard to discern in touch; they were grouped with the embedding form. The principle is illustrated in Figure 8, a figure designed by us and undergraduate Rizvana Chishty.

--- -------------------------------- ------

Insert Figure 8 about here

-- --

Squares in Figure 8 line up in two directions. Mostly, the display seems to be filled with what looks like straggly vertical lines. If sighted subjects search for straight lines formed by the squares undoubtedly they will notice the straggly columns. What is usually missed by vision is that every other horizontal row is an evenly-spaced straight line. The grouping we see in the display depends on which line is more closely spaced on average (Kubovy, 1994). The verticals are denser than the rows. Ergo, we may only see the columns.

The perceptual grouping in Figure 8 is highly significant in touch as well as vision. Sighted and blind observers are keenly aware of the lines into which visible and tactile dots group, despite the absence of any continuous border. Burila (aged 15), from Romania, drew a horse with dotted lines (Laoutari-Gritzala, 2006, page 43). The head of the horse was shown by over 20 well-spaced dots. Evidently, the dots are to be grouped by the observer. The physical continuity of the boundary of the head is represented by perceived continuity, not actual continuity on the picture surface. The sparse dots tell touch and vision about continuity. The perceiver is aware of continuity, without needing to see or feel a physically continuous line.

Awareness of surfaces

Spotty texture units on a visible surface in a black and white photo can be separate and distinct, but make the perceiver aware of a continuous surface. A tablecloth made of a spotted material is a good case in point. The awareness of the continuous cloth surface need have no colour or brightness. That is, its qualia are the continuous forms of opaque surfaces. What we perceive in looking at an outline drawing is surfaces between the lines though the regions between the lines are blank. The awareness is of something concrete, since it is of a physical surface at a particular place and time, but also it is abstract, since nothing inherently to do with lightness, darkness or colour is part of the percept of the unbroken expanse. The optical feature that is part of the awareness for sighted people is that it is opaque. The tactile equivalent may be that the surface seems to be firm.

Like vision, touch produces an awareness of surfaces. That awareness can be between pressure spots. With our fingers splayed, the parts of a surface pressing on the fingertips are spread out. They are physically separate. Despite the distinct separations, the perceiver is aware of a continuous surface. As we run our fingers over a surface, we get shear forces on our fingertips (Symmons, 2005). Via the shear we can become aware of how the surface rises and falls, has bumps and hollows, comes toward us and recedes. The surface appears continuous. Pressure and shear are physically absent in the gaps between our spread fingertips of course, but we are aware of continuity in the gaps.

Tactile pictures rely on dots of pressure being grouped. The groups support awareness of continuous surface. As a picture is drawn, an artist can feel the picture, and become aware of a continuous surface edge represented by groups of dots and lines. The region alongside the line represents the surface with the edge. Also, as the artist reaches out and touches a dot, the dot's direction is signaled. A set of such directions given by Burila's line of dots tells the observer about her horse. The set of directions reveals the edges of the surfaces of the object in question.

In sum, the lesson of Figure 8 is that vision and touch give us awareness of surfaces, not just light and pressure. The awareness involves perspective because it has to do with direction. In intending to make a picture, what has to be dug out of the awareness is relations between form, direction, and projection. This is not trivial for the beginning artist. The relations have to be discovered piecemeal. That is why there is a drawing development sequence. If the same kind of awareness, and the same content of awareness, is present in vision and touch, little wonder the blind and the sighted could have the same drawing development sequence.

Visual and tactile brain regions

Pascuale-Leone (2005) contrasted brain imaging during scribbling and drawing tasks. He reports Esref uses the primary visual cortex when engaged in drawing, and simultaneously an area dedicated to processing forms of visible objects. Esref's brain language centres are quiet during drawing. Pascuale-Leone's findings are exceptionally important. They suggest the erstwhile visual areas are a spare computer, with a bias for haptic spatial tasks as well as visual ones (James et al, 2002; Fiehler et al, 2007), that the blind can employ in drawing development. (The deaf must also recruit auditory areas for non-auditory tasks, likely including vibrations and rhythms.) The drawing developmental sequence may be the same in blind and sighted children precisely because the same brain regions are entrained. The regions may solve the same tasks for the blind and the sighted. They may make the blind and the sighted aware of relations between dots, lines, groupings, surfaces, directions, convergence, foreshortening and projection to the picture surface.

Conclusion

The blind and the sighted use perspective projection in making and using tactile pictures, and pictures by the blind include the use of freehand parallel, one-point and two-point perspective. This claim has implications for the history and theory of pictures, perception and the brain, and common features in the development of drawing in the blind and the sighted.

References

Cunningham, A. (2006) Sadie can count. Lakewood CO: Sensational Books.

Eriksson, Y. (1998) Tactile pictures: pictorial representations for the blind 1784-1940 Goteborg: Goteborg University Press

Fiehler, K, Burke, M., Bien, S., & Roesler, F. (2007) Multimodal cortical network of movement control within the dorsal stream: Evidence from sighted and congenitally blind humans. Poster presented at the International conference on Cortical mechanisms of vision, Centre for Vision Research, York University, North York, CA, June 19—23.

Hammad, S., Kennedy, J. M., Juricevic, I. and Rajani, S. (in press) Angle illusion on a picture's surface. Spatial Vision

Heller, M.A. (2003) Haptic perceptual illusions. In Touching for knowing Hatwell, Y., Streri, A. and Gentaz, E. (eds.). Amsterdam: John Benjamins. (pp. 161-171)

Heller, M. A., Wilson, K., Steffen, H., Yoneyama, K. & Brackett, D. D. (2003). Superior haptic perceptual selectivity in late-blind and very-low-vision subjects. Perception, 32, 499-511.

Hopkins, R. (2000). Touching pictures. British Journal of Aesthetics, 40, 149-167

James, T.W., Humphrey, G. K., Gati, J. S., Servos, P., Menon, R.S. & Goodale, M.A. (2002) Haptic study of three-dimensional objects activates extrastriate visual areas. Neuropsychologia, 40, 1706-1714.

Juricevic, I. & Kennedy, J. M. (2006) Looking at perspective pictures from too far, too close and just right. Journal of Experimental Psychology: General, 135(3), 448-461.

Kennedy, J. M. (1993) Drawing and the blind. New Haven: Yale Press

Kennedy, J.M. & Juricevic, I. (2006) Blind man draws using convergence in three dimensions. Psychonomic Bulletin and Review, 13 (3), 506-509.

Kubovy, M. (1994) The perceptual organization of dot lattices. Psychonomic Bulletin & Review, 1, 182-190.

Laoutari-Gritzala, A. (2006) Blind children paint. Athens: Ifet S.A..

Lopes, D. M. M. (1997) Art media and the sense modalities: Tactile pictures Philosophical Quarterly, 47, 425-440.

Pascual-Leone, A. (2005) Learning about seeing from a congenitally blind painter. Paper presented at Art Beyond Sight: Multimodal approaches to learning. Conference at the Metropolitan Museum of Art, NY, Oct 14-15th.

Sedgwick, H. A. (2003). Relating direct and indirect perception of spatial layout. In H. Hecht, R. Schwartz & M. Atherton (Eds.), Looking into pictures: An interdisciplinary approach to pictorial space. Cambridge, MA: MIT Press.

Symmons, M.A. (2005) Active and passive haptic exploration of two- and three-dimensional stimuli. Unpublished PhD thesis. Melbourne: Monash University.

Figure captions

Figure 1 Drawings of a cube by blind adults in Ann Cunningham's art class in Colorado

Figure 2 How direction depends on the vantage point: The angle between the directions to two fixed posts shrinks if the observer steps back.

Figure 3 Three cubes in one-point perspective. Receding parallels are depicted by lines converging to a single vantage point. Receding faces are foreshortened. Viewers see the leftmost cube's lower oblique as longer than the horizontal line of the base of the front face, but it is shorter.

Figure 4. Three cubes in parallel perspective. Receding parallels are depicted by parallels on the picture surface. Two drawings are foreshortened. The cube on the left is not foreshortened and viewers have the mistaken impression the oblique is longer than the horizontal line for the base.

Figure 5. Drawings of cubes by Esref. Drawing 1 may be a convention. Drawing 2 is more novel, and shows the cube balanced on a point with a vertex pointing at the observer. Drawing 3 shows the cube in front of the observer but moved to the left, exposing the side.

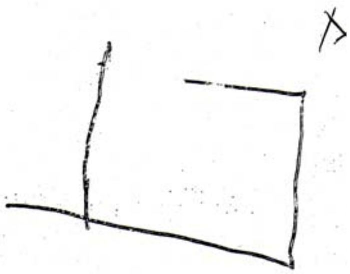
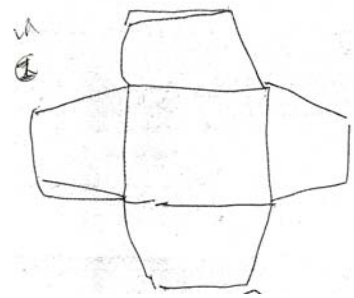
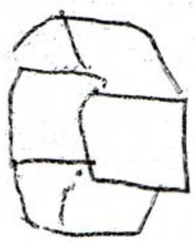
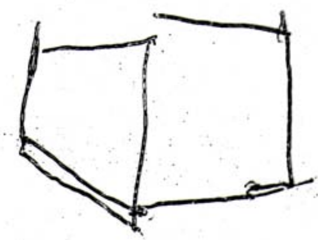
Figure 6. Drawing of a house by Esref. The vantage point of the observer is above a corner of the house, and back from the house. The lines for the side and end wall use convergence.

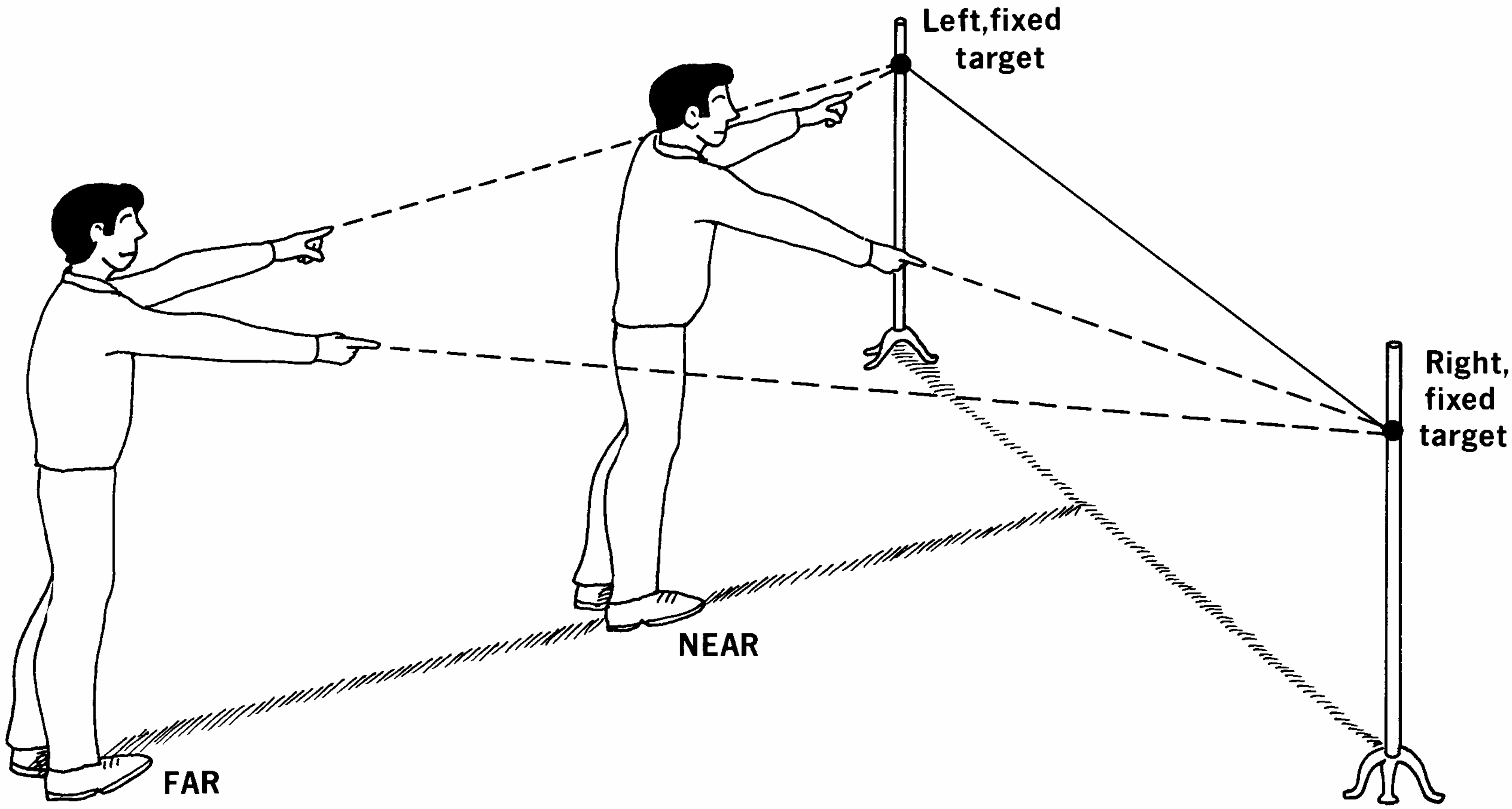
Figure 7. Drawing of a dog, an insect and a man by Esref.

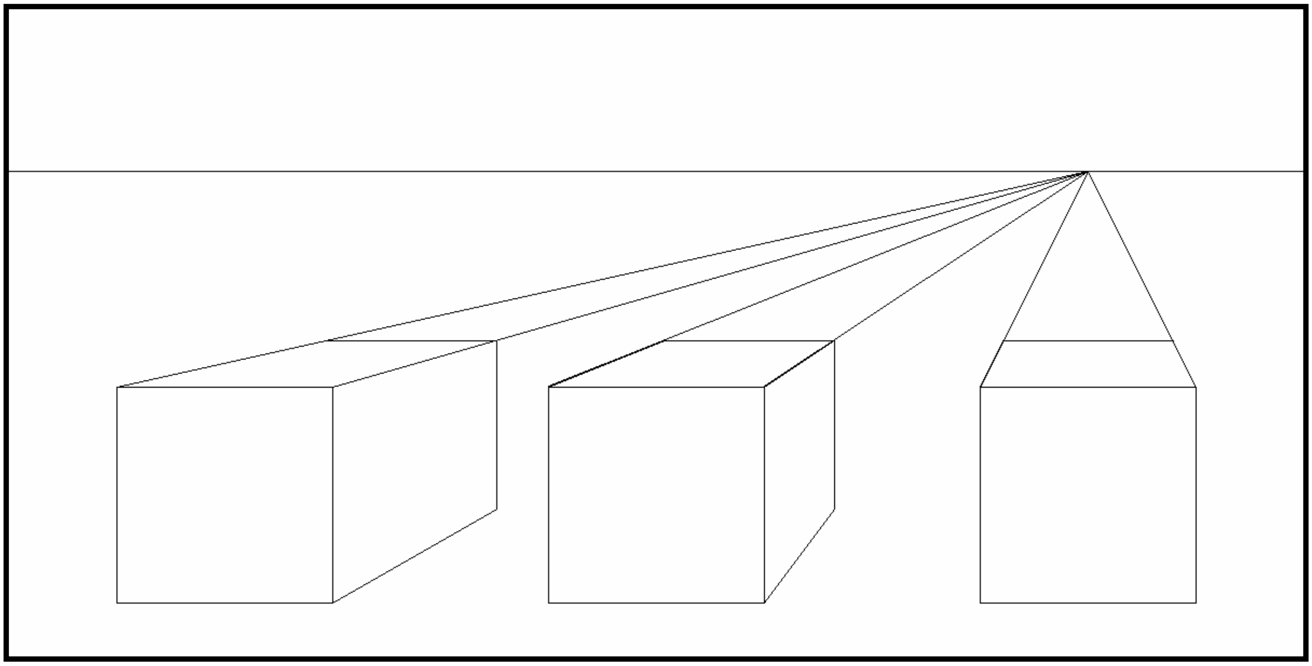
Figure 8. Straight lines of squares. Viewers readily notice the irregularly-spaced straight columns, and miss the regularly-spaced straight rows. The columns are denser.

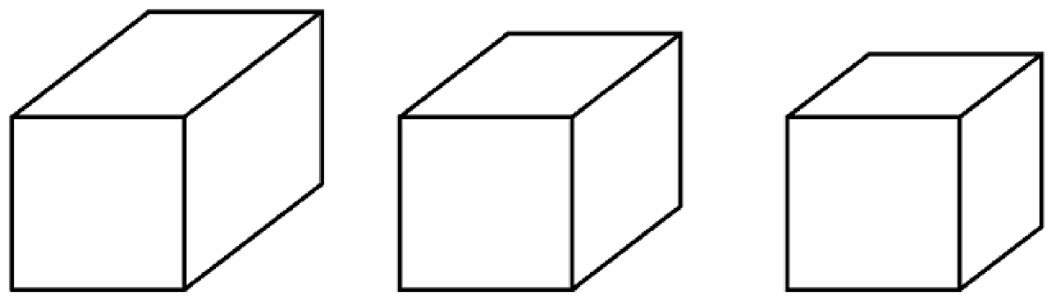
Acknowledgments

We thank Mr. Armagan for honouring us with his talent, his time and his diligence, and we wish to acknowledge the aid and advice of Joan Eroncel, who brought Esref Armagan’s historic work to global attention. Ms Eroncel translated for us during meetings with Mr. Armagan.

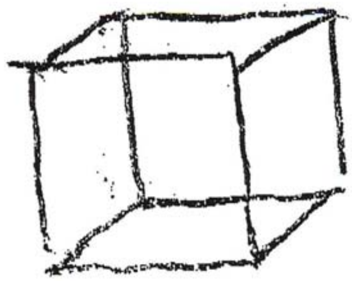






Left,fixed
target
Right,
fixed
target
NEAR
FAR

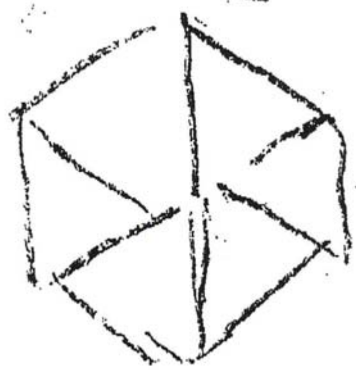




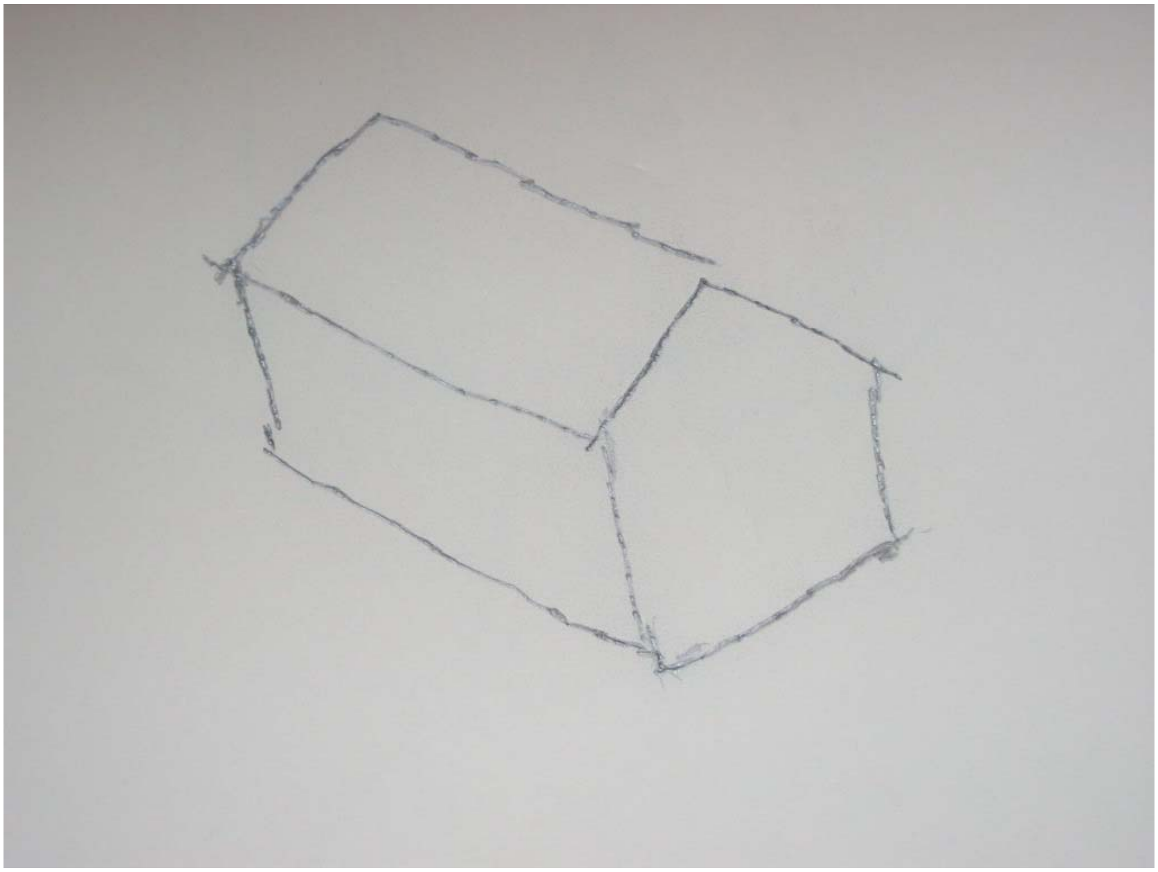
1

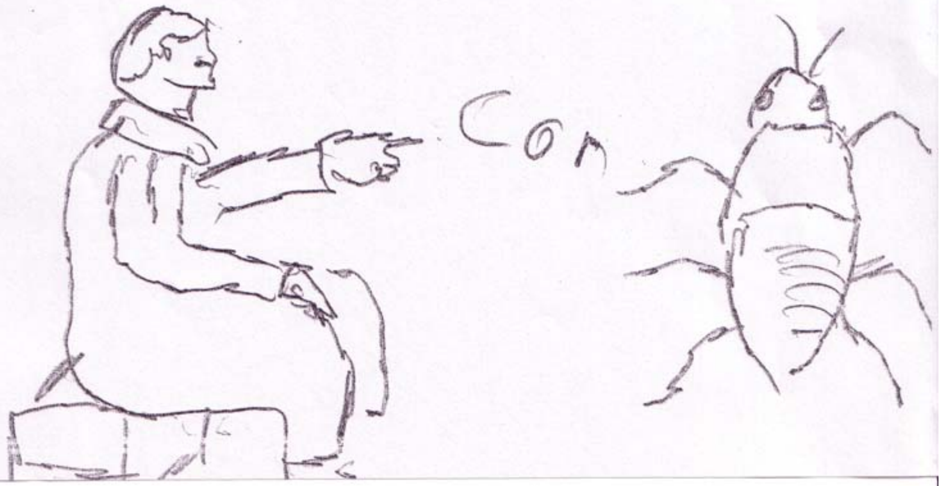


2



3




Con