Blind man draws using diminution in three dimensions

John M. Kennedy and Igor Juricevic

University of Toronto

Running head: Tactile picture convergence Word count 3260

Address for correspondence:

John M. Kennedy, University of Toronto

1265 Military Trail

Toronto, ON M1C1A4 Canada

kennedy@utsc.utoronto.ca

Tel 416—287—7435

Fax 416-287--7676

Abstract

Could the principle of convergence in three spatial dimensions be reflected in drawings by the congenitally blind? A man who has been totally blind since birth was asked to draw scenes such as a tabletop with three cubes receding to the observer's left side. He used converging lines to show tops of the cubes receding in depth. He drew the cubes to the left smaller than the cube in front of the observer. He drew faces of cubes to the left with tilted lines, pointing to below the front face of the cube in front. The result approximates three-point perspective. We note the directions of objects from a vantage point in touch converge much as they do vision.

Here we report a man who is congenitally totally-blind used pictorial convergence to show depth and drew a scene with three cubes in a manner approximating three-point perspective. This use of convergence in a picture of a cube is of general interest since the question of what can imply depth to blind and sighted observers has been debated since William Molyneux in the seventeenth century posed the theoretical question to John Locke (Lopes, 2003, pp. 178-180). We argue directions of objects from the observer's vantage point are relevant to pictorial convergence for the sighted and the blind.

Pictures can be made in a raised form for use by the blind (Axel and Levent, 2003). People totally blind from birth who have had little or no experience drawing make outline pictures of objects after a few minutes practice with a raised-line drawing kit (Kennedy, 1993; Heller, 2000; Millar, 1994). Two blind people who have extensive practice drawing have been tested. One (a blind child in Rome) draws objects using parallel projection (Kennedy, 2003), that is, nearby and more-distant spaces of the same size in the scene require equal-sized spaces in the picture. One (an adult in New York) uses convergent lines in accord with one-point perspective (Kennedy and Juricevic, 2003), that is, parallels in one dimension such as a flat ground converge to one point. (For the sighted, a familiar picture in one-point perspective would be a depiction of railroad tracks, the lines for the rails converging towards the line for the horizon.)

Convergent lines in a picture representing parallels in the depicted scene are late in drawing development in the sighted child, typically after age 9 or 10, and only become common in early adolescence (Willats, 1997). The amount of convergence is highly imprecise unless a calculation method is formally taught. We show a blind man used one-point convergence in this imprecise fashion in several pictures. He then sketched a house

in rough two-point perspective. That is, parallels in two planes (the front and end walls of the house) converge in two directions, one to the left and one to the right of the centre of the picture. He went on to use convergence, size diminution and tilted lines in dealing with depth in the three dimensions of space, x (horizontal), y (vertical) and z (depth) in a picture of cubes. We suggest the convergence, diminution and tilt are related devices that fit with the directions of parts of a scene from an observer, albeit one without sight. We speculate our informant generalized his remarkably fluid use of one-point convergence to solve the specific tasks we asked him to undertake.

Consider a cube on a table, sitting directly in front of the observer but below his or her vantage point. Let the cube move to the observer's left. Now let it move further to the left. To show this set of cubes, devices such as omitting or showing side faces are needed to reveal which cube is to the fore, and which are increasingly distant to the left. Tops, fronts and sides of cubes need to be drawn systematically. This task is challenging to sighted observers. It can be solved using devices to do with convergence in x, y and z dimensions. That is, the convergence can be not only to points to the left and right of the picture's centre, but also to a point below the centre of the picture. The three cubes will be called "the cube to the front," "to the left of the one in front" and "leftmost" in our analysis.

This task was given to a blind man who has made pictures frequently ever since he was a child. (His parents gave him drawing materials to stop him scribbling on the furniture, he reports.) First he was given a series of drawing tests, several pertinent to one- or two-point convergence. Then the three-cubes test was given. Would he use convergence to show distance in several directions?

Method

Subject

EA, aged 51, is a congenitally totally blind man, from Turkey. He has an incomplete grade school education. One eye is missing and the other is a microball that has no light sensitivity. Medical opinion is that he never had light sensitivity. He has previously been asked to draw moving wheels (Kennedy and Merkas, 2000). As a child he drew on his parents' furniture, in dirt or sand (Motluk, 2005), and paper, making thick indented lines. He reports asking people about pictures and he recalls that in his teens or early twenties he was told the parallel sides of roads can be drawn converging. His drawings are not rote copies, since he can explore a novel object and produce an excellent, easily-recognized picture of it.

The present authors have seen over 50 pictures made by EA, at his own behest. Joan Eroncel, who translated instructions into EA's native Turkish for this study, has seen many hundreds. In none is two- or three-point perspective evident. However, he drew distant objects such as houses smaller than ones in the foreground. EA drew receding sides of houses converging (Motluk, 2005), that is in one-point perspective, while drawing fronts of houses with parallel lines.

Procedure

EA was asked to undertake 15 drawing tasks including one pencil crossing on top of another, people standing, walking and lying down, an array of three objects from different vantage points, cars at different distances on a road, receding rows of glasses, a table and chairs, a house and three cubes -- one placed in front of him (an 8.5cm width wooden cube set on the table at which he was seated), one described as to the left (again

demonstrated with the wooden cube, moved double the cube's width to the left), and one to the left again (again demonstrated, with the cube moved another two widths to the left). Here, results of picture tasks relevant to one- and two-point convergence will be noted, prior to presenting the 3 cubes task. EA was not given any time pressure. Times to complete drawings ranged from about half a minute to several minutes. Time to start a drawing after the task was given ranged from a delay of a few seconds to about two minutes (for the 3-cubes task).

Results

In Figure 1, EA drew the car in the distance small, showed the fronts of each car smaller than the rears, and used lines for the roadsides that converge with distance. Also, he drew two rows of glasses, with three glasses per row, converging, as did Tracy, blind adult from New York (Kennedy, 2003). The further glasses are drawn smaller, closer together and higher up the page. He also drew the sides of a table converging. In sum, in Figure 1 one-point perspective is present in three tasks.

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

Insert Figures 1, 2 and 3 about here

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

Figure 2 has drawings of a model house. Top left is the house from the front. The rectangular roof is drawn converging. Top right is the house from the end wall, showing its peaked roof. From above the roof is drawn as adjoining rectangles, in parallel projection. Bottom right are two drawings of the house situated with a corner in front of the observer. EA's first drawing is the upper one, with parallel oblique lines showing the

sides receding in depth. The second is a sketch he made while explaining that the sides meeting at the corner can each be drawn “narrowing.” It is in two-point perspective, the first ever such drawing observed from EA.

Figure 3 shows EA’s three-cubes drawing. The cube on the right is the one in front of the observer. The top converges upwards on the page. The top of the middle cube (left of the “cube in front”) is drawn converging up the page and to the right. It converges to the same area as the lines for the top of the cube in front. The top of the cube on the left is drawn with highly tilted lines, converging sharply to the area above the cube in front.

The vertical face of the cube in front is drawn converging downwards slightly. (This is a hallmark of a tilted picture plane.) The angle between its left and right sidelines (measured between straight lines made by joining the line junctions at the top and bottom of the sidelines) is 7 degrees. This may be EA’s second use of two-point perspective, but the convergence is slight. For present purposes we emphasize that lines for three vertical edges of the cube to the left are tilted -- 15 to 20 degrees to the vertical, bottom towards the right, in a five o’clock position, pointing to the area below the cube in front. The three vertical edges of the leftmost cube are tilted in a similar way (each about 20 degrees to the vertical). As a result, if the lines for the front face of the cube to the front are extended downwards, and tilted lines for verticals of cubes to the left are extended, they converge.

The sizes of the cubes diminish as they recede to the left. For convenience, take the line for the left edge of the cube to the front as a standard. The line for the same edge of the cube to the left is .62 of the standard. The same edge in the leftmost cube is .4 of

the standard. As a result of this diminution, an imaginary line connecting the tops of the three cubes and another imaginary line connecting the three bottoms converge to the left. In addition the set of cubes is flanked top and bottom by lines converging to the left, suggesting the support surface receding to the left. These were drawn last.

Lines for three tops converge to a region above the cube in front, sidelines of vertical faces point to the region below, and sizes diminish to the left. Tops converge to show z, verticals on the left tilt in showing y, and sizes diminish (converge) for x, taking in all three spatial dimensions.

Discussion

EA's drawings include one- and two-point perspective. In the three-cube drawing he uses distance between lines diminishing in several ways in the three dimensions of space, approximating three-point perspective.

It may be especially revealing that cube verticals were shown tilting and thereby converging. This suggests a tilted picture plane (Kubovy, 1986). A set of verticals project as parallels if the picture plane is parallel to them. The idea that a tilted picture plane is relevant is reinforced by EA's behavior while drawing the three cubes. He held his hands, tilted, halfway between his face and the table – something he did not do for any other drawing. He posed for about a minute, evidently considering the task. He then began drawing steadily and decisively. We suggest he was considering the directions of parts of the scene from the vantage point of his head, and how these intersect the plane defined by his hands.

EA said that the tasks with the glasses, table and chairs, house from different vantage points and three cubes were novel. If so, Figures 2 and 3 may indeed be his first

use of two-point and an inventive approximation to three-point perspective. He previously drew receding sides of an object converging, but, to our knowledge, always as if one side of an object was parallel to the picture plane and one was receding. In contrast, a house with its corner forward has its two orthogonal sides both receding from the picture plane. What is new is that EA applied the convergence principle to both sides, generalizing aptly from the one-point case, and then to three sides of a cube. He generalizes his use of convergence to novel tasks. He is not restricted to examples learned by rote, if the house-corner and three-cubes tasks are novel. If he generalized from comments about drawing sides of roads converging with distance -- a modest level of supportive feedback and instruction -- integrating this with tactile information about direction, his achievement is noteworthy.

EA considers cubes to the left of straight-ahead can be drawn smaller the further away they are. However, if the x dimension of the picture plane was parallel to the front faces of the cubes all their fronts would all be drawn the same size. To depict objects to the left smaller, the picture plane should be rotated out of the frontal plane, anticlockwise viewed from above. However, the frontal cube is drawn with parallel horizontal lines, as if the picture plane is not rotated. EA may simply have argued that since the cubes to the left are receding in distance they should converge in size, much like his cars in Figure 1.

Why was diminution with distance appreciated by EA? A major reason could be that convergence is a matter of direction. That is, just as visible objects lie in different directions around a seated sighted person, they lie in different directions for a blind observer reaching out to touch them. Visual and tactile reaching directions are identical. Both sighted and blind observers use direction in daily routines. For both kinds of

observers, as an object recedes the directions to its sides come together. What is important is that the spatial skill underlying the routines may support use of an approximation to three-point perspective in the blind as well as the sighted.

Though EA's use of kinds of pictorial diminution may be rooted in common, everyday skills with direction, we speculate it is nevertheless notable for theories of development. Direction information is used in connection with convergence in drawings only after very considerable drawing development in the sighted child (Willats, 1997). Drawing development in the sighted normally plateaus at one- or two-point perspective. In many years of testing thousands of sighted children and adults drawing cubes we have not seen an instance of a sighted person who draws in three-point perspective without having been explicitly taught.

EA did not calculate exact rates of diminution, and exact directions of convergence. But the three-cubes drawing contains space between lines diminishing roughly in the right directions to conform to the three dimensions of space.

That EA is so advanced in drawing development suggests blind children and adults should be given pictorial opportunities in plenty. Blind and sighted children may be on the same drawing-development ladder, likely to go through the same stages.

EA selects his own topics and draws at his own behest, depicting novel objects successfully in the judgment of the sighted. He indicates he receives modest feedback from observers in the form of interest and praise, and we and Ms. Eroncel have observed this in several circumstances. To produce pictorial forms, he does not depend on being taught specific drawings, though he notes that if he wants to know the color of an object he has to ask. We hypothesize that his skills with forms, suitable vantage points of the

observer, and kinds of projection are largely his own devising, relying on direct interaction with objects and lots of practice in drawing. However, the roles of feedback, tasks and solutions from other people, and matters such as the availability of models for the blind and the sighted, deserve a great deal of attention, and our hypothesis should be recognized to be a conjecture.

We should note that the house-corner task is especially pertinent to a key principle. EA applied the convergence evident in a one-point perspective drawing of the roof to the front and sides, in two-point perspective. Just so, the Renaissance discovery of exact perspective is thought to have resulted from Brunelleschi, the architect, drawing a building in Florence (the Baptistry) that had two receding orthogonal sides (Kubovy, 1986). The selection of the house-corner task favors development, it might be argued. Once EA generalized convergence from one to two dimensions, to cope with the house corner, the way to three for the cubes may have been facilitated. If so the possible role of a facilitating task needs to be made clear. In addition, since we have given this task to other blind people (Kennedy, 2003; Kennedy and Juricevic, 2003) but they did not invent two-point convergence, it seems likely there is a role in development for a prepared mind, highly practiced with principles used in certain tasks, just as much as for new tasks relevant to a key principle. That is, EA's regular use of one-point convergence in several tasks may reveal he was ready to advance developmentally, given a well-defined and suitable task to which a variation of one-point convergence could be applied.

In sum, in his drawings EA used diminishing distances between lines to depict recession in one, two and three-dimensions. Convergence in direction due to increasing distance from a vantage point matters to the blind and the sighted. Pictorial diminution in

all three spatial dimensions is an advanced development, which we suggest EA reached more on his own initiative than through instruction. The developmental route he has taken may be open to the blind for the reason it is to the sighted. Directions of objects from a vantage point matter to both touch and vision.

References

Axel, E. and Levent, N. (2003) Art beyond sight. AEB and AFB Press, NY, NY.

Heller, M. A. (Ed.) (2000) Touch, representation and blindness. Oxford University Press, Oxford.

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

Kennedy, J. M. (2003) Drawings by Gaia, a blind girl Perception, 32, 321-340

Kennedy, J. M. and Juricevic, I. (2003) Haptics and projection: Drawings by Tracy, a blind adult. Perception, 32, 1059-1071

Kennedy, J. M. and Merkas, C. E. (2000) Depictions of motion devised by a blind person Psychonomic Bulletin and Review, 7, 700-706

Kubovy, M. (1986) The psychology of perspective and Renaissance art. Cambridge: Cambridge University Press.

Lopes, D. M. McI. (2003) Are pictures visual? A brief history of an idea. In Axel, E. and Levent, N. (Eds.) Art beyond sight. AEB and AFB Press, NY, NY. (Pp. 176-185.)

Motluk, A. (2005) Seeing without sight. New Scientist, 185, No. 2484, 37-39.

Millar, S. (1994) Understanding and representing space. Oxford University Press, Oxford.

Willats, J. (1997) Art and representation. Princeton: Princeton University Press.

Figure captions

Figure 1

Drawings by EA using convergence in the z dimension: road with two cars, rows of glasses, table and chairs.

Figure 2

Drawings of a house by EA using parallel projection, convergence in one direction and convergence in two directions.

Figure 3

Drawing of three cubes, using devices to show recession in three dimensions. One cube is depicted as straight ahead (right), one is to its left (middle), and one is further to its left.

Acknowledgments

Joan Eroncel must be singled out for recognizing EA should be given scholarly attention. We thank EA for participating in this study. We offer this paper to Rudolf Arnheim, in his 100th year.

Figure 1(left)

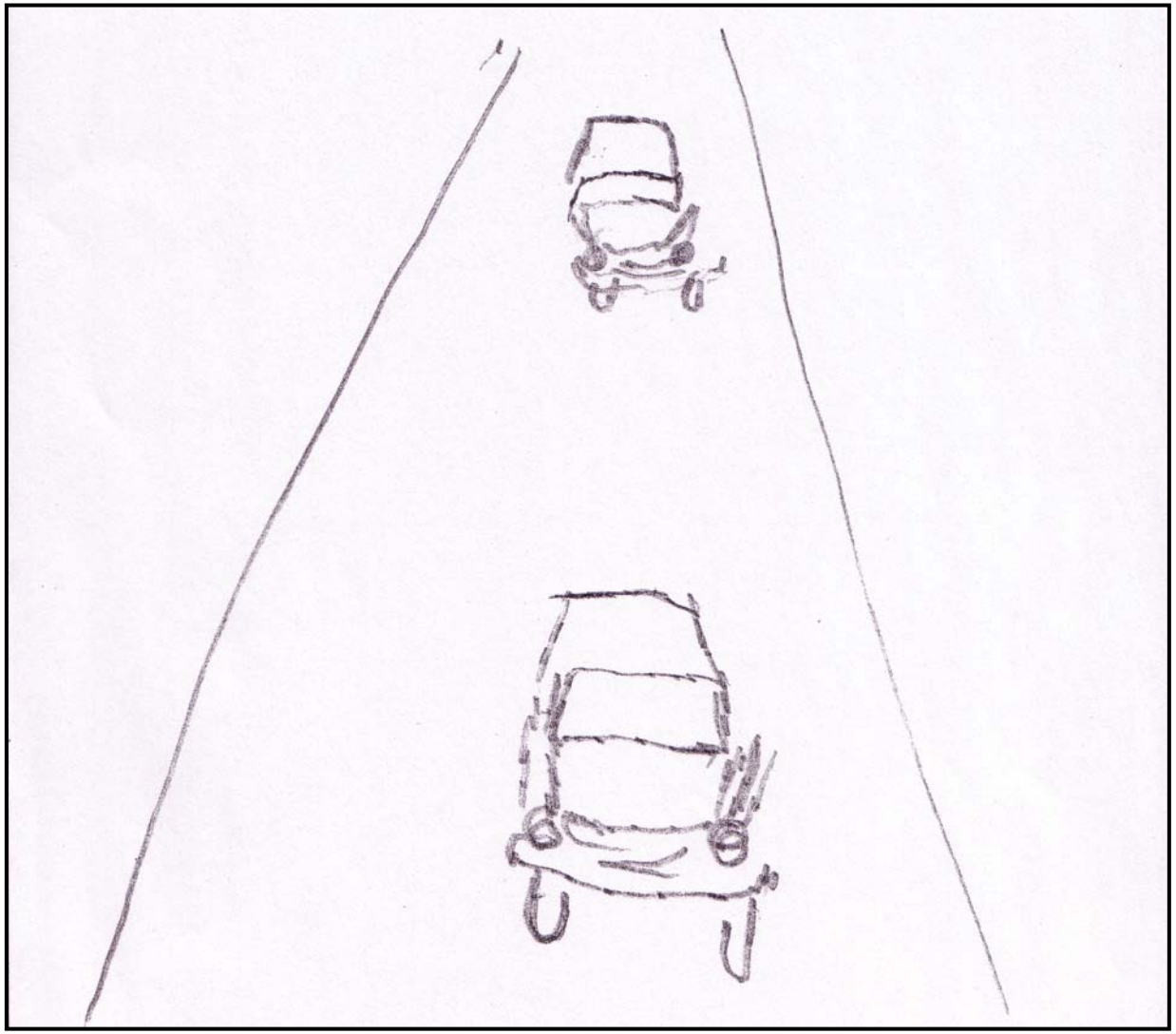

Figure 1 (middle)

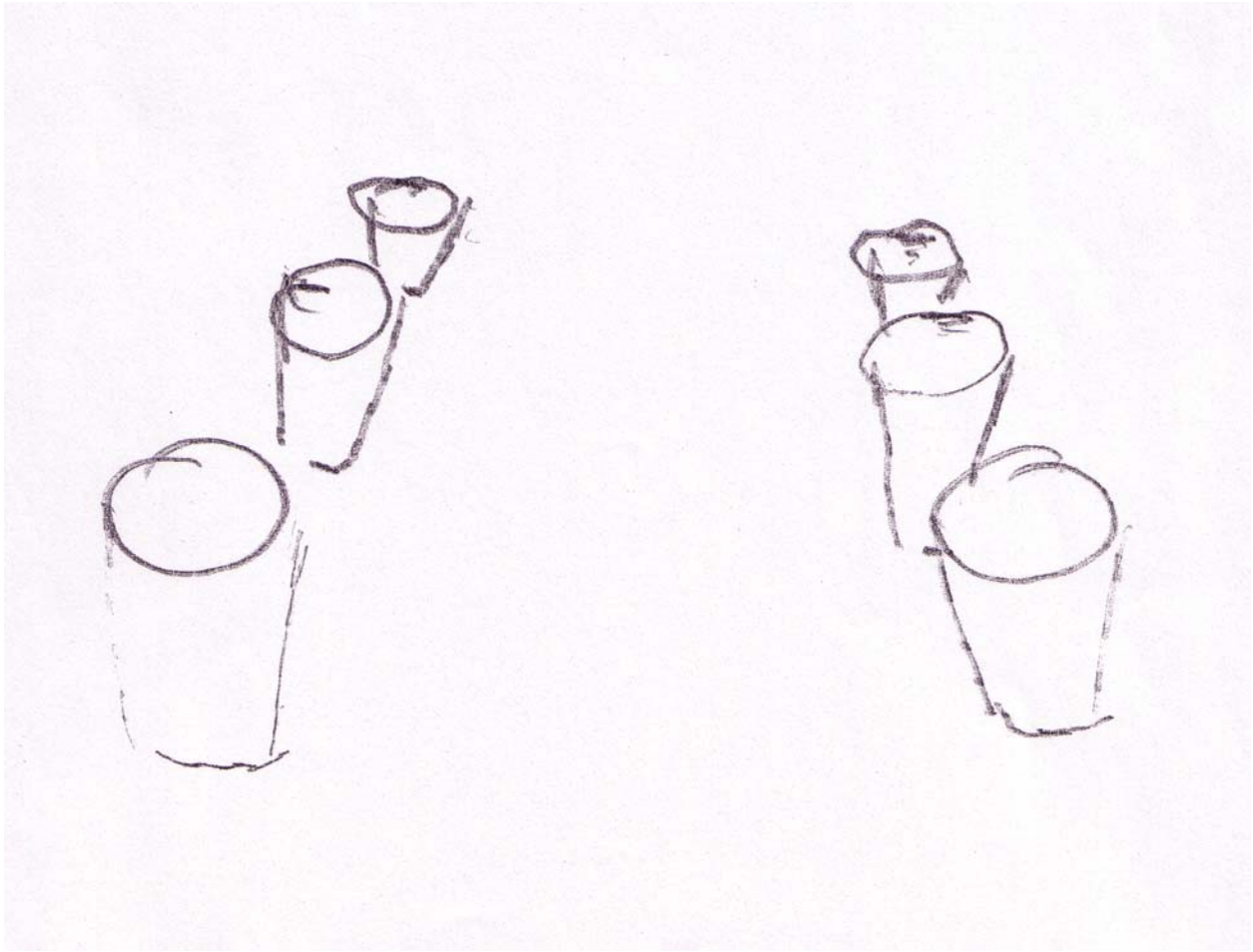

Figure 1 (right)

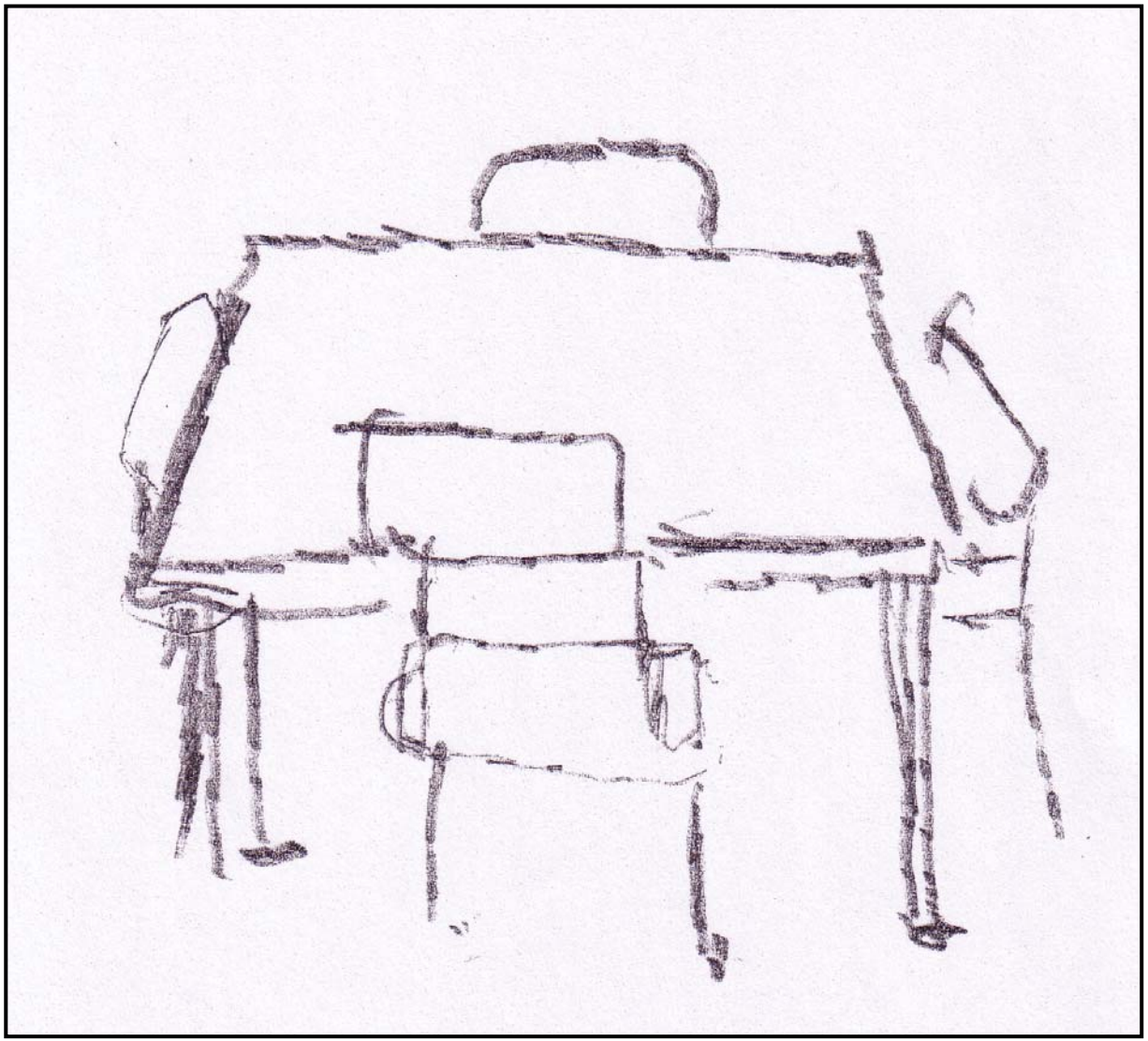

Figure 2

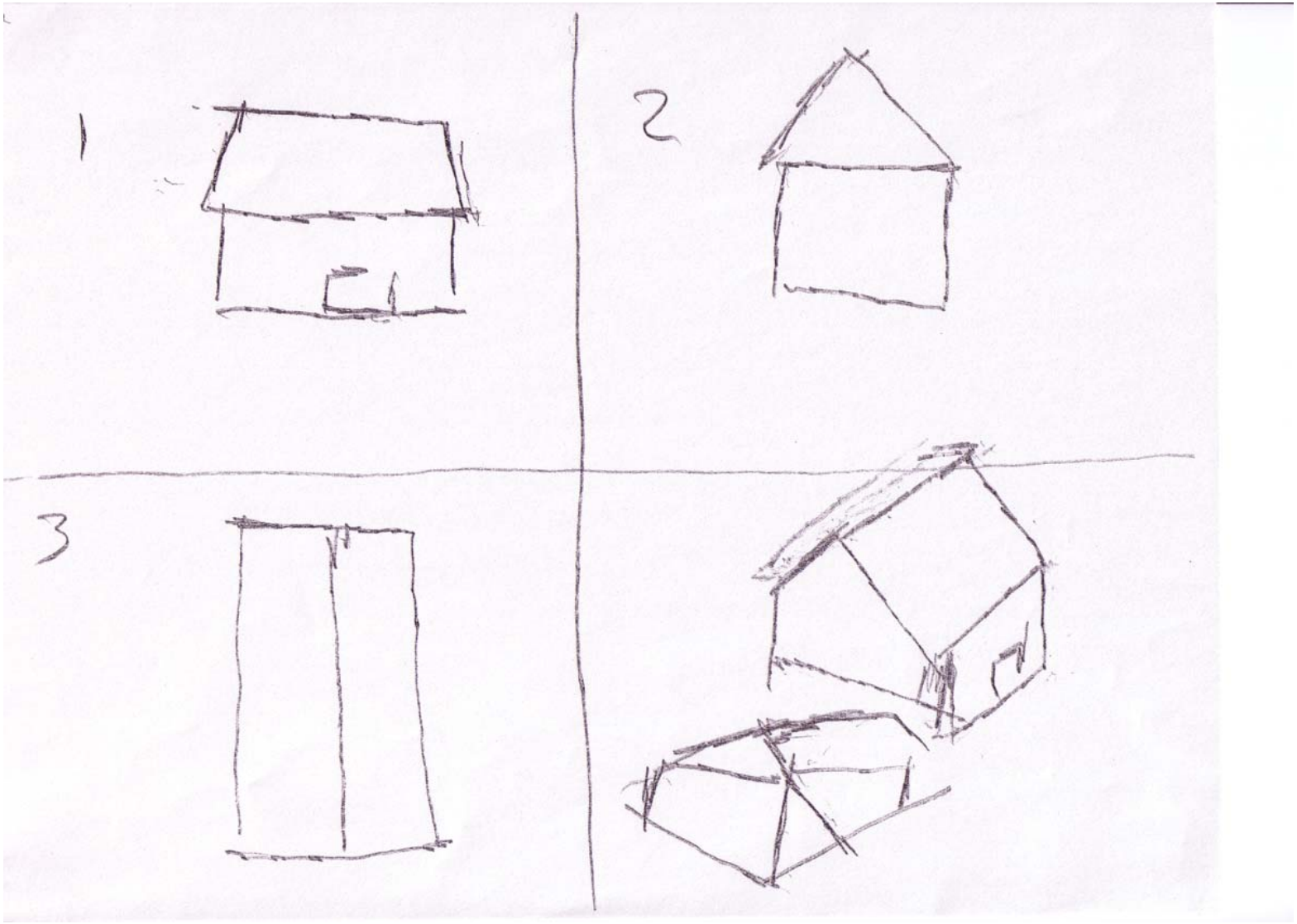

Figure 3