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# Outline, mental states, and drawings by a blind woman

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**Abstract.** Outline pictures depict surface edges, and via extensions from this base they can represent sensory and psychological referents. Outline drawings standing for edges of surfaces are relatively ancient, and lines for actions, sounds, and psychological states quite recent—mostly little more than a century. The novel finding here is that lines for psychological states of several kinds are invented by a blind woman, EW, who began making raised-line drawings as an adult. Notably, she invented novel devices representing thoughts and emotional impressions. If lines depict surface edges literally, they depict motion, sensory effects, impressions, and thoughts metaphorically.

## 1 Introduction

Blind people can depict objects and scenes (Amedi et al 2008; Axel and Levent 2003; Heller 1989; Lopes 2006; Millar 1972). The range of tactile pictures is debated (Eriksson 1998; Hopkins 2004). It will be argued here, in this study, that a blind woman, EW, depicted psychological states in metaphoric pictures. What is new in this report is EW's cognitive topics—impressions and thoughts. Expressionism may have influenced EW, I will suggest.

Kennedy (1974) argued outline drawings copy discontinuities in perceptual input, but here the key idea is that lines primarily stand for surface edges (discontinuities of depth and slant), and discontinuities of other kinds are secondary. The theory described here attempts to answer the questions: *What do lines depict? With what physical features? What inputs matter? How can the scope of lines be extended?* My presentation is phenomenological and uses Gestalt grouping and the Gibson (1979) idea that pictures copy informative shapes (Hochberg and Brooks 1962). I will suggest lines and edges trigger groupings I will call *filaments*. Realistic pictures copy edges. Depiction of sounds and thoughts introduces metaphor.

### 1.1 *Theory of outline*

In 1749 Diderot wrote that a blind man recognised a person's profile drawn on his hand as a line (Kennedy 1993). An explanation is still needed (Lederman and Klatzky 1998; Lopes 1997). We require a theory of vision and touch that deals with the actual physical line in a drawing (Laursen 1990) and also with edges of a represented surface. Blind subjects beginning to use pictures recognise and draw raised-line pictures of familiar objects (D'Angiulli et al 1998; Heller and Ballesteros 2006). Those with extensive voluntary experience with pictures—rare cases, one from Rome, one Ankara, one New York, one Toronto, and EW from Augsburg, Germany—depict a wide range of referents (Kennedy 2008a, 2008b). However, most tactile pictures studied to date copy true form (Willats 1997, 2005)—a ball's occluding bounds as a freehand circle, a book's occluding edges as a rectangle. True forms are visible and tangible. They have been shown since cave art times (Tedesco 2007). A Medieval example of profuse use of line, the *Utrecht Psalter* (820–835 Common Era) has true-form outline on every page (166 drawings in all). Besides true form, the *Psalter* uses parallel projection (parallel edges in the referent shown by parallel lines in the picture) and inverse

perspective (receding parallel edges in the object shown by lines diverging on the page). In the 1400s, linear perspective began to be used systematically. In this, receding parallel edges are shown by converging lines with the rate of convergence related to the distance of the vantage point from the picture plane (Kubovy 1986).

### 1.2 *Directions and projected figures*

True forms of edges are tangible and so they should appear in drawings by the blind. But, in addition, blind people may readily appreciate that lines show egocentric directions. Indeed, drawing development in the blind and the sighted may entail increasing emphasis on egocentric directions and projected forms (Nicholls and Kennedy 1992). Projected form in vision is called visible figure, following the Scottish philosopher Thomas Reid (Hopkins 2000, 2003). Projected form is present in touch too, as observers reach out to the edges of a distal object. The directions to edges of a table vary as the vantage point moves, and if the vantage point from which one reaches out descends to close to table height the set of directions becomes highly compressed—foreshortened in touch just as it is in vision. Impressions of direction may be especially important in depiction for the blind. Like a sighted person looking at a picture, a blind person feeling an outline may have a two-fold impression (Hopkins 2004, 2008; Lopes 1997) of a real surface with a raised line at a particular distance and direction, and a depicted surface in a particular direction and nearer than a depicted background. Two-fold impressions of physical lines and depicted surfaces fit a mimesis definition of pictures. “Pictures typically elicit experiences as of the scenes they depict, which experiences resemble, in important respects, face to face experiences of the same scenes” (Lopes 2006, page 12), and “this claim is neutral as regards the sense-modality of the scene presenting experiences ... it does not presuppose that the experiences are visual ... Some pictures are made of raised lines standing for objects’ outlines and touching the raised lines typically elicits the scene-presenting experiences” (Lopes 2006, pages 16–17).

### 1.3 *Physical lines on picture surfaces*

What part of a line depicts a surface edge? The physical features on a picture’s surface can be continuous threads or separate dots. Both trigger Gestalt grouping phenomena (Hecht et al 2003; Todorović 2008; Wertheimer 1923). The grouping has a location on the picture surface and egocentric direction from the observer but no brightness or colour (in vision) or pressure (in touch). It cannot show the colours of a rainbow or the darkness of a shadow (Cavanagh and Kennedy 2000). It appears continuous even if the elements being grouped are discrete. Let us call the continuous group the *filament* of the line. In both vision and touch, grouping as a filament may be the internal neuronal activity that supports perception of surface edges.

Hypothetically, a filament is present in a continuous line and if the input elements are dots it connects them. Emrich et al (2008) speculate that lower brain regions support perception of the dots and gaps, and higher regions provide the apparent continuity. They suggest discharges active in unison, with feedback, allow component features of a perceptual object to belong to the same object. While neural synchrony may not be the final explanation of connectivity, apparent continuity needs to be accounted for. Many perceptual objects could rely on Gestalt grouping principles in lower-order brain regions to create them (Kimchi and Peterson 2008). Of interest, fragmented elements that are physically aligned join perceptually even if their spacing is larger than that of surrounding elements (Kovács and Julesz 1994). Alignment is perceived, not just proximity. Also, Emrich et al (2008) find that perceived connectivity persists momentarily when the elements that give rise to it are removed, suggesting that a filament may be triggered by low-order elements but, like the Cheshire Cat’s smile, may exist as a form at brain levels above those sensitive initially to the elements.

Mid-level grouping principles based on patterns in the environment could also help create filaments. These include rules for joining surfaces, and 3-D projection principles related to vantage points of the observer. Further, connectivity could be influenced by more cognitive factors, such as familiarity with particular objects.

Spillmann and Ehrenstein (2004) argue for parallel stimulus processing in several retinotopically organised brain areas, and, of importance, cross-talk between these and non-visual regions. Likely the same holds for tactile brain areas with cutaneous-region organisation, and their access to cross-talk. In this model of brain processing, a final, stable form can be influenced by many regions, though “the cortical representation of surfaces is still a matter of conjecture” (Spillmann and Ehrenstein 2004, page 1582).

Unified fragments provide two kinds of connectivity for a region—the edge, and the surface. The edge is to the side and the surface is to the fore and between the edges. The boundary edge may have implications for the region’s surface, implications that can be used in outline drawings. In this connection, Grossberg and Mingolla (1985) described a feature processing system in which information due to high-frequency boundaries is diffused uniformly across neighbouring regions. Regions can be defined by low-frequency information, but are subject to features triggered by the high-frequency information. Thereby, filaments defining continuous edges could be sources of surface features extending across the neighbouring regions—filling in, broadly understood (Spillmann and De Weerd 2003). Besides allowing filling in of colour and brightness, the filaments may help provide regions with surface properties such as apparent slant, solidity, and distance (Rubin 1915). Filaments defined by different kinds of inputs (eg monocular or binocular) could control regions and surface perception in similar ways.

I propose that the depicting filament can be at one of a line’s contours, at both, or in the middle. To understand this suggestion, consider that outlines in cave art are often quite thick physically (Tedesco 2007). I will focus on a case in which one exterior contour of a line provides a depicting filament. Consider a sharply pointed V shape, inverted and pointing upwards, depicting the horn of an ox and drawn with thick lines. Since the lines are thick, the exterior contour of the V and the interior contour are obvious. Of interest, it is the exterior contour, and not the interior one, that depicts the sides and tip of the horn. Notably, the exterior contour comes to a point that depicts the tip of the horn. The interior contour also comes to a point but, naturally, it is inside the V. Further, because the line is thick, the interior contour and its point are a considerable distance from the exterior contour and its point. The narrower the V, and the sharper the point, the further the point of the interior contour is from the depicted tip. For a notably narrow V, the interior contour of a thick line falls short of showing the horn’s tip by a wide margin. In contrast, the interior contour of a very thick line might provide the depicting filament standing for the border of the belly of the ox. In addition, if the line is not particularly thick, the filament can be in the middle of a line.

Depicting a corner, the filament often lies in the middle because if each contour stood for a surface edge, the edges would be separated by the thickness of the line—the corner would appear to have a crack or caulking. And, of interest to tactile picture theory, just like vision, the grouping principles of touch may enable a filament to be located at the middle of a line, at either contour, or at both.

#### 1.4 *Even breadth*

Line thickness plays a role in depiction. Rubin (1949) described an *even-breadth* impression. A thick, wiggly line can depict a trail of toothpaste squeezed from a tube. In this case, both contours of the line provide filaments, enclosing the rounded surface of a 3-D body that appears to have the same thickness along its length despite twists and turns in the line. To perceive the thickness of the body, part of the filament on one side

of the thick line is grouped with part on the other side, and the parts grouped keep the apparent thickness uniform. Depicting a thick body, the line's two boundaries stand for occluding bounds between the perceivable front and the hidden back of the object, bounds given by tangents to the body's surface from the observer's vantage point. The interior of the line stands for the convex rounded 3-D foreground. Other even-breadth referents include a rut or crack with foreground on the sides of the line and the line's interior depicting a recessed space (Cutting and Massironi 1998; Kennedy 1997). Hypothetically, touch might use two filaments in Rubin's even-breadth fashion, like vision.

### 1.5 *The inputs that are perceived as surface edges*

In 1688, Molyneux asked whether blind people, who knew the shapes of cubes and spheres by touch, could recognise the objects if an operation gave them sight (Morgan 1977). Information in touch might be available to vision. The same point can be made within vision. Vision can make out one and the same surface edge from a spectral border and a luminance border; a monocular border and a binocular border; a static border and a kinetic accretion-and-deletion border defined by elements being occluded and disoccluded (Kennedy et al 2003). Likewise, physical features on picture surfaces generate many kinds of inputs to the perceptual system (Cavanagh and Kennedy 2000), including ones in which elements are physically separate. Spillmann and Ehrenstein (2004) point out there is evidence for neurons sensitive to foreground and background direction not only at luminance borders but also at separate elements giving rise to illusory contours and separate elements in random-dot stereograms giving rise to stereo edges.

In vision, continuous filaments based on separated elements support apparent surface borders. Likewise, we may touch an occlusion or corner with splayed fingers with gaps between the fingers but the tangible border appears continuous, particularly if the hand is moving along the edge (Gibson 1962; Lederman and Klatzky 1998). That is, given discrete inputs, we pick up the information for continuous surface edges, with the same shape and egocentric direction, in vision and touch from many input borders, visual and tactile, and from dotted and continuous lines.

### 1.6 *Non-literal depiction*

Static line drawings are not copies of motion in the scene, and in simply showing surfaces they cannot depict mental states. True for the sighted, this is also true for blind perceivers and creators of pictures. Indeed, Gaia, a totally blind girl of 12, saying pictures cannot show motion (Kennedy 2003), distinguished what pictures cannot show from what she did not know how to draw (eg a house from a vantage point above a corner). Nevertheless, in the 1800s, curious devices extended the range of line depiction. Here I suggest these are metaphoric pictures, relying on features in common with their referents (British Museum 1938; Kennedy 1982).

In 1810 Berwick (in Northern England) drew a cartwheel in motion by fading the spokes and replacing them with arcs centred on the hub (Kennedy et al 1993). Thus began a change in illustration in the nineteenth century, especially the last two decades (Gombrich 1972; Kunzle 1973, 1990; McCloud 1993; Mainardi 2006), producing action devices now used worldwide in comic books. Action lines resemble visible tracks left on the ground applied to the air metaphorically. Since breezes are invisible, lines showing their path—breeze lines—are also metaphoric for the sighted (Kennedy 2008a), as are sound lines coming out of a window of a musician's room [an early sound line example from Outcault (1895–1898) appears in a panel from 5 July 1896]. If action lines, breeze lines, and sound lines are based on common properties with their referents, they could be appreciated and invented today by blind people inexperienced with comics (Kennedy and Merkas 2000). Indeed, EW commented that lines she drew radiating from a swimmer's hands might be metaphoric to the sighted but they are literal to the blind (Kennedy 2008a). Within a large body of water, streams

of water running through the swimmer's fingers can have distinct surface edges in touch, while being invisible to sight.

### 1.7 *Common properties and thoughts*

Devices for psychological states too might rely on features in common with the referent, and be invented by the blind. An early example, in *Scraps* of 17 March 1887, from London, shows a drunk looking at a door which seems to have ten keyholes surrounded by swirling action lines, showing us the inebriated experience (Clark and Clark 1991, page 19). Simultaneously we see the sot and what he experiences—many unstable keyholes. Lines radiating from a person's head emphasise the referent and suggest anger, surprise, or insight depending on the context. Stars and planets such as Saturn around a head suggest trauma in a 1922 *Barney Google* (as shown in Perry and Aldridge 1971, page 128). If the *Barney Google* five-pointed stars are a metaphor for the bright sparks we see after concussion, the early use of the addition of a planet is an entertaining, hyperbolic *metalepsis*, a metaphor based on a metaphor (Vicari 1993). Some devices for mental states are pure conventions [eg a question mark above a character's head in a 1916 comic, as shown in Goulart (1990, page 176) is an early use of a convention for being taken aback], but stars and swirls have significant features. Concussed we see stars, and dizzy we see wavy motions.

To date, the range of pictures for the sighted is broader than the range shown to be comprehended by the blind. The task of the present report is to present pictures showing one blind person's abilities across a range of literal and metaphoric images, and in particular to show depiction of cognitive and affective states using features common to the states and line pictures. To this end, I present below a case study of EW detailing four remarkable pictures.

## 2 **Methods**

### 2.1 *Participant*

EW is a totally blind woman, born in 1972 in Japan, and has lived in Germany since 2000. She was interviewed in December 2008 and February 2009. As a result of retinal blastomas, both eyes were surgically removed in infancy, the right at 11 months, and the left 6 months later. She has a BA degree (English literature and linguistics, Tokyo), and an MA in library studies (British Columbia). In 2003 she met Elke Zollitsch (2003), a junior-school teacher whose blind students drew raised-line pictures of common objects such as people, trees, towers, balloons, bicycles, cars, and carts. Zollitsch encouraged EW to draw. In 2006, I interviewed her for the first time and subsequently published a report of four of her drawings (Kennedy 2008a). The primary purpose of the 2008 and 2009 meetings was to study new pictures drawn by EW, and to give her drawing tasks concerned with use of line and projection systems.

Like most blind people (Hayhoe 2003, 2008), EW was not encouraged to draw as a child. She recalls being told as a child that blind people cannot draw and that her drawings were poor. However, shortly after beginning to draw with Zollitsch's encouragement, she took holiday trips on which she carried a drawing kit. She used this to record scenes and experiences of interest. She indicates she chooses the topic unaided and devises the picture herself.

### 2.2 *Materials*

With a ball-point pen, EW draws on plastic sheets resting on a rubber mat. The sheets depress and rebound under the ball point resulting in a thin raised line—tangible and visible. The lines appear white. For clarity, her figures are presented here with contrast reversed. The size of the originals of the figures is 27 cm by 34 cm, including the margin containing the picture title. EW brought 87 pictures to the interviews. These were a selection she made herself from her 2006–2008 drawings. The images

include scenes from home in Augsburg, and trips to Australia, Italy, Kenya, and Canada. The referents include people, buses, kangaroos, buildings, flowers, rock outcrops, and insects. EW draw a line about 2.5–3.0 cm above the bottom of each picture and wrote her initials, the topic of the picture, and, usually, the date. The pictures are usually oriented as landscapes—wide dimension horizontal. Exceptions use the vertical to show heights (eg a rope suspended from a cliff).

### 2.3 Interview procedure

The information in this report comes from interviews in 2008 and 2009. In face-to-face interviews, EW was questioned non-directively. She was asked to describe each picture one at a time, and she was questioned about particular lines by placing her hand on a line and running along it, while saying “What does this line stand for?” or by guiding her hand to a section of the picture and asking “What does this part of the picture represent?” or “What do the lines at the top (or bottom or left or right or centre) of the picture stand for?”. The lines were described as forms (curves or rectangles or parallels or zigzags) without mentioning referents. Occasionally, on a tabletop her hand was guided around a shape on a larger scale than the form in the picture, to help clarify the form in question. She was also asked about specific features, such as dots. Because of time constraints, EW was not asked about every line in every picture. Her comments were written down at the time of interview, and read back to her as they were written. Occasionally, EW corrected herself and the corrections were written down and read out. Only her corrected text is quoted here. Some additional questions were answered by e-mail in February 2009. These also were non-directive (eg “What did the shapes XX in picture ZZ stand for?”). Spelling has been corrected in the quotations from e-mails, but the wording is verbatim.

## 3 Results

I will describe each of the four drawings by EW, focusing in turn on depictions of physical features (how objects and parts of the environment are drawn), on aspects of perspective, on action lines, and finally on line representations of affective and cognitive states, in each case emphasising what is novel. By way of *précis*: EW’s figure 1 shows rock pillars and trees on a desert plain, with short vertical lines for breezes. The pillars may be drawn in a literal manner, breeze lines metaphorically. Figure 2 shows sounds from a pond—loud frog calls drawn as dense, textured, thick lines—a strong metaphor for sensory impressions and their variations. Figure 3 contains long trails of small sinusoids that EW meant to represent warm impressions carried around a beach scene—a historical trace rather than a physical pathway. Figure 4 contains a cup of hot coffee, with dense oblique lines for heat. Curved lines around the cup stand for meandering thoughts. Consider EW’s comments on these figures in turn. Quotations are mostly from the face-to-face interviews, with any from e-mails given a tag—the word email and a date.

Figure 1 is *Pina* (short for Pinnacles) dated 11.18.08 but should be 11:08:08, she said when asked about the numerals. Set in Australia, it is “the pinnacle desert we visited in our tour. There are different sizes and shapes of pinnacles. These were just pillars, spread all over. Some are far away. Those are the smaller ones at the top. Simpler lines. Cone shaped. Some of the ones I touched. I tried to draw how the surface feels like. The ruggedness and the different heights”. Asked about the dots in the picture, she said: “The sand. It was a desert. There were some trees that are not too tall, and some taller than some of the pinnacles”. She indicated some of the shapes depicting trees. Asked about oval clusters of lines, she said: “Shrubs you couldn’t get through”. Asked about vertical lines, some quite thin, between the other forms, she said: “These are occasional winds from the sea. The sea is not there. It is close to the sea”.

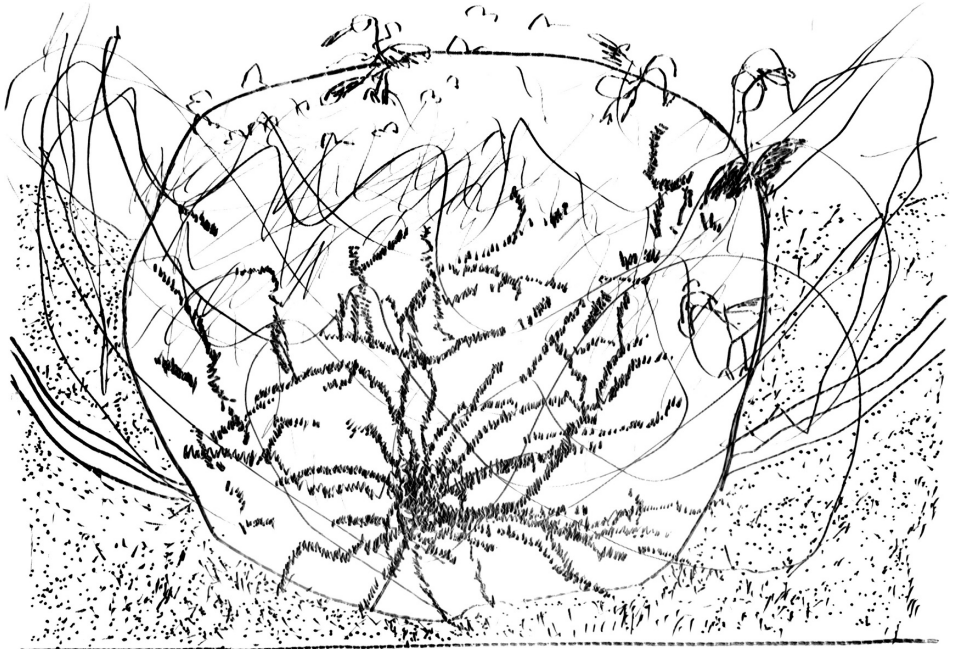


**Figure 1.** *Pina*, 11 August 2008, by EW. In the top middle is a vertical line depicting a breeze.

She was asked about the different sizes of the pillars. She said the smaller drawings at the top of the picture show distant pillars. She indicates she drew the figures smaller and smaller, roughly, to show their distance, and did not judge carefully how small to make them.

Figure 2 is *Banjo Frogs*, Lake Derwent, Oatlands, Tasmania, 31 August 2008. EW said: “On Tasmania, they have this dried-up lake. I could walk on it. It’s covered with grasses. All over this lake you hear these groups of frogs. King frogs. Bigger ones. They have deeper vibrating voices”. Asked what the large circle in her drawing showed, she said: “The outline of the lake”. Asked about the large number of curved lines crossing the lake outline, she said she drew “some faint lines that represent the wind that day”. She added: “I only tried to represent the sound of the frogs. It sounded like they were scattered across the lake. Some of them were together in groups. There is a dense one”, she said, indicating a knot of thick lines at the centre of the bottom of the picture “and a couple of smaller ones”, she said, while indicating the smaller group at top right. She went on: “And at one part of the lake you hear it more intensely. And in some other parts it is more scattered. It sounds like they are in communication”. She continued, “the zigzags are the vibrating voices of the frogs. It is not a single frog. Each line of zigzags represents the chorus”. Asked about dots in the picture, she said: “Dots? Sand around the lake. I only did half”. Asked about shapes at 3 o’clock and noon on the circle, she said these are ducks. “Ducks, far away, we walked past them.” Asked by e-mail about the parallel lines from left and right coming to the large circle, she replied (e-mail, 12 February 2009): “The route we took to go down into the lake and come back up again. It was a tiny, dried-up lake”.

Figure 3 is of *Mindil Beach*, Darwin, Australia, drawn about 22 August 2008, she commented during the interview, noting that the date was inadvertently omitted from the picture. She said it shows “the swimsuit market at the beach with lots of exotic atmosphere. There are rows of stalls and street musicians playing music.



BANJO FROGS

LAKE DERVERTON OATLANDS

310808

EW

**Figure 2.** *Banjo Frogs*, Lake Derverton, Oatlands, Tasmania, 31 August 2008, by EW. The jagged dense lines stand for choruses of frog calls.



MINDIL BEACH

DARWIN

EW

**Figure 3.** *Mindil Beach*, Darwin, 22 August 2008, by EW. The sinusoid crossing from bottom to top middle stands for a pleasant impression being carried around the scene.

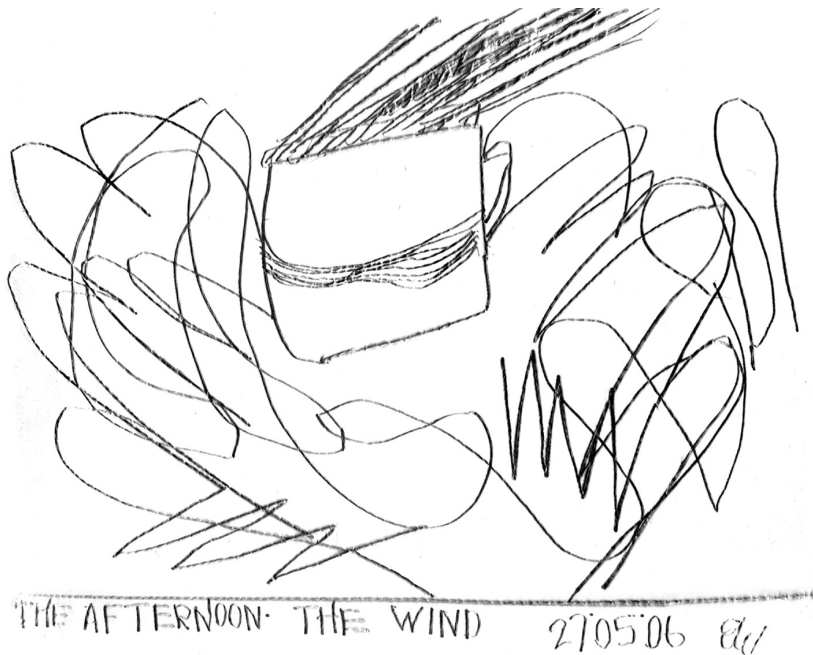


Lots of food. You go down to the sandy beach. In front of the sandy beach is [sic] the gentle waves". About the small sinusoids and zigzags that commence in the bottom right corner, left of a seated figure, she said: "That's the atmosphere you pick up at the market. Part of the scent you pick up at the market, part of the humidity, and the heat. It was very sultry because it was in the North of Australia. It was hot and humid. Tropical exotic atmosphere in the air". She was asked about the line: "Why does it go where it does?"—"That's the route we took [EW was with her husband], wandering through the market". She noted: "People are sitting eating on the beach or standing" and said "I wanted to divide the beach from the rest of the market. There was a clear line into the water. You are not allowed to go into the water. No one was swimming. Because of the danger of sea-water crocodiles". Asked about the small circles at the top left and right, with oblique straight lines coming across the beach area from the top right, she said: "The sun and the moon". She did not comment further at the time but returned to the small quadrilateral forms. "The squares are mostly stalls. I also did some fruit or things that might represent what they are selling. There is someone sitting playing the guitar [bottom right] and a person standing playing four didgeridoos [centre left], and something to put the didgeridoos in. And someone else playing drums [middle right]." She commented on the challenges in the picture by saying: "This is one of these difficult pictures to make. Markets are so hard to draw. I tried in Palermo".

In an e-mail of 7 February 2009, she wrote about the small circles: "It was the sunset market beach that opens only in the evening, till it is dark. So that is when the sun and the moon do their change of shift. And I remember being totally in awe of it, visiting a special sunset beach". She added: "Mood: relaxed, quietly happy, balmy. In Darwin, it was extremely warm and sultry even in what the locals call the dry season. The climate and the atmosphere was therefore very tropical. There were lots of people, but the overall impression ... was slow and peaceful .... All these created for me a rather exotic impression. The combination was something that is totally out of my daily life reality. It made me feel enchanted". She noted about the didgeridoos: "Another playing several didgeridoos of various sizes simultaneously—there was a sort of rack [centre right in the picture] that could hold those instruments at different heights". She mentioned that "coming from the market all the way to the beach ... the music was defining the mood".

Figure 4, *The Afternoon, The Wind*, dated 27 May 2006, is a picture of a cup surrounded on three sides by wavy lines. On both sides near the bottom are zigzags. In addition, oblique straight lines were attached to the line for the brim of the cup, and the cup contained wavy lines—closely packed generally horizontal large-wavelength sinusoids, the lowest in the picture just over one cycle, grading to the highest which has less than half a cycle.

EW said the coffee shown by the packed sinusoids "is still in the middle of the coffee cup, almost empty but still warm so it steams. Coffee steam coming out. I was thinking a lot. Not a cheery thought. The wavy lines are my meandering thoughts". They are an "endless wave of stream of thought that leads to nowhere. The zigzags are my sighing. Quite heavy ones, every now and then". She commented on the picture: "It's good. It doesn't have too many unnecessary lines". Later in the interview she mentioned that the steam is sensed by her hand as heat and her hand is placed above the brim of the cup to one side. In an e-mail of 27 February 2009 she described the packed sinusoids as showing the liquid level.



**Figure 4.** *The Afternoon, The Wind*, 27 May 2006, by EW. The lines around the cup stand for thoughts and the bottom middle zigzags for sighs.

#### 4 Discussion

My purpose in this discussion section is to show the forms of the lines in figures 1–4 suit their referents, with close attention to metaphoric devices for wind, sound, heat, and thoughts.

Figure 1 depicts a ground plane and, in the picture, pinnacle size is graded in free-hand perspective. Breeze lines are found where sand dots are omitted, the clearest example in the upper middle of the picture. A vertical line, it has a shallow V shape. To its right, past a stick-tree shape, are four other short vertical wind lines, partly as parallels but mostly as individual lines. EW was asked about these lines. Her finger was lead to the upper-middle line and then the four to its right. She indicated the lines stood for occasional winds. The lines fit the direction of winds and their shortness, isolation, and disconnection fits occasional. She has also used clusters of lines for winds in other pictures (eg in 3 of 14 pictures examined in December 2008). One showed strong winds, such as a wind vigorous enough to blow sand, and another showed a rock arch through which strong winds blow. Another showed winds in a beach scene.

The top-central breeze line in figure 1 is an individual line not a pair. Paired lines could stand for tangible edges of an invisible stream of air or water, which would be use of outline for edges, and, as EW commented, literal for touch while being metaphoric to the sighted (Kennedy 2008a). Taken as a line following the main path of the moving air in a space between obstacles, it is metaphoric.

The pinnacles in figure 1 exemplify literal drawing, with realistic forms and ways of projecting depth. In her terms (27 February 2009): “I used to draw pure objects like an object that I mostly know or have touched before like persons, animals, household things, plants, buildings, fruits and so on”. She called this “drawing objects plainly”. She contrasted this with later drawings: “Now together with the objects I also draw other senses like smell, taste, feelings—tactile feelings I mean—and weather, emotions, atmosphere and so on”. As weather, breeze lines fit this category, deemed here to be metaphoric.

The edges of her pinnacles are outlined, and her trees are stick figures. Her bushes use dense forms to show them as impassable. Individual forms and their deployment in space are shown by freehand perspective, successfully depicting the environmental basis of depth and size perception—a ground plane (Gibson 1950).

In figure 1, higher denotes further in distance. On a ground plane, bases of receding objects elevate in direction from the observer (Juricevic et al 2009). EW also drew distant objects small. The topmost row of forms in the picture consists of small cone shapes (top left cone of the row, 1 cm tall). The row of cones just below is about twice as large (top left of the second row, 1.8 cm tall). The next row of pinnacles in the top third of the picture is drawn twice as large again (top left of the row, 4.2 cm tall). The largest have their basis in the bottom quarter of the picture. The central pinnacle is 12.4 cm tall.

Figure 1 is further evidence that blind people can draw in realistic ways. This capacity could be a basis for distinguishing literal and metaphoric ways of drawing. Consistent with the theory above, EW uses lines for edges of objects. Corners are not depicted in figure 1, but, in drawing a limb of a starfish, she drew a line for a convex corner. She said: “The line in the middle—that’s the highest [part] of this arm. It has a distinctive corner ... some volume, declining on both sides”.

EW depicts spatial layout in realistic ways. Indeed, while she uses rough rules of thumb, not calculated rates of foreshortening, her graded foreshortening is sophisticated in the development of drawing in the sighted child (Golomb 2002; Nicholls and Kennedy 1992; Willats 1997), except she made no use of obliques to depict receding edges. Her graded depiction of a ground plain is more advanced than the drawings by 8–10-year-old blind children studied by Zollitsch (2003). These generally show objects lined up left-to-right but not graded in the vertical dimension simultaneously to show foreshortening. In sum, figure 1 shows a significant level of ability to draw realistically, capturing perspective features of the 3-D world with lines used for edges and, in addition, in its breeze lines it includes apt metaphoric use of line.

In figure 2, choruses of vibrations are drawn as dense zigzags, in EW’s terms. Often the lines on the page are actually dense hatch marks. For example, the main knot of these lines has a leftward limb at 8 o’clock with l, V, and M shapes formed by the hatch marks, including several M shapes attached to one another, in a row, and so the picture does indeed contain zigzags. However, a rightward limb at 2.30 o’clock has many separated hatch marks. In this instance, the two limbs, together with over twenty other limbs (twenty-four in total by my count, several more matched than zigzag) come from a particular locus and spread out. This suggests a nest of frogs in one location, with calls radiating from there. It is not clear if the undulations of the lines of zigzags and hatch marks represent calls waxing and waning, but that would fit. Also, the intensity and roughness of the elements fit with loud, raspy frog-calls. Their combining at times and being more separable at others is suggested by the limbs sometimes overlapping each other, as well as by zigzags and separate hatch marks.

Comic-book artists since the 1890s have drawn a few lines coming from trumpets and windows to show sounds, but trails of dense hatch marks and zigzags are novel, remarkable, and apt. The trails are dense, with many marks and ups and downs close together on the page, radiating from a main location that is large in comparison to its limbs, in keeping with a blended chorus of calls. EW has drawn devices for other sounds—in Kennedy (2008a) a trumpet’s sound was shown by a simple cone of straight lines—but figure 2’s device is unique. It is not an action line, not a surface-edge line, not a tactile topic, and it is not thought. It shows variation, plainly, by varying on the page. By being dense and with thick heavy lines radiating from a centre, it stands for a sensory impression that involves vivid events repeated closely spaced in time, spreading out from a central locus.

In figure 3, *Mindil Beach*, what is of special interest is EW's assertion that an atmosphere is drawn as a thin sinusoidal line, from the lower right continuously through the rows of stalls and then on to the beach area. She stated that the line stood for an atmosphere, that was tropical, sultry, and exotic, and something you pick up, blending scents, humidity, and heat. The mood she relates to this is relaxed, quietly happy, and balmy. The minor sinusoidal variations in the line shape depict the atmosphere, while the large trail these make criss-crossing the picture show the path taken by EW and her companion. The lines are continuous and lengthy, with the minor sinusoids present from the beginning to the end of the lines. On the larger scale, by taking paths through the mid-section of the scene, reaching to the beach, the lines also show sounds from the market carry to the beach and sustain the mood there. The minor sinusoidal variation is generally smoother than the swooping lines and angular zigzags in figure 4—in keeping with the change from coffee-cup-scale to a terrain and a more positive mood. The sinusoidal variations cross the picture several times, the smaller sinusoids representing a long-lasting positive atmosphere, and the larger ones a path through the scene. (The sinusoids are paired in the middle region—EW was walking with her husband.)

EW is explicit that figure 3 lines are intended to depict atmosphere, and it is quite possible that by this term she included a mood as well as a blend of the sensory impressions. By comparison, in figure 4, angular zigzags are heavy sighs, each change of direction obvious in each zigzag. The direction changes in figure 3 are more rounded—a shape generally taken to have soft, warm, positive referents, while angular forms are harsher (Kennedy 1997; Liu and Kennedy 1997). Warmth, humidity, music, and smells in combination produce an emotional tone and it is that affect she depicts in figure 3, not any particular sensory signal. As a depiction of atmosphere, with or without her mood, figure 3 represents a personal reaction, a mental state, rather than a single distal or proximal external stimulus such as the frog calls in figure 2.

Most originally, in addition to heat and sighs, figure 4 contains representations of thought. Motion in space is connected to meandering thoughts straightforwardly (Gibbs 2006; Lakoff and Johnson 2003). EW's thoughts did not come to a conclusion about her difficulties and the term 'meandering' applies both to moving without a clear destination and to thinking about problems without arriving at a solution. The lines may be a metaphor not a metalepsis, matching meandering cognition to the shape of a line without requiring an additional, intermediary metaphor. She offered no comments about an intermediary. She simply described their shape and the course of her thoughts with similar terms (Matlock 2006).

The curves showing the sequence of thoughts turn back on themselves. The lines cut across each other. Beginning and end are not obvious. The lines change direction smoothly in some places and abruptly at others. The traces do not proceed in a straight line, which might be used for a clear, orderly argument with a goal. The curving, abruptly doubling-back, criss-crossing shape of the line is apt for its referent—troubled, lengthy thought that repeats itself but finds no answer.

Some of the lines for thoughts turn into large zigzag lines for sighs. A connection between thoughts and sighs is made on the page. The zigzag lines suggest motion in one direction and its reverse, with abrupt changes in direction several times, like several heavy sighs raising and lowering one's shoulders.

EW uses zigzags and sinusoids repeatedly but with different referents—frog choruses, impressions, thoughts, and sighs. To be specific, they require some context. That is, in the context of specific pictures they have significant features relevant to their referent—density, smoothness, and angularity. The chorus of calls is shown by very dense repeated elements, the comfortable impression by a smoother, less dense sinusoid; thoughts by inconsistent, curving lines; and sighs by jagged lines with straightforward directions between changes in direction.

The obliques that represent steam involve two principles. They suggest steam coming to one side of the cup, not because it is blown there by a wind but, EW commented, because that is where she had her hand and sensed the heat. That is, the lines stand for a selection of the steam and heat radiating from the coffee. The effect on the observer is the basis for the selection of part of the heat and therefore the directions of the lines. In Kennedy (2008a) EW showed tequila by drawing a glass with liquid and adding, separately, sinusoidal lines coming from the glass to depict the effect of the alcohol on the drinker. The result is obliques and sinusoids that refer to the observer's experiences. What is unique here is that the obliques depict the physical topic while simultaneously revealing aspects of the percept.

EW was asked to describe what led to her showing sounds, impressions, and thoughts. In an e-mail of 7 February 2009 she wrote:

"I began by drawing concrete objects, animals and people from my childhood memories, such as my pet rabbits ... The idea of bringing other elements such as sounds, smell, impressions, feelings, atmosphere etc. gradually came to my mind. ... Another new method I started experimenting with at that time is to take a particular scene or part of a day and try to draw the overall impression of that scene or part into a picture. The coffee cup picture was one of those."

In an e-mail of 9 February 2009 she wrote:

"What led to bringing intangible elements like sounds, smell, feeling etc. ... As I was experimenting with my drawings, the idea of utilizing other supporting elements such as smell, sounds, feeling etc. gradually developed in my head. ... For instance, I discovered I could probably represent the particular tulips I have touched ... by first drawing the flowers themselves, and then adding the things that made up ... those particular moments I was experiencing the tulips, such as the soft breeze blowing in the garden, birds' chirping in the distance, occasional traffic noise, the scent of grass, the warmth of the sun etc. And so it has developed further. ... The reason for that, I guess, is the urge to draw, and to record certain impressions in a multisensory way. ... For example, I have just returned from a pleasant walk and am feeling well, healthy and creative. And want to draw. Nothing particular about that walk occurs to me to draw, but I want to have the impression from that pleasant walk recorded. So I try to put together different factors of that walk into a picture, such as crystal clear air, the feeling of soft snow under my feet, some children I met on the way, trees I have walked past etc. ... Bringing not touchable elements into the pictures and drawing the overall impression are similar to each other."

About drawing objects versus feelings, she wrote: "The first method, I think, is more focused on a concrete object while the second is more abstract". As a reviewer noted, it may be that EW typically draws what she takes to be concrete objects before adding metaphoric elements. But she can proceed directly to metaphors, for in drawing a mariachi band she included no concrete objects, only representations of sounds (Kennedy 2008a).

To support the contention that EW's devices are her own inventions, consider a text by the person who encouraged her to draw. Zollitsch (2003) writes that her blind students draw "spontaneously and independently" and the students' drawings have revealed "their imagined view of the world as they experienced it" (page 159). She does not examine the drawing for 'something missing' since "in his drawings the blind child reveals and illuminates this unique existence", because the drawings are 'direct' and 'immediate expressions of their personality' (page 161). In sum, she provides support rather than instruction and advocates self-expression.

Miesel (2003, page 4) wrote: "The word (expressionisme) is French ... and the idea of self-expression was developed in France first in the studio of Gustav Moreau and then by his most gifted student Henri Matisse". One result was German Expressionism, an influential school in the twentieth century, reflected in Zollitsch's non-directive goals,

avoiding explicit instruction. EW reports that her drawings are often shown to Zollitsch. Although Zollitsch is highly positive about her pictures, Zollitsch does not instruct her. Zollitsch does not suggest topics, insist on certain techniques, point out flaws or advise on possible improvements. Further, the topics and metaphoric devices in figures 1 to 4 are not present in her work with nine visually handicapped children (Zollitsch 2003).

Evidently, EW's drawings are created independently. They reveal a wide range of topics that may be understood without conventions being taught, motivating the kind of broad theory attempted here. They support the view that besides physical referents, the blind can devise metaphoric pictures with apt devices for purely cognitive referents.

Some cautionary notes deserve to be aired. First, EW may well have heard it said that objects in the distance look smaller, and other features of perspective may have been mentioned in passing. How and when such hearsay influences drawing by blind people remains to be determined, and is clearly a significant but complex matter, in part because hearing about the rules of perspective and translating these into drawings seem to be quite different issues. If the development of drawing in the blind is like that in the sighted, such remarks may have an impact mostly when the person has been through earlier stages in spatial representation in which diminution with distance is not used. Second, some shapes she drew such as the sun and moon in figure 3 could only be known by instruction. Third, EW was interviewed some time after her drawings were completed. While her remarks are clear and pertinent, in principle some aspects of her comments may be a posteriori. Reinterpretations or reconstructions may have occurred. One wonders what impact non-directive questions can have on reconstructing an interpretation. How this might change the conclusions here is unsure. However, most of her comments are about referents of major forms in the pictures and there is little doubt about their intent. Finally, her metaphoric drawings require explanation. Unaided, their topic would not be apparent. They are unusual inventions, idiosyncratic, ingenious. Their aptness becomes evident once their topic has been stated. For example, likely no one would guess that figure 2 shows frog choruses. EW's metaphors are like riddles requiring an explanation (eg Why is a raven like a writing desk? Because Poe wrote on both). Once the referent is explained, the relevant features are clear.

In conclusion, EW's drawings fit a theory of outline pictures in vision and touch. The blind can draw individual static physical objects and scenes literally and realistically, using lines for surface edges. They can deploy lines metaphorically for motion, sound, and psychological matters. Most originally, on her own initiative, EW has devised line devices for psychological states, including sensory events, mood, and thoughts.

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