

A Fearful Symmetry: Borges and the Geometric Language of the Brain

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...for a man is fearfully and wonderfully made, and curiously wrought.

(Psalm 129)

Jorge Luis Borges has often been read as a kind of architect of labyrinths, as a master builder of elaborately structured tales that transpire in a rarefied atmosphere remote from social and political concerns. These readings are often based on flawed assumptions as to how Borges establishes a relation of the human intellect to the world, or the notion that his aesthetic concerns are somehow divorced from political realities. Gabriel-Garcia Marquez, though profoundly influenced by Borges, describes his work as a "literature of evasion" (qtd. in Alazraki 13). Paul De Man claims "His stories are about the style in which they are written" (23), positing an enclosed, self-referential system. John Updike similarly sees Borges' fiction as a sealed object that contains truths too delicate for the cold light of day: "His ideas border on delusions; the dark hints ... he so studiously develops are special to the corrupt light of libraries and might vanish, one fears, out of doors" (67). These readings miss a profound element of what Borges' work offers, that is, an invitation to consider foundational aspects of the nature of our being in the world. As Robert Scholes remarks, "we have missed the reality of Borges because we have misunderstood his view of reality and of the relationship between words and the world" (130).

There are other commentators, who, like Scholes, have resisted the prevalent strains within Borges criticism. Daniel Balderston writes that critics "have embraced his 'fantastic literature' or denounced him as escapist, both reactions which assume that the stories have nothing significant to say about reality, history, or politics" (2). Jose Eduardo Gonzalez makes a similar point: "For years critics have refused to address the question of politics in Borges. With a few exceptions, most critics still see Borges's fiction as 'apolitical' or 'ahistorical'" (3). And Mark Frisch concurs: "Critics have not looked seriously at his epic tales from the standpoint of politics. Nor have they thoroughly considered the nature of the self as it relates to politics" (130). While this article will not take up the subject of politics directly, it shares the concern of these critics that Borges has often been read in too narrow a fashion and without sufficient consideration of the importance of particular material and historical realities to his writing. By considering how Borges' stories illustrate aspects of the embodied nature of cognition, this article seeks to bolster readings sensitive to ways of viewing "the nature of the self" that are not normally considered in criticism of Borges. Through an examination of the way in which Borges' fiction is suggestive of some recent findings in the field of neuroscience, this article provides a materialist reading of his fiction without foreclosing on the enigmas and quandaries with which his work so often deals.

In order to discuss Borges' fiction in terms of neuroscience it is necessary to address the mutual web of exchange between literature and science that harkens back to their long historical interrelationship and their bases in imaginative discovery. Though there are certainly recognizable differences between disciplines, there has been a growing awareness of ground held in common. Elinor Shaffer has called the

current approach of the humanities to the sciences "a central feature of intellectual life" (12). George Levine writes "Literature has been unable to avoid science because science asserts an epistemological authority so powerful that it can determine even how we allow ourselves to imagine the world" (8). At the same time science dominates cultural consciousness, it is also dependent on the tools of literature. A host of writers across disciplines (Kuhn, Feyerabend, Latour, and more recently, Beer, McCloskey, and Gross, among others) have pointed to the dependence of science on narrative and metaphor and to the way scientific knowledge is informed by cultural norms, stressing the "contingent construction of scientific representation and the embedding of its symbols in the language and culture of its time" (Sleigh 6). Borges' thought experiments as to the apprehension of physical space are particularly relevant in this regard when considered alongside recent discoveries in neuroscience regarding the cognition of space.¹ Borges' treatment of science is not, however, uncritical. Allen Thiher sees Borges' use of scientific knowledge as a way to critique modern epistemological structures: "Borges aims at demonstrating the aporia of scientific theory or, more generally, the paradoxes of any self-referential epistemic project" (220). Far from shutting down the conversation, however, Thiher claims that his work develops "experimental possibilities of an interface between science and literature" (238). The cognitive sciences have been a particularly fruitful point of interface in this regard, Steven Pinker noting a "coming together of the humanities and the science of human nature" (Brockman 50). This article hopes to contribute towards this interdisciplinary interface through exploring the questions raised by such an interface, and by examining the challenge Borges offers to modern epistemological paradigms.

May-Britt and Edvard Moser's 2005 discovery of grid cells in the entorhinal cortex of rats has opened new ways of thinking about how mammalian brains process visual stimuli. The way Borges formulates space in his stories "The Library of Babel" and "Death and the Compass" bears an uncanny relationship to these findings. In "The Library," Borges suggests that the hexagonal rooms are "a necessary form of absolute space, or, at least, of our intuition of space" (*Labyrinths* 52). The hexagonal firing patterns of grid cells, which form, according to Edvard Moser, a "triangular array overlaid on the entire space available to a moving animal" appear to offer something very much like Borges' necessary form (Figure 1).

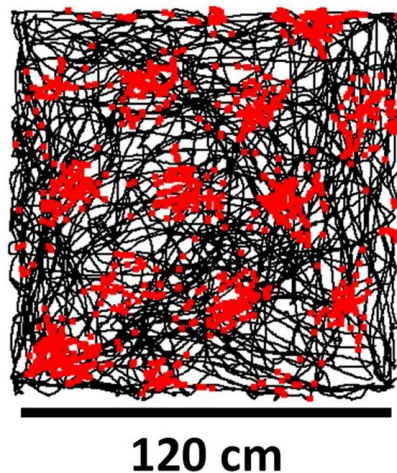


Fig. 1.

The black line represents the movement of a rat through a 120x120 cm space; the red dots represent the firing of grid cells. R.M.A. Hayman, G. Casali, J.J. Wilson and K.J. Jeffery. "Grid Cells on Steeply Sloping Terrain: Evidence for Planar Rather than Volumetric Encoding." *Frontiers in Psychology* 6.925 (2015). Permission under Creative Commons Attribution License.

Something like this grid is also visualized at the close of "Death and the Compass," when the protagonist "looked at the trees and the sky subdivided into diamonds of turbid yellow, green and red." Borges demonstrates something fundamental about the embodied nature of our seeing, as highlighted by recent work in the field of neuroscience. Drawing on the work of Kant, Wordsworth, Pascal and others, this article will consider how Borges constructs his oneiric spaces and what these spaces in turn suggest about grid cells and their implications.

"The Library of Babel" opens with the words: "The universe (which others call the Library) is composed of an indefinite and perhaps infinite number of hexagonal galleries," diffusing universal form into discrete physical units. This alignment famously appears in the work of Galileo, when he declared that the universe "is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures, without which it is humanly impossible to understand a single word of it; without these one is wandering about in a dark labyrinth" (qtd. in Saiber 18). For Borges, however, the geometric form provides the shape of the labyrinth itself rather than a decipherable language. Yet, this labyrinth is not entirely devoid of light, containing "spherical fruit which bear the name of lamps. There are two, transversally placed, in each hexagon. The light they emit is insufficient, incessant" (51). The use of geometric language ("transversally") to describe the placement of the lamps, along with the strange regularity and repetition of the library's form, suggests a kind of ideal and abstract environment. However, as Robert Burton, the author of Borges' epigraph demonstrates, there is a long history of the application of geometry to the human body. In his delineation of the body, Burton includes this description: "Fibrae are strings, white and solid, dispersed through the whole member, and right, oblique, transverse, all which have their several uses" (150). Borges' lights, in this anatomical context, bear a relation to eyes, suggesting that the universe/library is as much internally as externally located (the mere act of location implies agency, and it may be that what we find so compelling in this story is that it tells us something about our own minds). The hexagonal cells bear a marked resemblance to recently discovered grid cells which are involved in the perception of space: "Grid cells have multiple regularly spaced firing fields that, for each cell, form a hexagonal grid spanning the entire open space available to the animal" (Derdikman). The images below (Figure 2) depict the consecutive activity of a grid cell in the entorhinal cortex of a rat, where "t" equals elapsed time.

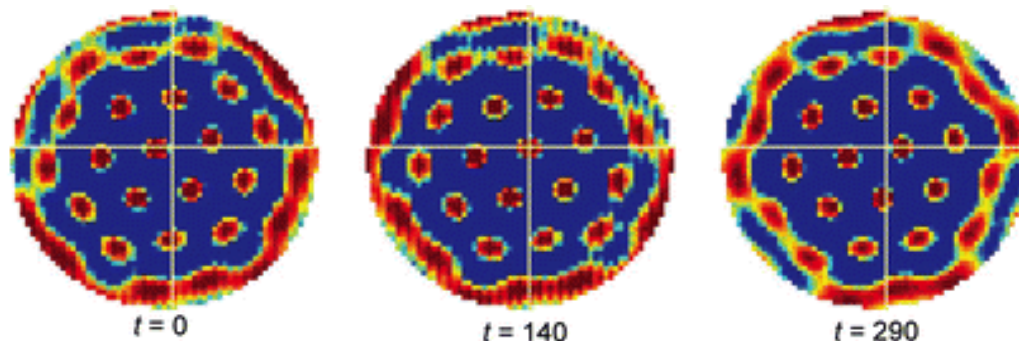


Fig. 2.

Edvard I. Moser, Emilio Kropff, and May-Britt Moser. "Place Cells, Grid Cells, and the Brain's Spatial Representation System." *Annual Review of Neuroscience* 31 (2008): 74. By permission of the author.

The word "cell" was not understood as the basic unit of life until the nineteenth century. Since the eleventh century the word has signified "A dwelling consisting of a single chamber inhabited by a hermit or anchorite" ("Cell," def. 1a). Borges' story appears to play on this original sense, as well as its later appropriation, and the vast difference in time between them. In a way, the text encourages us to consider the nineteenth-century meaning through the lens of its original eleventh-century space of contemplation. There is both a meticulously ordered method and a metaphysical inquiry at work in the voice of the narrator. The language employed in the story has itself a geometrical quality, as the words shape and are shaped by the space they inhabit. Before discussing further the implications of the discovery of grid cells for a reading of "The Library of Babel" and "Death and the Compass," it will be necessary briefly to describe the scientific background in which cognitive maps came to be theorized. This will enable a more thorough connection between the science and Borges' fiction.

A seminal 1948 paper by psychologist Edward Tolman describes experiments with rats in a maze which revealed the formation of cognitive maps: "incoming impulses are usually worked over and elaborated ... into a tentative, cognitive-like map of the environment ... indicating routes and paths and environmental relationships" (192). The basis laid down by Tolman for thinking about how the brain created maps of the environment was later extended by John O'Keefe. In studying activity within the hippocampus of rats, O'Keefe postulated that "the hippocampus provides the rest of the brain with a spatial reference map" (O'Keefe and Dostrovsky 174). He located cells within the hippocampus that fired when the rat was in a specific place in the testing area. This appears to be the first representation of a mammalian brain independently mapping place onto space, that is, marking out specific spaces with specific cells in the brain. O'Keefe suggests that the firing of these cells is not directly linked to specific sensory data, but has some deeper source:

... units fired maximally when the animal was in a particular location on the testing platform. Tests such as rotating the platform relative to the room or turning off the room lights suggested that the activation of those units was not due to any single sensory stimulus but instead depended on some more complex configuration of stimuli or perhaps on some abstract concept such as place. (O'Keefe 78)

O'Keefe's work provided a new way of thinking about what part the brain plays in constructing notions of the dwelling in and inhabiting of specific places. The notion that the brain acts independently of sensory stimuli in forming notions of place has recently been furthered by research on grid cells, which has revealed ever-greater complexity in the ways in which cognitive maps are formed. Following Edvard and May-Britt Mosers' discovery of grid cells in the entorhinal cortex of rats (for which, along with O'Keefe, they were awarded the Nobel Prize for physiology or medicine in 2014), a study of human subjects by Doeller, Barry and Burgess has indicated the presence of grid cells in the medial entorhinal cortex of the human brain.² Grid cells, unlike place cells, present regular firing patterns that create a grid across the entire space available to the animal: "Place cells differ from grid cells not only in their lack of periodic firing fields but also in the apparently random relationship between the firing fields of different neurons" (Moser, Moser, and Roudi). Grid cells and place cells work together with other cells (such as head-direction cells and border cells, see: Barry and Burgess, "Neural Mechanisms of Self-Location") in creating cognitive

maps that enable the animal to navigate through its environment. Grid cells' distinct arrangement of equidistant spatial firing fields led to the hypothesis that these cells encode a cognitive representation of space; that is, a representation which is not determined primarily by the environment, but is imposed on the environment by the brain (according to Sargolini et al., "An Environment-Independent Spatial Coordinate System"):

The discovery of grid cells, and their functional organization, opens the door to some of the first insights into the workings of the association cortices, at a stage of neural processing where firing properties are shaped not primarily by the nature of incoming sensory signals but rather by internal self-organizing principles. Grid cells are place-modulated neurons whose firing locations define a periodic triangular array overlaid over the entire space available to a moving animal. (Moser, Moser and Roudi)

In light of the above studies, and in anticipation of the direction of future research, the "hexagonal rooms" formed by grid cells appear to function as just the "necessary form" of the "intuition of space" described in "The Library of Babel." The positing of the letters of the books in the library as "organic" further suggests that the Library may be a metaphor for the material, the letters the elements of organic matter. Borges' construction of the shape and format of the books in the library may have been influenced by Daniele Barbaro, who in 1556 proposed the dimensions of the perfect treatise: twenty-seven books, sixty-four chapters, and 216 lines per chapter, cubes of three, four, and six, respectively (Saiber 15). Though the arrangement of the book in Borges' library contains no obvious geometrical ratio, they follow Barbaro's general three-part outline, containing "four hundred and ten pages; each page, of forty lines, each line, of some eighty letters" (*Labyrinths* 52). The resistance to a balanced mathematical relationship here is suggestive in what it relates about Borges' view of the indecipherability of the universe. A large number of the books of the library are unreadable; this does not mean they are without meaning, however. The hexagonal cells of the library retain the geometric ratio which the books dispense with, demonstrating that the site of knowledge is not the book, but the mind of the reader.

The hexagon, according to Floyd Merrell, is "perhaps the most frequently occurring ornamental design in human cultures throughout history," suggesting an embeddedness of geometrical form in human consciousness. Hexagons are prevalent both in nature and in human-made structures due to both their strength and efficiency. Hexagons in the natural world are perhaps found most familiarly in the beehive. Along with a diagram (Figure 3) which illustrates the process, Merrell describes how bees:

build their cells around themselves by gyrating about a point while secreting wax ... The form of the cell, one might assume, would be circular, but the capillary action of the wax adhering to itself causes it to cluster at six equidistant points along the circumference to form a hexagon, which is naturally the densest and most economical packing of the parallel cylinders. (199)

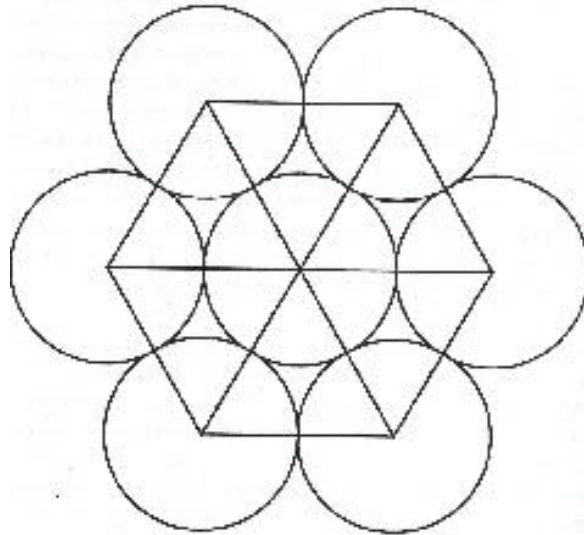


Fig. 3.

Floyd Merrell. *Unthinking Thinking: Jorge Luis Borges, Mathematics, and the New Physics*. West Lafayette, Indiana: Purdue UP, 1991. 199. By permission of Purdue University Press.

The bee gyrating about a point might be compared to the firing of grid cells at certain points as the animal moves through its environment. The clustering of the wax at “six equidistant points” recalls the six-fold symmetry of the grid orientation discussed above. “Dense” and “economical” would not only be accurate descriptions of Borges’ prose; they also apply to the symbol he employs. Grid cells allow the animal to map and navigate through a given environment, and provide a model that can be remembered for future use. The way in which *The Library* is divided into numbered “circuits,” which themselves contain an unknown number of hexagons, suggests the circuitry of the brain in a general sense, as well as describing the kind of path formation and path integration for which specific parts of the brain are thought to be responsible.

These “cells,” whether they refer to honeycombs or to the grid cells within the brain, might be described in terms of *The Library* as “*a ubiquitous and lasting system of hexagonal galleries*” (*Labyrinths* 58; italics in original). Yet, unlike the honeycomb, the hexagonal room and the grid cell are not objects of direct sensory perception, but can be posited as *a priori* conditions of vision, that is, as representing underlying conditions through which we experience the world (Kant’s view of space as an *a priori* therefore appears significantly bolstered by findings on grid cells). When Moser, in the previously mentioned study, refers to “internal self-organizing principles,” he stresses that grid cells are not shaped directly by sensory input, but are themselves part of an internal structure of perception. “Self-organization” is a scientific concept with a number of applications across various disciplines (including artistic creation, as described by Briggs and Peat). The term was first used by Kant to argue for the internal dynamic of the objects of nature as responsible for the observable organization of their forms:

The part must be an organ *producing* the other parts – each, consequently, reciprocally producing the others ... Only under these conditions and upon these terms can such a product be an *organized* and *self-organized* being, and, as such, be called a *physical end*. (557)

The Library may be thought of as such a self-organized system. Perhaps the most commonly given example of self-organization in the natural world is what is known as the Benard cell, which appears suddenly as a group of hexagonal cells out of an increasingly chaotic system (and which also may have had a role in inspiring the form of Borges' library). Benard cells are usually demonstrated by the heating of a liquid from below that creates a difference in density between the bottom layer and the top layer of the liquid, increasing turbulence within the system. Out of this turbulence the Benard cell spontaneously forms:

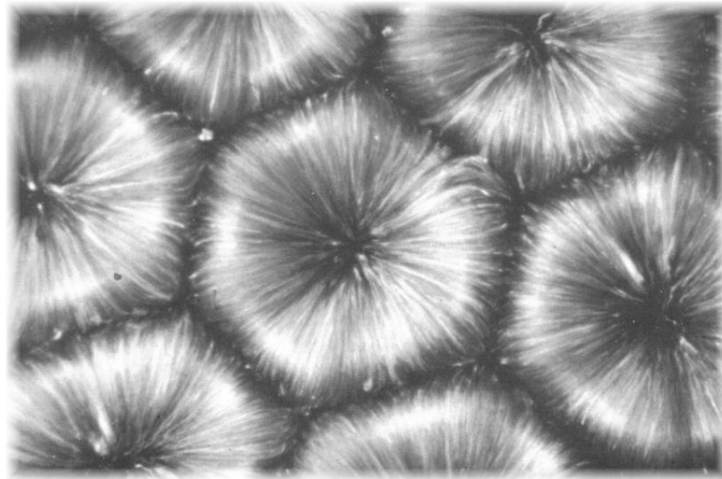


Fig. 4.

Milton Van Dyke. "Rayleigh-Benard Convection Cells." *An Album of Fluid Motion*. Stanford, CA: The Parabolic Press, 1982. By permission of Sylvia Van Dyke.

The Benard cell is thought to be a model of the way the earth's atmosphere behaves. According to John Briggs and F. David Peat: "Scientists think the spherical shell of the atmosphere, possibly the whole atmosphere, might be a sea of seething Benard cells" (137). This convection pattern can be seen in cloud formations (Figure 5), in patterns projected onto the earth's surface, such as in the Uyuni salt flats in Bolivia, or on the surface of Lake Natron in Tanzania, as well as on the surface of the sun (Figure 6).



Fig. 5.

EUMETSAT. "Open Benard Convection Cells off the West Coast of Africa." <http://www.eumetsat.int/website/home/Images/ImageLibrary/DAT_IL_01_08_23.html>. Copyright 2016 EUMETSAT. Permission under terms of use.

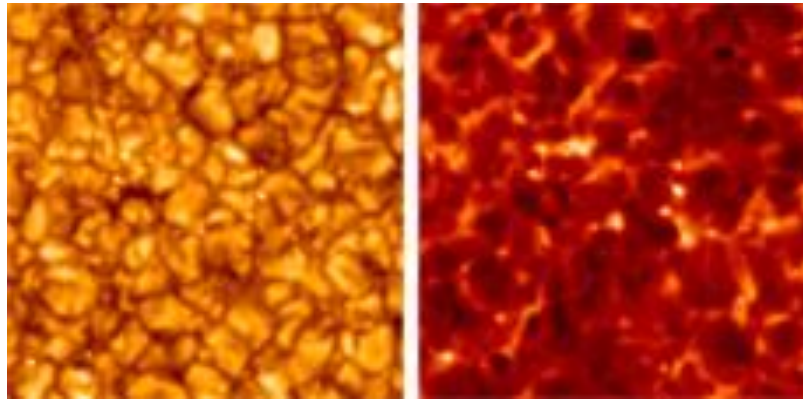


Fig. 6.

Japan Aerospace Exploration Agency. "Solar Surface Covered with Convective Cells." N.d. Digital image. *The Sun: Uncovering New Features of Our Closest Star*. Web. 27 Oct. 2014. Permission under JAXA Conditions for Material Usage.

These patterns, that form spontaneously and in a self-organizing fashion out of, to use Borges' words, "the divine disorder" (*Labyrinths* 56) are suggestive of the patterns formed in the books of the library, which are often unreadable but never without meaning. The "organic letters" which are "inimitably symmetrical" (53) suggest for the narrator the hand of a higher power. The narrator's speculation as to a "total book" that is a "perfect compendium" (56) of all the others might be seen in this light as a symbol of the principle of self-organization. A footnote, provided by an imaginary editor, explains the alphabet of the unknown author: "These two signs [the comma and the period], the space and the twenty-two letters of the alphabet are the twenty-five symbols considered sufficient by this unknown author" (53). That "the space" is given as a symbol is particularly significant in the way that it defines the unknown and imaginary, providing both outward shape and internal structure to the text.

The way in which the spaces of the self-organized convection cells resemble the spaces created by the firing of grid cells suggests an essential relationship between the mind and the world that is an often overlooked element in Borges' fiction. Kant's *Critique of Judgment* is relevant here as well, in that he relates the purposiveness of natural organisms to the workings of the mind, or more precisely: "the ascription of purposiveness to organisms is a matter of our regarding organic natural processes as analogous to reason's intentional activity" (Ginsborg). This relationship is famously described by William Wordsworth in the preface to *The Excursion*:

How exquisitely the individual Mind
 (And the progressive powers perhaps no less
 Of the whole species) to the external World
 Is fitted – and how exquisitely, too –
 Theme this but little heard of among men –
 The external World is fitted to the Mind;
 And the creation (by no lower name
 Can it be called) which they with blended might
 Accomplish. (*The Poetical Works* 5: lines 63-71)

Considering Borges in terms of Wordsworth provides further evidence for the importance of the relationship between the mind and the world in Borges' work. As counterintuitive as it might seem, Borges' work demonstrates something like this

fitting between the mind and the world, albeit removed of the teleology implied by Wordsworth here. The "might" or power also connotes creative possibility, or conditionality. For Borges, there is no "might" in either sense. The world and the mind appear to share an underlying correspondence, but we cannot know with any certainty what its purpose might be. A teleological creation becomes unravelled and the sense of accomplishment evaporates into the air.

What Borges calls "the perfect nightmare" ("Nightmares" 39) is perhaps the appropriate place to further develop this relationship with Wordsworth, and further demonstrate the depth of Borges' gaze into the nature of materiality. This is the Arab Dream episode from Book Five of *The Prelude*, in which the stone and the shell, geometry and poetry, become enigmatic symbols of human knowledge. The stone and shell bear a close comparison to Borges' Aleph and Zahir, as the Bedouin/Quixote who carries them bears a close resemblance to Borges: "Of these was neither, and was both at once" (*Major Works* 437). And the mysterious source of this dream raises the question of who is dreaming whom, a theme returned to again and again in Borges, most specifically in "The Circular Ruins." What these similarities indicate is the extent to which Borges is invested in a poetic and philosophical tradition that, however precariously, places the material embodiment of experience at center-stage.

In writing about his literary development, Borges explains how some of his early attempts at poetry were "poor imitations of Wordsworth" ("An Autobiographical Essay" 30). That Borges' first book was one of poetry, *Fervor de Buenos Aires*, is an important fact often overlooked by his critics. Borges later explains: "I feel that all during my lifetime I have been rewriting that one book" ("An Autobiographical Essay" 34). In a preface to these poems, Borges connects the poetry with an embodied sense of a particular place and its "familiar neighborhoods":

In this volume, Buenos Aires does not stand for the topographical convention implied by its name; it is my home, its familiar neighborhoods, and, along with them, what I experienced of love, of suffering, and of misgivings. (*Selected Poems* 268)

"Death and the Compass" returns to this Buenos Aires of the mind and body many years later, as the scene of a metaphysical detective story. Like "The Library of Babel," the story can be read to address certain underlying functions of the perception of space. The title itself addresses notions of directionality, position, and path formation ("la brujula" or "compass," refers to the physical instrument and does not carry the other meanings, such as measure, extent, or scope, that it does in English). Grid cells are often described as providing a kind of "internal GPS" or compass to individuals, allowing them to navigate their environments without getting lost. The events of the story occur in and around particular geometric points in space. This is related to the way the brain creates a perception of position in a given environment. The creation of a grid by the brain provides a sense of distance based on motion and knowledge of previous positions. The plot of the story, in this sense, offers a parallel to the way in which the mind functions in constructing a sense of space.

In "Death and the Compass," we find that the protagonist Lonrot "reflected that the explanation of the murders was in an anonymous triangle and a dusty Greek word" (*Labyrinths* 82) (or in Wordsworth's more idealized terms, the human experience of the world is most essentially distilled through "Poetry and geometric Truth" [*Major Works* 436]). The particular geometry presented also recalls the firing of grid cells (the personification of the triangle as "anonymous" furthers this

comparison). Border cells are relevant here as well, as they are thought to function as a kind of anchor for the geometric structure of grid and place cells: "Border cells may be instrumental in planning trajectories and anchoring grid fields and place fields to a geometric reference frame" (Solstad et al). But it is the "triangular array overlaid on the entire space available to a moving animal" described by Moser that, besides recalling the "mystic equilateral triangle" (82) sent to Treviranus, is strikingly similar to what the protagonist experiences just before he is captured: "The evening moon shone through the diamonds of the window; they were yellow, red and green. An astonishing, dizzying recollection struck him" (84). Perhaps even more telling is the moment at the story's conclusion when, without any mention of filter, "the sky subdivided into diamonds of turbid yellow, green and red" (86). These diamonds, or lozenges, which repeatedly appear in the story, are necessarily doubles of Sharlach's equilateral triangle. He knows that Lonrot will be compelled to draw out this reflection and seal his own doom, as confidently as a mathematician knows the result of a simple sum. This geometric configuration of space is something woven into the fabric of the tale and demonstrates Borges' obsession with what for Blake was a "fearful symmetry" ("The Tyger").

Lonrot's "astonishing, dizzying recollection" might be read as the understanding of the way geometry and language reflect one another. In establishing this reflection, Borges takes part in a long tradition. Arielle Saiber, in her study *Giordano Bruno and the Geometry of Language*, provides background for a perceived correlation between geometry and language during the Renaissance:

Similar to Barbaro's theory for the ideal shape of a treatise, the French philologist and utopian thinker Guillaume Postel published a text in 1553 on the inherent geometric features of written language. Other Renaissance thinkers, such as Luca Pacioli and John Dee, also explored the fact that letters and words are made of points, lines, curves, and angles, and the magus Heinrich Cornelius Agrippa theorized that geometric figures occupy a place between images and letters. (16)

But the primary figure for Saiber, as the title of her book indicates, is Bruno, who she views as exemplifying this trend. And what she writes of Bruno often times seems true of Borges: "Geometry was for him a warehouse of metaphors and structures that could be called upon to help reinforce the scaffolding of his philosophical and scientific thought. Bruno saw geometry's figures as equivalent to language's figuratives..." (17). Carter Wheelock suggests that Borges' style is essentially Baroque, which he defines as "a time and a circumstance in which the creative intellect ceases to find value in the results of thought and turns to contemplating the forms of its own activity" (qtd. in Gonzalez 150). For Jose Eduardo Gonzalez, this turn is indicative of a correlation between style and mental process:

Borges' extremely paratactical style divides every paragraph, every sentence, into small sections. Sections are separated from each other by a comma, period, colon, or semicolon (or, less often, a loose conjunction). Each one of these small parts is supposed to stand for an autonomous mental process. (156)

The word "cell" again comes to mind here, particularly in its meaning, from the twelfth-century onward, as "Any of the (imaginary) cavities or compartments in the brain thought to be the seats of particular mental faculties" ("Cell," def. 7a). The

cognition of space (as aided by grid cells) is thus linked to language in Borges through its geometric configuration. As the fifteenth-century humanist Marsilio Ficino put it, nature was like the "intelligence of the geometrician when he inwardly constructs imaginary matter" (qtd. in Saiber 16). These units or sections that Gonzalez posits as autonomous mental processes also help to explain the fact of the reappearance of particular words, phrases, and even sentences across various Borges works.

While often read as a kind of post-modern anti-detective story, "Death and the Compass" can further be seen as a parable for the way the brain works to produce the experience of space. This can be compared to the way Lonnrot plots out points on a map based on the passing events, and his knowledge of the geometric symbolism involved in these events.³ Throughout the story we have suspended a comparison between three-sided and four-sided shapes that also reflects the play between the numbers three and four. While studying the map, Lonnrot sees another equilateral triangle reflected in the one drawn there:

Suddenly, he felt as if he were on the point of solving the mystery. A set of calipers and a compass completed his quick intuition. He smiled, pronounced the word Tetragrammaton (of recent acquisition) and phoned the inspector. (*Labyrinths* 82)

This shift from a three-sided to four-sided perspective is represented in space in the shift from the prism-shaped Hotel du Nord to the rectangular Triste-le-Roy. It can be represented in the brain by changes to grid cell patterns: "Grid patterns can be distorted by changes in the shape of the environment. When a square test box is changed to a rectangle, the grid pattern may rescale selectively along the axis of transformation" (Stensola et al). The way in which the compass and calipers form the subject of the sentence can be thought of in the way grid cells are instrumental in the creation of a sense of location. Lonnrot's condition can be described, in a figurative sense, as a rescaling "along the axis of transformation" of his discovery.

In another way, Lonnrot the disciple of reason can be thought of as the scientist attempting to unravel the secrets of a world that is both inscrutable and hostile, a looming sphinx. Scharlach, his nemesis, can translate from German as "scarlet fever." Lonnrot shares his name with Elias Lonnrot, a nineteenth-century Finnish physician, philologist, and collector of Finnish oral poetry. According to Alan Swedlund and Alison Donta, "Between approximately 1820 and 1880 there was a world pandemic of scarlet fever and several severe epidemics occurred in Europe and North America" (159). It was during this pandemic that Elias Lonnrot began practising medicine, at a time when there was no cure for the disease. In this way, Borges' story presents the detective's ultimate failure as mirroring the historical state of a humanity (and a humanism) inevitably subject to the ravages of illness, scarcity, and death.

There are often allusions in Borges' fiction that follow long, meandering paths that take readers far from the plot of the story, yet leave them in surroundings oddly familiar to those that they left. The character of C. Auguste Dupin, alluded to in the story's first paragraph, first appears in Poe's "The Murders in the Rue Morgue." It is not difficult to read, in the meeting of narrator and protagonist, something of the situation of Borges' tale, transplanted from Poe's Paris to Borges' Buenos Aires:

Our first meeting was at an obscure library in the Rue Montmartre, where the accident of our both being in search of the same very rare and very

remarkable volume, brought us into closer communion ... It was at length arranged that we should live together during my stay in the city; and as my worldly circumstances were somewhat less embarrassed than his own, I was permitted to be at the expense of renting, and furnishing in a style which suited the rather fantastic gloom of our common temper, a time-eaten and grotesque mansion, long deserted through superstitions into which we did not inquire, and tottering to its fall in a retired and desolate portion of the Faubourg St. Germain. (179)

The mirroring of the characters here is similar to that of Lonrot and Scharlach, forming what David Halliburton calls a "complete binary system" (238). And it is Scharlach, at the story's close, who becomes the narrator, or rather, is shown to have been constructing the plot all along. The "very rare and very remarkable volume" is a subject of more than one Borges story, and is in some ways the container of the stories themselves. As the narrator of "The Library of Babel" states, "I have wandered in search of a book, perhaps the catalogue of catalogues" (*Labyrinths* 52). The "grotesque mansion, long deserted through superstitions into which we did not inquire," and its placement in a desolate part of the city, is a model for the abandoned villa of Triste-le-Roy.

This relocation is not simply a transplanting, but suggests that underlying truths about the nature of experience can be considered regardless of place. When Lonrot ascends the villa at Triste-le-Roy, he has an uncanny experience that speaks to something beyond the dusty and perverse structure it appears to address:

On the second floor, on the top floor, the house seemed infinite and expanding. *The house is not this large*, he thought. *Other things are making it seem larger: the dim light, the symmetry, the mirrors, so many years, my unfamiliarity, the loneliness.* (*Labyrinths* 84; italics in original)

The juxtaposition of particular elements creates a kind of existential condition that describes something about the relation of the individual to space. In the 1920s, Edwin Hubble, with access to the newly built one-hundred inch reflecting telescope at Mount Wilson Observatory in California, completed a set of observations that led him to the conclusion, now a commonplace, that the universe is expanding. For the ancients, notes Cornelius Lanczos, the cosmos was the starting point for geometrical theories: "The stars themselves gave rise to the concept of a 'point': triangles, quadrangles, and other geometrical figures first appeared in the constellations; the circle was realized by the disc of the sun and the moon" (qtd. in Saiber 11). To rephrase Cassius, it is both in the stars and in ourselves. It is hardly surprising that in the next line of Borges's story we find Lonrot gazing at the moon through a geometrical grid: "The early evening moon shone through the diamonds of the window" (84).

At the story's close, all geometric calculation is reduced to a simple and ruthless line. Yet, this line might itself be seen as an elegant solution to a complex problem. Lonrot's last moments illustrate a final, desperate illumination:

"In your labyrinth there are three lines too many," he said at last. "I know of one Greek labyrinth which is a single straight line. Along that line so many philosophers have lost themselves that a mere detective might well do so, too. Scharlach, when in some other incarnation you hunt me, pretend to commit (or do commit) a crime at A, then a second crime at B, eight kilometers from A, then a third crime at C, four kilometers from A and B,

half way between the two. Wait for me afterwards at D, two kilometers from A and C, again halfway between both. Kill me at D, as you are now going to kill me at Triste-le-Roy." (86-87)

The reference to Zeno's paradox has been much discussed, with the assumption that the line which Lonrot proposes here is the same one that Sharlach agrees to provide. There is, however, another mathematical and philosophical line deserving of consideration, Pascal's "Hexagrammum Mysticum Theorem." In brief, the theorem states that given a hexagon inscribed within a conic section, the continuation of the lines of the hexagon's opposite sides will meet at a line, known as the "Pascal line" (Figure 8).

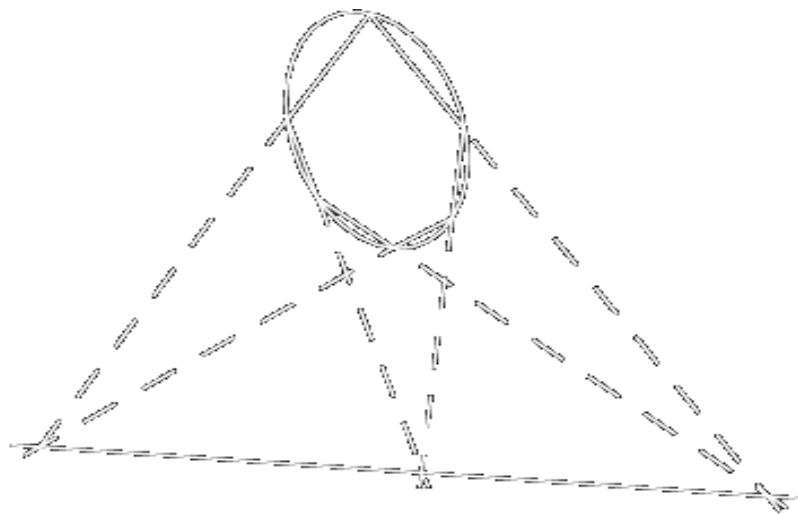


Fig. 8.

Eric W. Weisstein. "Pascal's Theorem." *MathWorld – A Wolfram Web Resource*. <<http://mathworld.wolfram.com/PascalsTheorem.html>>. Permission under terms of use.

"Death and the Compass" ends with such a meeting of opposites in a straight line. The three opposite pairs of sides of the hexagon are reflected in the incessant repetition of the number three throughout the story. How these three pairs (which might be read in the tale as Lonrot's false perception of the mystery and Scharlach's artificial creation of it, the identical and opposing halves of the villa, and the symmetrically-opposed main characters) create a fourth is the subject of the final lines of the story.

"The next time I kill you," replied Scharlach, "I promise you that labyrinth consisting of a single line that is invisible and never ends." (87)

Perhaps Sharlach's single line is also Pascal's, and the mystery that must have struck the sixteen year old Pascal with awe is something like Lonrot's own discovery, in the act of geometrical calculation, of the location of the fourth murder. It is interesting to note here that though the six-point figure of the hexagon does not appear in Borges' story, it does appear elsewhere in relation to the ratio of 3 to 4. If we recall Barbaro's proposal as to the dimensions of the perfect treatise, we find he calculates the ideal number of books, chapters, and lines as the cubes of 3, 4, and 6 respectively. The next shape in the series of prism and rectangle appears to be the hexagon. Lonrot's failure to foresee his own death might be seen in part as his inability to decipher, as if his fate was written out in one of those books of The Library which appear to be a jumble of letters. And like those searchers of The Library, Lonrot "did not remember that the

possibility of a man's finding his Vindication ... can be computed at zero" (55). The illusion of the infinite divisibility of Zeno's line is extinguished, with a ruthless accuracy, by the mystical theorem of Pascal.

Rather than merely a rarefied, idealized, or otherworldly place, the fiction of Borges reveals the space of the intimate and familiar: "To go from one planet to another is like going to the farm across the way. When you entered this room, you were carrying out a voyage through space" ("Utopia of a Tired Man" 94). Borges' fiction, in asking us to rethink the nature of our relationship to the space around us, also prefigures scientific findings as to how we find our way, demonstrating how the humanities and the sciences might be thought of not as cultures in conflict, but as one culture treading the same paths. Borges points out that the divisions that do exist between the arts and sciences are largely artificial and both are therefore subject to, on a deeper level, the same ontological analysis. If much of what we tend to hold true is revealed by this analysis to be based on seemingly arbitrary and shifting symbols, this is not entirely problematic. Borges' voyages of discovery teach us not to be dismayed by either the contingency of all knowledge, or the vastness of what we do not know. As Heraclitus noted, "nature loves to hide" (qtd. in Sandywell 234), and perhaps we are compelled, as one of Borges' early poems tells us, "to obey that which is hidden" (qtd. in Paz). The "fearful symmetry" of Blake's tiger are the bars which we look through, in Borges' "The Other Tiger":

Searching through the hours of the afternoon
For the other tiger, not in the poem. (48-49)

Notes

1. There has been a growing interest in examining Borges' work in terms of the sciences. A recent conference at the University of Buenos Aires took Borges and the hard sciences as its subject. *The Garden of the Forking Paths* has long been recognized as influential on quantum theory, specifically in the formation of the "many-worlds" theory of Hugh Everett (the theory, in layman's terms, that there is a very large – perhaps infinite – number of universes, and everything that could possibly have happened in our past, but didn't, has occurred in the past of some other universe or universes).

2. As the study states:

Consistent with grid cells, the mean grid orientations in the six-fold symmetry model varied randomly between participants, ruling out a role for specific visual features of the environment ... Notably, the coherence of the potential grid orientations in each participant's right entorhinal cortex was significantly correlated with that participant's spatial memory performance. This parallels findings that entorhinal cortex activation can predict memory performance and provides a first indication that grid-like representations might usefully guide behaviour in mammals.

3. The fact that the letter containing the map is signed "Spinoza" also references this philosopher's use of a geometric method in the unfolding of his *Ethics*.

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