The Natural Philosophy of Emanuel Swedenborg

A Study in the Conceptual Metaphors of the Mechanistic World-View

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DOI:
10.1007/978-94-007-4560-5

2012

Document Version:
Peer reviewed version (aka post-print)

INTRODUCTION

Of making many books there is no limit and no end on the earth.
    Lo! Scarcely has a great pile of sand the same number.
And as the birds lack number, like the fish in the sea,
    so the many books on earth lack number, too.
The greater part of them utter empty talk, useless sentences without substance,
    making a display of sonorous words that are nonsense.
Beware lest you are deceived by the cunning fair looks of a book:
    for often there is poison hidden under sweet honey.

Swedenborg, from Swedberg's *Vngdoms regel och ålderdoms spegel* ('Rule of Youth and Mirror of Old Age', 1709)

Prologue on a grain of sand

Books are grains of sand, countless as the birds of the air and the fish in the sea. Far too many books are written, Emanuel Swedenborg complained.[1] Yet for his own part, he never managed to overcome the rather severe graphomania that haunted him right up to the end. Through time it resulted in a considerable heap of sand. Altogether his writings, translations of them, and books about him have built up an impressive and not inconsequential sandbank in the ocean of knowledge. Being stranded on this sandbank is not without risks. The quicksand of uncertainty and unreliability can give way beneath one's feet, and waves of scrutiny can wash everything out to sea.

Anyone out there on that sandbank, looking around, cannot avoid realizing that metaphor—thinking about something through something else—occurs abundantly in Swedenborg's thought. Books are sand. The world is a machine. The metaphors impelled new thoughts, allowing him to form ideas about the unknown from what is known. That is what this particular grain of sand, this book, will be about; it is a study that seeks to provide a description and understanding, not only of what Swedenborg thought, but also of *how* he thought as a mechanistic natural philosopher, up to and including 1734. That was the year in which he published two works about the principles of natural things and about the infinite,

Principia rerum naturalium and *De infinito*, in which he espoused a mechanistic world-view that stands out in clear contrast to the organic conception that he embraced in the following ten years and the voyages he began from 1745 into an immaterial spiritual world. The early Swedenborg regarded the world as gigantic machine, everything was machines, everything could be explained as geometry in motion. If Swedenborg's world machine were dismantled into its constituent parts—space, signs, waves, the sphere, the point, the spiral, and infinity—one could arrive at a better understanding of how it was designed. It is an investigation that aims to paint the first concerted and complete picture of Swedenborg's early natural philosophy, from geometry and metaphysics to technology and mining science, situated in his time and context. That is the most important contribution to the research on Swedenborg and the history of eighteenth-century science. Additionally, in order to reach a deeper understanding of his natural philosophy and his creative mind, this book aims to penetrate his way of reasoning, with image schemas, metaphors, categories, and other cognitive abilities. In that respect this study is a contribution to the current methodological development of a cognitive history in what has been called the cognitive turn within the humanities. But the approach can also shed new light on this influential visionary's esoteric theology and doctrine of correspondences, which actually is a metaphorical system grounded in his cognitive qualities and experiences.

The verses about the vanity of writing and reading books were written by Swedenborg for his father, Bishop Jesper Swedberg's book *Vngdoms regel och ålderdoms spegel* ('Rule of Youth and Mirror of Old Age', 1709), at the time when he himself was completing his university studies in Uppsala. Perhaps he was tired of everything. Waking nights weaken the body, he continued his lamentation, make a young person resemble the night, an internal disease consumes him and his face increasingly takes on the blue-black colour of death. The words alluding to the meditation in Ecclesiastes about the vanity of vanities encapsulated an edifying theme for the disconsolate reader: 'And further, by these, my son, be admonished: of making many books there is no end.'[2] When Swedberg later sums up his life of toil and diligence in his autobiographical *Lefwernes beskrifning* ('Description of My Life', 1729) he says: 'but I am not as yet afflicted in the way the same Preacher [Ecclesiastes] writes:

much study is a weariness of the flesh.'[3] If anything, assiduous work enlivened him instead. In any case, a medical student does not need so many books, said the professor of medicine at Uppsala University, Lars Roberg, an acquaintance of Swedenborg's. One book is sufficient, the book of nature. 'Like the people with whom one mixes, one should ensure that books are honest, beneficial, and honourable,' he declared, for 'Books are for the Soul what food is for the body. It should be adequate and not a mixture of many different kinds.'[4]

Books can give nourishment, but also stomach-ache. Swedenborg read and wrote indefatigably. In June 1740, at the tercentenary celebrations of Johann Gutenberg and the art of printing, Swedenborg wrote about how printing presses were propelled by the waves flowing from the source of Pallas, goddess of wisdom.[5] A torrent pours forth from the presses. The intensity of the flow from his own pen increased when, as seer of visions, he entered into the geography of the spiritual world. In *De telluribus* (1758) he describes how, during a voyage in space, he got into conversation with some spirits from a distant solar system. On our globe, he explained, there are remarkable sciences and arts that are unparalleled anywhere else in the universe:

> such as astronomy, geometry, mechanics, physics, chemistry, medicine, optics, philosophy. I went on to mention techniques unknown elsewhere, such as ship-building, the casting of metals, writing on paper, the diffusion of writings by printing, thus allowing communication with other people in the world, and the preservation for posterity of written material for thousands of years. I told them that this had happened with the Word given by the Lord, so that there was a revelation permanently operating in our world.[6]

With the aid of printing, people can pass on and store their thoughts and inventions for thousands of years, to future generations, to new creatures on earth. Among the immense numbers of stars and planets in the vast universe there is only one globe where the art of writing is known. Only there can sciences, mathematics, and philosophy be found.

In Swedenborg's ideas about writing, about books as grains of sand, one can—as so often—find threads going back to earlier sources, such as classical authors or the Bible. Counting grains of sand is a classical metaphor for the impossible. Archimedes starts *The Sand Reckoner* from

the third century BC by saying that there are some ‘who think that the number of the sand is infinite in multitude’.[7] How many grains of sand, he asks, would it take to fill the whole universe with sand? He proceeds from the number of grains of sand in a volume the size of a poppy-seed, and with a new method for expressing very large figures, Archimedes succeeds in stating the figure as ‘a myriad-myriad units of the myriad-myriad-th order of the myriad-myriad-th period’.[8] This figure is much larger than the number of grains of sand in the entire spherical universe, which Aristarchus of Samos had calculated to contain a number of less than 10,000,000 units of the eighth order, that is to say, 10^{63}. It would thus be a very large but not infinite number. The quantity of grains of sand expresses unfathomable numbers, but this can also be invoked in a more comforting way. In an attempt at encouragement, Ovid wrote that there are innumerable possible hunting-grounds for women, and attempting to list them was like trying to count the sand on the beach.[9]

The Bible likewise contains grains of sand. God’s thoughts are more in number than the sand, the Psalter says, or as the Swedish bishop Johannes Rudbeckius renders this in his hymnal *Enchiridion* (1622):

> And if to tried to count by hand /
> The thoughts of God to tell the score /
> They would be more than all the sand /
> That lieth on the ocean floor /
> And therefore I shall try no more.[10]

The seed of Abraham will multiply as the sand upon the sea shore, hostile armies attack like a swarm of locusts or the dust of the earth, countless are the sins, and death grinds us down to dust and sand.[11] ‘That which is crooked cannot be made straight: and that which is wanting cannot be numbered,’ wrote the philosopher Andreas Rydelius, citing Ecclesiastes.[12] The antiquarian Johan Peringskiöld the Elder, in *En book af menniskiones slächt, och Jesu Christi börd* (‘A Book about the Human Race, and the Lineage of Jesus Christ’, 1713), alludes to the enormous growth of the children of Abraham predicted in the Book of Genesis: ‘as the dust of the earth, as the stars of the heaven, and as the sand which is upon the sea shore.’[13] Fertility comes from above! Grains of sand, stars, and locusts represent immeasurable amounts that instil trembling amazement. In *Guds*

werk och hwila (‘God’s Work and Rest’, 1685), Bishop Haquin Spegel writes about the countless sand at the bottom of the sea and the wet shore, like herbs, grass, and spices in the summer fields, the light-winged snow covering the mountains, and the ‘blue-starred ceiling’ with its glistening carbuncles and jewels, ‘In an order that we humans cannot grasp.’[14]

The sand blows through scientific texts as well. The metallurgist Georg Bauer, better known under the name Georgius Agricola, cited Naumachius’ assessment of gold and silver as mere dust, like the stones scattered on the beaches and along river banks.[15] Sir Isaac Newton, elected by history as the very model of a sober scientist, saw himself in his own eyes as a boy who had played on the sea shore, taking pleasure in ‘finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me’.[16] The polymath Eric Benzelius the Younger saw with a different eye and searched with his learning in ‘our dark gravel’, wrote the historian Olof Dalin in a memorial sketch. But if you could not find it there, ‘You will now find total knowledge / In eternity’s own light.’[17] The grain of sand is the trifle that disappears in the mass. The world is so large, and man so small: ‘I, a speck of dust in Paradise, a human’, sighed the alchemist and councillor of the realm Gustaf Bonde.[18]

The sand metaphor, like many other metaphors, can be found throughout the history of ideas, and it cannot really be traced to any specific source. Instead it seems as if the metaphors were an integral part of language, of our way of reasoning. One premiss of this study of metaphor in Swedenborg is that it is not always possible to demonstrate influence from a particular quarter; instead there are special cognitive abilities which enable us to think in one way or another. Metaphor is not just poetic adornment or educational parable with its origin in classical authors or the Bible, but is an intrinsic part of the way scientists reason. They imagine the invisible and unknown in terms of what is visible and known, they describe reasoning and research as something spatial, a walk along the sea shore, a voyage over a perilous ocean. An unusually palpable example of this metaphorical way of reasoning is the mechanistic natural philosopher and visionary biblical exegete Swedenborg. Few have taken the metaphorics of the mind to the ultimate limits as he has done. It is also, in line with Carlo Ginzburg, a matter of searching for what was taken for granted, things for which no arguments were given, in other words, not

concentrating on the most obvious parts of a work of art, but on the seemingly insignificant details.[19] Like a physician confronted with symptoms, the historian standing before the fragments sees them as signs, clues to the historical context. By studying a small detail, some metaphors, in Swedenborg, we can also see out into the surrounding reality, into the society, the thought, and the science around him, as if discerning the macrocosm reflected in a microcosm. Anyone who points the microscope at a heap of sand, wrote Robert Boyle, will easily see that each grain of sand has its distinctive size and shape, like a rock or a mountain.[20] In the words of William Blake, we see a world in a grain of sand.[21] There are so many books, countless as the grains of sand, and on top of everything—here is another grain of sand on the shore of the immense ocean of knowledge.

Biographical guide

What was known was just a small part of the great unknown. Swedenborg was in a space that seemed to lack bounds, in a geographical space with blank spots and a cosmos without a discernable end. What he knew about the world was a starting point for understanding the unknown. Movement in space and action in the world are an essential part of reasoning. From the beginning, when he entered this life on 29 January 1688, it was the dirty alleys, cold brick churches, illuminated court halls and aristocratic palaces of Stockholm. He was christened Emanuel, 'God with us'.[22] But where was he to go? 'I do not know my exit or my entrance: O lead me therefore in all innocence', as a children's hymn says in Swedberg's hymnal (1694).[23]

His way took a scientific course, a choice that was not unlikely encouraged by his cousin, the future physician Johan Moræus who taught Latin in the Swedberg home.[24] In a shaky hand, Swedenborg had written his name in a small disputation booklet from 1695 about the cure of diseases.[25] In the following year his mother, Sara Behm, left this earthly life after an illness. At the age of eleven he matriculated at Uppsala University, and for ten years the blocks around the River Fyrisån were the centre of his geography, with short lines between the Cathedral and the main university building, the Gustavianum. Coming from a family of mine owners, he regarded the 'nation' of Västmanland-Dalarna, the union of

students from those mining provinces, as his true geographical domicile. When Swedberg left his post as professor of theology and moved to Skara in 1703, where he served as bishop in a diocese that included the Swedish congregations in America within its bounds, Swedenborg remained in the house in Uppsala. His brother-in-law, the university librarian Eric Benzelius, married to Swedenborg's sister Anna, moved in. Also living in the house in 1704 were some other distant relatives, including the teenagers Andreas Rhyzelius and Andreas Kalsenius. 'Our hostel that autumn and the following spring,' wrote Rhyzelius, 'was a dark, wretched, and unhealthy chamber down by the river; yet we throve and studied tolerably well there.'[26] What exactly Swedenborg studied we do not know. It is not unlikely that he received a broad education in science, mathematics, and philosophy.

On 1 June 1709 Swedenborg completed his studies with a viva voce in the great auditorium of the Gustavianum, defending a thesis, written by himself, about various maxims in Seneca and the actor and mime Publilius Syrus, *L. Annæi Senecæ & Pub. Syri Mimi forsan & aliorum selectæ sententiæ cum annotationibus Erasmi & græca versione Jos. Scaligeri* (1709).[27] His opponents were Andreas Rhyzelius and Jonas Unge. Professor Fabian Törner presided instead of Johan Eenberg, who had recently died. After the disputation, the meadows and fields around Brunsbo, the bishop's residence outside Skara, became his home while he awaited his departure into the outside world. The Danes had cut off the sea routes after the momentous defeat of the Swedes at the hands of the Russian troops of Peter the Great on the Ukrainian fields near Poltava on 28 June 1709, so there was no option but to wait and pass the time studying mathematical sciences.[28] He wanted to get away, out into the world, to escape as quick as he might, far from the dreadful, desolate province of Västergötland.[29]

In the late summer of 1710 his circles widened to include Europe. The encounter with the big world was rapturous, with its foreign languages, sounds, and smells, its palaces, cathedrals, and libraries. Together with some friends, Sven Bredberg, Eric Alstrin, and Jacob Ludenius, he trudged the streets of London, visiting the sights. 'The air is daily laden with the continual smoke of the coal that is burned here,' Bredberg noted in his travel diary, 'probably the cause of the severe chest pains that I have to endure.'[30] Swedenborg discussed the problem of longitude with English

astronomers, admired beautiful books in the Bodleian Library in Oxford, and then continued over to the continent to stroll along the canals in Leiden, to immerse himself in mathematics in Paris, and to publish poems in Greifswald. On his return to Sweden, after five years, he had the honour of becoming assistant to the famous engineer Christopher Polhem, which lasted until 1719, and was appointed by King Charles XII as extraordinary assessor in the Royal Board of Mines. This work brought him to damp winter days in Lund, salty bays in Bohuslän, the intractable rapids at Trollhättan, to the front lines at the Norwegian border, and down into the terrifying depths of the Falun mine. On 23 May 1719 the children of Bishop Swedberg were ennobled, assuming the name Swedenborg. As the eldest son, Emanuel took up his seat in the diet, where he was an active participant until his old age. A new trip abroad followed in the years 1721–1722, taking him to Holland and Germany. Then came ten years with neither foreign travel nor published writing. Yet he was far from idle during this time. He had become an ordinary member of the Board of Mines and took an active part in its commissions, with matters concerning mines, ironworks, models of machines, steam engines, and much besides. He was commissioned by the board to make tours of inspection to sulphurous mining districts, and in his free time he wrote thick bundles of paper about the mineral kingdom, about chemical processes and mining. In 1733–1734 he was once again on the move, visiting Germany and Bohemia, to publish his largest work hitherto, *Opera philosophica et mineralia* (1734), three volumes about the principles of natural things, about iron and copper. The plan here is to follow him closely until that year.

After 1734 he abandoned his mechanistic explanation of the world and oriented himself towards an organic world-view. The world was no longer a machine but something living. In ambitious projects he threw himself into the anatomy and physiology of the human body, in search of the abode of the soul. He went to France and Italy, constantly on the trail of the physiological functions of the brain. On the fifth trip to Holland and England (he is said to have spent twenty-two years of his life abroad), however, he was tormented by strange dreams in a time of anguished inner crisis.[31] His life was never to be the same again. In his nocturnal dreams he began to discern a message. Someone wanted to say something to him. Then in 1745, after a visit to a tavern in London, he met Christ. Two years

later he resigned from the Board of Mines, left the geometrical fields of natural science and embarked on research expeditions in a completely different landscape, the immaterial space of the spiritual, non-geometrical world. There he found a breathing space, enjoying a completely new freedom of movement between the cities, societies, gardens, and planets of the spiritual world. In his thoughts and dreams his geography expanded. With his discovery of the correspondences between natural and spiritual meaning, he gained the key to the inner message of the Bible. Finally, on 29 March 1772, he took the irrevocable step over to the other side, the spiritual world.

All cannot have been in vain after the many years that had elapsed: the years of growth, the travels, the almost thirty years as assessor in the Board of Mines, all the intensive studies in mathematics, geology, astronomy, metallurgy, physiology, anatomy, and philosophy. Apart from the world that was known to him, his spatial experience incorporated what friends and relatives had told him about America, the Orient, Tartary … and all the books that had given him insight into everything from mining in Siberia to imaginary trips to the inhabited moon. He must have carried all this earlier experience with him on his spiritual journeys. When a spirit wondered how a philosopher like him could become a theologian, he replied, 'from early youth [I] had been a spiritual fisherman.' And a 'fisherman', Swedenborg explained, 'in the spiritual sense of the Word, signifies a man who investigates and teaches natural truths, and afterwards spiritual truths rationally'.[32]

Literature about a phenomenon

Swedenborg's remarkable destiny, moving from natural science to the doctrine of the spirits, from rationalism to mysticism, from mathematics to angelic song, has baffled many exegetes. Some lament this 'tragic fate' and say that Swedenborg was once a very promising scientist, but was unfortunately afflicted by mental illness. The astronomer Erik Prosperin wrote in 1791 about Swedenborg that 'from the great chasm between the *Algebra* and the new Jerusalem, we had reason to sigh over the delusions of the human mind'.[33] Others, including the German philosopher Immanuel Kant, mounted an attack with a whole book, *Träume eines Geistersehers* (1766), and declared that Swedenborg was a charlatan and a

liar and that everything he wrote had its origin in the pure fantasies of a sick brain. There is also a diametrically opposed standpoint. Swedenborg was the second Christ who brought the third testament, a universal genius, the spiritual Columbus, the Buddha of the North, a titanic mental power cast in heroic form.[34] Swedenborg is at once fascinating and terrifying. Many have been amazed at Swedenborg's curious hybrid combining dry-as-dust mathematics with oneiric fantasy. Friedrich von Schelling, describing Swedenborg's doctrine to the author Per Daniel Amadeus Atterbom, wrote of how 'the loveliest comfort, the most devout poetry, the most brilliant depth of thought carry on a strange and wonderful war with abstract dogmatism and poor mathematics'.[35] Schelling's disciple, Gotthilf Heinrich von Schubert, explained Swedenborg's abstruse dream mathematics as 'a higher form of algebra'.[36] Swedenborg's destiny raises questions about the relationship between science and religion, between the truths of reason and the Bible, and the issue of what is meaningful in life. He is an excellent case for studying the interplay and incongruity between science and religion. In him there is existential wonder in the face of God and nature, revelation and rationality, wisdom and love. Swedenborg would see 'That which earthly eyes do not see: / The fierce geometry, the crystal / Labyrinth of God and the sordid / Milling of infernal delights', wrote the Argentinian author Jorge Luis Borges.[37] He saw a line through the fog. Quite simply, he sought to understand the world.

The first task worthy of respect for research into Swedenborg was to organize, catalogue, publish manuscripts, and translate the works of a man who seemed to observe Apelles' maxim 'nulla dies sine linea', not a day without a line. He left almost 42,000 pages behind. It has mainly been representatives of the Swedenborgians' own church, the 'New Church', that have take charge of the work of publishing all this.[38] The resulting editions may not be scholarly, but they are useful. Among the more important contributions we may mention the photolithographic reproduction of Swedenborg's manuscripts by the American Swedenborgian Rudolph L. Tafel from 1869–1870, and James Hyde's *A Bibliography of the Works of Emanuel Swedenborg* (1906).[39] Since 1898 the Swedenborg Scientific Association has published a journal of widely varying quality, *The New Philosophy,* for studies of Swedenborg's philosophical, scientific, and theological writings. Another periodical with similar content came later, *Studia Swedenborgiana*. In the first half of the

twentieth century, three American New Church members were active. These were Alfred Stroh, who directed the publication of the unfinished collection of Swedenborg's scientific writings, *Opera quædam aut inedita aut obsoleta de rebus naturalibus* (1907–1911); Cyril Odhner Sigstedt, who took great pains to put together a collection of documents concerning Swedenborg, called 'Green Books'; and finally perhaps the foremost of them, Alfred Acton, who translated a long series of Swedenborg's scientific writings and compiled Swedenborg's letters and memorials, with a commentary, in *The Letters and Memorials of Emanuel Swedenborg* (1948–1955).[40]

In this book I will present all the scientific texts by Swedenborg, supplemented with quite a few new discoveries of hitherto unknown texts by and about him. Based on the empirical material, this will give a more balanced and complete analysis of Swedenborg than anything achieved hitherto. For my task here, the New Church studies and interpretations of Swedenborg's writing cannot be used without some difficulty. They have a different purpose, often based on an assumption that everything Swedenborg wrote is true, and that there is an internal coherence, that the contradictions are only apparent in his theological 'canonical works' from *Arcana cœlestia* (1749–1756) onwards. Swedenborg's scientific theories chiefly interested his fellow scientists around the last turn of the century.[41] Yet the history of science as written by scientists is tricky to use. In many cases the aim has been either to admit Swedenborg to the success story of science or to expel him from it, to elevate him into a national hero, or to show that his science was a prophetic as his spiritual doctrine. Swedenborg's research on the brain has attracted particular interest and has been rated highly. He has not infrequently been assessed in relation to the scientific level of the exegete's own time, as scholars read into it their personal and contemporary concepts of science and disciplinary boundaries, trying as far as possible to avoid 'extra-scientific', philosophical, and cultural factors. Here I will analyse Swedenborg from a perspective in line with contemporary cognitive history of science, that also reckons with the cognitive processes of the agent and the spatial, cultural, and social environment. In general, it may also be said that many Swedenborg studies have had problems setting him into his own times; the Swedish works and the Swedish history of ideas have caused particular difficulty. It is easy to be affected by this rootlessness in time and

geography. One of the major contributions of this work is to place Swedenborg within the European, especially the local Swedish, intellectual context and debate.

In academic research there is a strange silence surrounding Swedenborg, the eighteenth-century Swede who—alongside Carl Linnaeus and King Charles XII—has attracted the greatest attention outside Sweden. Only one doctoral dissertation has been written about Swedenborg in Sweden, and that was in the discipline of comparative literature in 1961. In Sweden is it chiefly literary historians with an obvious interest in the history of ideas who have devoted time to Swedenborg. A classic study is the one by the literary historian Martin Lamm from 1915, published much later in English as *Emanuel Swedenborg: The Development of His Thought* (2000). Here Lamm seeks to demonstrate that Swedenborg's theological system can be viewed in the light of his natural philosophy, that there is a link between them. The dream crisis is not a watershed between the two periods. Lamm's method rests in large measure on an implicit idea about intellectual influence, that Swedenborg's theological and scientific thought can be explained on some causal basis as the impact of other thinkers. Lamm was constantly searching for 'the genesis of Swedenborgian theosophy', that is, the influences exerted on Swedenborg by his own scientific studies of Plotinus, Descartes, Locke, Polhem, or others.[42] This kind of quest for sources can easily lead one in the wrong direction. As regards the influence of Milton, Inge Jonsson demonstrates in *A Drama of Creation: Sources and Influences in Swedenborg's Worship and Love of God* (2004, Swedish original 1961) how easy it is to be mistaken concerning influence by proceeding from external similarities of thought.[43] Instead the similarities can be ascribed to older common sources, in this case Ovid. The focus in Jonsson's dissertation is Swedenborg's religiously inspired creation story from 1745. By means of extremely careful studies of Swedenborg's works on natural philosophy, chiefly from the time after 1734, and by searching out many of his sources, Jonsson sheds light on the Swedenborgian creation drama. In *Swedenborgs korrespondenslära* ('Swedenborg's Doctrine of Correspondences', 1968) Jonsson has subsequently published what may be described as the weightiest and most authoritative study ever written about Swedenborg. He has tracked down countless sources and predecessors of the late Swedenborg's most central

idea, the doctrine of correspondences between words and concepts. The doctrine of correspondences, he shows, can be traced back to the works on natural philosophy, having arisen from the mathematical spirit and with its roots in, among other things, the universal mathematical tradition.

The only substantial contribution by a historian of ideas is Tore Frängsmyr's examination of Swedenborg's geogony in a chapter of his dissertation *Geologi och skapelsetro* ('Geology and the Doctrine of the Creation', 1969). From more recent years we may mention the sympathetic portrait by the author Olof Lagercrantz (1996, published as *Epic of the Afterlife* in 2002), although his method is not entirely without problems, and Lars Bergquist's detailed, sensitive reading of *Swedenborg's Dream Diary* (2001, Swedish original 1988). Bergquist has also produced the latest in the sequence of biographies of Swedenborg.[44] In *Swedenborg's Secret* (2005, Swedish original 1999), he has more skilfully than anyone else succeeded in capturing Swedenborg's life story, his personality and existential quest. In addition to this we have the Latinist Hans Helander's richly commented and exemplary scholarly editions of Swedenborg's Latin poems, an achievement without parallel in Swedenborg studies. Finally, an Italian historian of philosophy, Francesca Maria Crasta, has written a piece of sound scholarship about Swedenborg's natural philosophy, *La filosofia della natura di Emanuel Swedenborg* (1999), although it does not go far beyond what can be found in earlier research.[45] But what has been written *about* Swedenborg is overshadowed by everything that has been written about the reception of Swedenborg, about his successors and readers, about his literary influence on a large number of philosophers and authors, about Swedenborgianism and the history of the Swedenborgian Church.[46]

To sum up, it may be said that there is no comprehensive monographic study of Swedenborg's early mechanistic period up to 1734. In addition, there is a dearth of studies in the history of ideas using contemporary source material, especially the Swedish material. Nor has anyone tried to answer the question not only of what Swedenborg thought, but of *how* he thought. This gap in the research is what the present book aims to fill. The Polish author Czesław Miłosz formulated the challenge: 'the Swedenborg phenomenon, in effect, belongs to those enigmas which, if ever solved, would shed light on the laws of human imagination in general.'[47] I take the reverse approach, of proceeding from what we know about the human

imagination to see if it can shed light on the phenomenon that is Swedenborg. This is a book about how the natural philosopher Swedenborg thought.

A theory of Swedenborg's brain

What did Swedenborg think about, how did he think as he walked through the landscape, peered through the microscope, or sat in the library with a book opened in front of him? It was in Swedenborg's brain, in his conscious and unconscious thinking, that his thoughts were formed. In the natural cycle, his brain has gone the way of all flesh, but his thoughts have survived as signs and letters in his writings. As an author, scientist, and visionary, he has passed on a part of his world, his thoughts and experiences, to posterity. If we proceed from the way people think in general, their mental abilities, reason and cognition, in other words, if we consider *how* people think, not just *what* they think, we could get close to an understanding of how Swedenborg shaped his ideas about nature, man, and God. This is a cognitive history of ideas, a history of thinking. What is called the 'cognitive turn' in the humanities has generated vigorous growth of research into different cognitive explanatory models of human expressions and cultural evolution, for example, in cognitive poetics, neuroaesthetics, and cognitive anthropology.[48] These approaches are combined in a theory of cognitive science in order to arrive at an understanding of creative processes. In the historical sciences there is also a growing interest in cognitive-historical analyses, particularly in archaeology and history of science.[49] The aim of the cognitive history of science suggested here is to reconstruct scientific thinking on the basis of cognitive theories.[50] Research in cognitive history has generally dealt with the fundamental cognitive practices such as reading and counting, as well as scientific and religious perceptions.[51]

A cognitive history can achieve a deeper understanding of the creative mind, can connect the historical studies to other fields of knowledge production, and can better cover the diversity of human modes of thinking in history. Explanations based on discourse theory and social constructivism are inadequate for explaining the entire breadth of human thought. A cognitive history also considers the things and the environment surrounding man, his perceptions, emotions, and cognitive processes.

Here, it is not primarily a matter of which of Swedenborg's ideas are true or false, what he wrote or did not write, from whom he acquired one idea or the other—even though that is important. It is rather a matter of trying to reach an understanding of how he arrived at his conceptions and statements about the world, or in a way how the thoughts moved in his brain. To aid him he had the human capacity to create mental images, to store knowledge, to communicate, to construct idealized models, to categorize, and to use metaphors, metonymies, mythological associations, and images.[52] Swedenborg drew analogies, made comparisons and derivations, performed mathematical and geometrical calculations, drew structural parallels, and interpreted nature's signs. In one sense his natural philosophy rested on a hope that reason is rational and logical, that nature is geometrical, and that the mind and mathematics are transcendent, that is to say, independent of us, objective, and eternally true.

What makes the thought of a different age enigmatic and difficult to understand may have to do with the way in which these mental capacities were used. People had a different spatial perception, focused on other metaphors, divided the world into other categories, drew boundaries differently, had other mental images, made other associations, and had a different pre-understanding when observing things. Approaching an alien mode of thought becomes even more complicated when one considers the communication between minds, that is, how people tried to convey thoughts with the aid of language, orally, or by reading and writing, visually with images, or with musical notes. We are dealing with a cognitive mental universe that no longer exists. The cognitive approach is a 'palaeontology of ideas', an endeavour to progress from a diachronic 'genealogy of ideas', following the threads back in time or down to the present day, to a more synchronic perspective that dwells on what was different in a foreign time, retrieving extinct and forgotten ideas like fossils from another world with a different way of thinking. These fossils of history can reveal the scope of the human mind, and the differences can tell us what they valued, how their cognitive reality differed from ours. It is possible to think differently from us.

The attempts that have been made to get at bygone people and their world-view, on their own terms, have not infrequently invoked a kind of intuitive empathy for their emotional moods and social life. A cognitive history of ideas should require something more than this. We must

imagine the actual sensory impressions, we must see, hear, feel, smell, and taste as they did, try to see things as they did, try to get close to their pre-understanding, perception, mental images, associations, categorizations, and metaphors—quite simply, we must start to think as they did. All this is of course a chimera. Total empathy with a period is rendered difficult by the fact that the historical person and the historian understand a particular situation on different terms, by living in different cognitive, or—if you will—semiotic worlds with meanings and modes of thought that do not quite agree.[53] But to understand a different consciousness, the thought of a different age, as in this case Swedenborg's, may necessitate an attempt to imagine how others *see* the world. It is a matter of searching for the unconscious image schemas, the metaphors, the models, the shared general perceptions of a specific culture, that is to say, what is taken for granted and not consciously reflected on. A cognitive history of ideas could provide an understanding of how other people create meaning in life, why they believe what they believe, and how concepts and experiences guide people in a particular direction in life and thought.

There are at least three assumptions about thought that a cognitive history of ideas can rest on. In cognitive science it has been ascertained, firstly, that our concepts and reason are associated with and structured by the body, the brain, and our everyday action in the world.[54] Mind is embodied, situated and distributed. Space, the environment in which we live, the registration of the senses, and the movement of the body through the physical landscape, all are significant for thought. Secondly, it has been shown that most of our thinking takes place without us being aware of it. There are unconscious cognitive processes to which the conscious mind has no access, such as memories, mental images, conclusions, and perceptions of meanings. The unconscious conceptual system structures our conscious thought. Thirdly, reason is metaphorical, that is, abstract concepts are understood in terms of concrete ones, as conceptual metaphors allow us to think about one thing with the aid of something else. Based on a knowledge of the known, we draw conclusions about the unknown. To these assumptions one can also add that a thinking person feels and is social, belonging to a culture and to history. Reason is thus also shaped by emotions, interpersonal relations and, not least of all, by the surrounding culture and its history. Man is a historical creature, bearing the imprint of his history.

Thought and reason are thus mostly embodied, unconscious, and metaphorical, but also emotionally connected. Our cognitive, conceptual system enables us to fill everyday life with meaning, giving us a kind of embodied quotidian metaphysics. For even the most abstract philosophical, scientific, and mathematical problems we use these unconscious cognitive processes into which we have no insight, mostly unaware that we are thinking in metaphors. Since people have different cognitive capabilities, this also means that a person's thoughts can display individual features; in other words, one can find personal styles in philosophical and scientific theories. Personality permeates choices and the design of theories, arguments, and texts. Individuals each have their own world since they have their own experience. There is no wholly absolute reality that is the same for all human beings. Something of a textbook example of a personally coloured natural philosophy is Swedenborg's. In this work I will give a complete account of his entire natural philosophy and furthermore illuminate his personal style based on image schemas and metaphorical thinking.

These individual cognitive abilities remain more or less the same throughout life. We are, so to speak, prisoners of our thought patterns yet simultaneously unaware of this captivity. It is natural to change one's ideas, to adapt them, but on the cognitive level our freedom of action is limited because most of our thoughts come 'automatically' and unconsciously, in a flow that we cannot control. Swedenborg thought in more or less the same way all through his life. This cogitative inertia in Swedenborg is tellingly captured by Bergquist, when he quotes the saying that an author always writes the same book and a painter always paints the same picture.[55] A great deal of Swedenborg's thought can be understood in terms of this cognitive 'rigidity'. Many, most plainly Lamm, have sought to discern continuity and coherence in the ideas of the early and the late works of Swedenborg. In other words, there have been endeavours to establish some consistency, which seems to be lacking.[56] But it is not possible to gloss over the gaps, the irregularities, and the differences between the ideas. The incoherence is significant. For there are obvious contradictions between the periods, and in many cases he rejected his earlier ideas outright, for example as regards geometry and natural theology. Lamm's thesis has been fruitful for my work too, but an important shift in approach must be made. I will argue that it is not

primarily the *ideas* that are shared between the early and the late Swedenborg; instead the common feature can be found at a deeper cognitive level, in his *way of thinking*. The content of the ideas changed, but he went on thinking in more or less the same manner. He was aware of which ideas he abandoned or retained, but he was more or less unaware of his persistent cognitive processes.

The starting point for a cognitive history of ideas that I defend here is that philosophy, science, and mathematics do not really happen just in texts, in language, in laboratories, or in social contexts, but in brains and minds in interaction with the world around the subject, and are thus connected to the body, to perception, thoughts, and feelings. We humans are captured in our brains situated in the world, we are dependent on our thoughts and senses, our prior knowledge, our mental images, when we try to create a picture of the world. Science, in other words, is shaped by our distinctive way of reasoning, in metaphors, with aesthetic, axiological preferences and emotional factors. This bodily foundation means that 'non-scientific' and 'irrational' decisions are a part of scientific and mathematical activity, and thus the embodied-mind thesis, along with the theory of situated and distributed cognition, is difficult to reconcile with an internalistic history of science which presupposed eternal transcendent truths and rationality independent of the context. In that sense it is impossible to distinguish science from non-science. Let us now consider in depth four problems raised by my work with Swedenborg's natural philosophy, which impact on the rest of this book. These are: the significance of spatial perception for thought; metaphorical thinking; conceptual vision; and the problem of reading and writing. These problems have to do with the cognitive capacities of spatiality, metaphors, perception and distributed cognition.

Space and thought

A question to which Swedenborg's natural philosophy often returns is, which path leads into the unknown? How can one arrive at a knowledge of a world beyond the senses, the evanescently tiny world that dodges the most powerful microscope, and the immense, boundless space that disappears into the darkness in the telescope? Swedenborg was not a man to submit to laborious empirical and experimental work. He preferred to think about what others had collected. As a natural philosopher he tried to

find, independently of experience, the true internal causal structure and properties of reality. Natural philosophy was supposed to be rational, searching for general principles, how things really are deep down, and not like natural history, searching only to acquire knowledge through experience, by producing an ordered account of knowledge and of what is found in nature. At one and the same time he was in the small world, with empirically known space around him, with towns, churches, and meadows, and also in the big world, where the unknown began, the cosmological macrocosm. Swedenborg's mastery of this unknown space, both in the cosmos and in the world of particles, beyond the limits of vision, is one of the main lines in this book. The premiss is that ideas about the unknown space always go back to experiences of the known and familiar ambient space. That is why the unknown space also often resembles the known.

Our experience of space is significant for thought in that the body is connected to, conditioned by what it walks on and moves through, what it touches, tastes, smells, sees, and breathes, as a part of a larger context. Swedenborg realized how all the senses affected his state when, on a journey through Germany around midsummer 1733, he stopped at a Catholic church. He was spellbound by the powerful effect of the Catholic mass on the senses. Castrati and eunuchs sang in clear voices, he saw beautiful people, inhaled the smell of incense, heard the play of voices. To be sure, he observed, it was very beautiful, but Catholicism had been invented precisely to charm the external, not the internal senses.[57] This implies that perception, the movements of the body, and the manipulation of objects are significant for reasoning and forming concepts.[58] Experiences of the world are a source from which consciousness can draw nourishment. The theory of situated cognition proceeds from the assumption that we also use the world around us in our thinking; cognition thus arises in interaction between the brain, the body, and the world.[59] There is no sharp line dividing the brain from the world. In other words, cognitive activity cannot be separated from the situations in which it takes place. An understanding of a historical situation, or of ideas in history, therefore cannot be geared solely to human consciousness itself, but also to the world around this consciousness.

The brain creates inner representations of events in the outside world, builds up an internal mental world of perceptions or interpreted sensory

impressions and ideas which simultaneously become independent of the actual presence of what they concern.[60] Spatial experience develops in interaction with the surrounding world. Yet thinking does not just take place in the brain, but also in the body, in the hands, in the steps, and thoughts are placed out in the world, outside the head, in the landscape, in pictures, texts, objects, managed by means of pens, books, calendars, maps, as external memory banks and thought processors. According to this theory of distributed cognition, thinking can be said to float out into things.[61] Material culture can be described as an extension of our bodies and our thinking. It is therefore necessary to study material culture in order to understand the thinking of a period. Thinking quite simply needs the outside world if it is to function.

The dependence of human thought on the brain, the body, and physical experiences means that it cannot be transcendental in the sense that thought goes beyond how human beings happen to think. While there may be a world of thought independent of humans, we can never, for natural reasons, know it. We have cognitive limitations as a function of the body, the environment, and the long history of interaction between them. Ultimately, our concepts of the world proceed from the brain and the body in interaction with the external world. The meanings of a word exist in the head and are linked to perception.[62] The world we observe is therefore shaped by our cognitive preconditions. In other words, the world is dependent on our understanding of it, and our knowledge of it is not stable but changing. The subject adapts to the world and also changes it.[63] Swedenborg's and other scientists' theories therefore chiefly concern how they regard and understand reality, more than the external world in itself.

The significance of spatial perception for our concepts, such as spatial relations or orientation in space in relation to gravitation, is revealed in many ways in thought and language. We picture concepts as 'containers' with an inside, an outside, and a boundary between them. We perceive figure and background, part and whole, centre and periphery, straight and curved, cycles, balance, near and far, vertical and horizontal orientation, front and back. The logic of these bodily based 'image schemas' is used in language and in abstract thought, in philosophy, science, and mathematics alike.[64] Image schemas are embodied prelinguistic structures of experience that underpin conceptual metaphor mappings, that is, recurring structures that give patterns for reasoning and understanding. We talk, for example,

about *higher* mathematics, we say that we are *near* a solution to the problem, that we have time *ahead of* us… Spatial experience is crucial for the symbols we create. Man, according to Ernst Cassirer, has proceeded from organic and perceptual spatial experiences to an abstract or symbolic space that has opened up new knowledge, a new direction in his cultural life.[65]

Human consciousness shapes our model of the world on the basis of constants such as the rotation of the earth (the sun's movement over the horizon), the movement of the stars, the cycles of the seasons, and the relations of the human body to the outside world. Gravitation, the vertical position of the body, has resulted in the universal human experience of the opposition of up and down. Swedenborg's teacher, the professor of mathematics Harald Vallerius, was amazed at the paradoxical phenomenon that humans always walk around on the globe at right angles to the horizon, and always on the horizontal plane, and thereby simultaneously walk uphill and downhill.[66] Other pairs of opposites are right-left, alive-dead (which stands for something in movement, warm, and breathing, as opposed to something motionless, cold, and not breathing). The Russian cultural semiotician Yuri Lotman stresses this boundary that humans draw between inside and outside, between the cosmos of culture and the chaos beyond it.[67] 'Our' space, our culture, secure, harmoniously organized, is contrasted with 'their' space, the other, dangerous, chaotic. Cultures moreover organize themselves in the form of a special space-time, with a system of coordinates, temporal divisions into past, present, and future, and spatial categories of inside, outside, and the boundary between them. Territoriality is a fundamental instinct, defining a territory and staking out borders. The differences between inner and outer, above and below, occur repeatedly in Swedenborg. The theme is infinitely varied through the history of ideas, between material reality down here and the world of ideas up there, this world and the other world, man on earth and God in heaven. 'Above' reality is the ideal city, the island, or the country, as in the Utopian geography of the Renaissance, not only Thomas More's *Utopia* but also Tommaso Campanella's *La Città del Sole*, Francis Bacon's *New Atlantis* or, for that matter, in Swedenborg's spiritual world. And mankind is somewhere between Tartarus and the Empyrean.

This exposition on space and thought is intended to underline that human life in space affects our thinking, and that spatial perception and

ideas about the world are dependent on certain cognitive and mental factors. Swedenborg's perception and experience of space is thus not unimportant for an understanding of his natural philosophy. In other words, there is an interaction between the inner and the outer world. Day and night, light and darkness, gravitation, the landscape, and the compass points are a part of our thinking. As Lotman writes, 'Thought is within us, but we are within thought, just as language is something engendered by our minds and directly dependent on the mechanisms of the brain, and we are with language. […] And finally the spatial image of the world is both within us and without us.'[68]

Metaphorical thought

Metaphors ineluctably make their way into thought, as this introduction testifies, with its description of the amount of books being like the sand in the sea and of Swedenborg's life as a journey along a crooked road. A thinking being is a metaphorical thinker, Aristotle said, explaining metaphor as the application of the name of one object to another.[69] The use of metaphors in thinking—using the concrete to capture the abstract, proceeding from the known to learn the unknown—as I will show, has a highly palpable and central role in Swedenborg's thought. He constantly uses metaphors, from the known reality to the unknown, from the visible to the invisible, in both his natural philosophy and his theology. Swedenborg thought in metaphors.

In cognitive semantics, as represented by George Lakoff, Mark Johnson, and others, certain conclusions have been drawn from assumptions in cognitive science about the way humans think. One feature that has been seized on is the fact that humans think metaphorically. Our basic concepts do not function beyond our everyday experiences. To conceptualize non-everyday phenomena or abstract thoughts requires conceptual metaphors. Metaphor can then mean understanding and experiencing something with the aid of something else, or that a structure in one domain is transferred to another, from a source (the sensorimotor domain) to a target (subjective experience) which simultaneously preserves the deductive structure. Metaphors entail conceptualizing something in terms of some other thing, and function in a way as models for less well-known areas. We transfer knowledge about the known to the unknown, from the familiar to the unfamiliar, from the commonplace

world, society, human life, engineering and handicraft, to the invisible particle world, to the soul and God. One could say that metaphorical thought means finding similarities between things, but also forgetting dissimilarities, being able to generalize and abstract. The creation and use of metaphors requires creativity and imagination.

Many of our fundamental concepts are organized on the basis of one or more spatial metaphors.[70] There are metaphors that transfer a structure, or proceed from a spatial orientation that arises from the action of the body in physical reality. Our experiences of physical objects give rise to ontological metaphors, that is, seeing events, emotions, ideas, and states as objects, entities, substances, or containers. They can be metaphors such as imagining life as a journey or intellectual influence as a physical force. Time can be understood spatially as something flowing along a line or in a circle. Thinking can be described in terms of movement, moving forward step by step without skipping any stages, or taking the straightest course to the conclusion without going in circles or getting away from the subject. To think is to travel. It is a walk along a path, a voyage on the sea, a journey with or without a goal. The researcher can get lost in the labyrinth of reality. He cannot find the narrow trail out of the jungle, he can be driven off course on the ocean of knowledge, or after much searching he may find the straight road towards the goal, 'truth'. The landscape with its settlement, habitability, shifts of light and shade, also gives conceptual patterns. Wilderness and darkness are ignorance and irrationality. Fortified castles and light represent sure knowledge and wisdom. To think is also to see. Knowledge is vision. What is unknown, difficult to comprehend, is obscure darkness. Without knowledge we grope in the dark. To acquire knowledge is to shed light on things, a knowledge that enables us to see and allows new findings to see the light of day. Knowledge brings enlightenment, we see, feel, everything is clear. What is significant and important is of greater weight or size. Similarity is understood as physical nearness, difficulties are burdens, and organizational structures are like physical structures. Swedenborg himself constantly returns to descriptions of thinking in such metaphors of space, travel, and light, and this is far from unusual in philosophy. These metaphors are used unconsciously, automatically in everyday life and arise from our quotidian experience. Language itself contains many dead metaphors based on the movements of the body, in words such as *understand*, *reflect*, *grasp*, *comprehend*.

Without metaphors, abstract reasoning would be impossible.[71]

Metaphorical concepts have their origin not just in our physical but also in our cultural experience. The more layers of metaphors we employ, the more abstract and culturally specific the concept becomes.[72] Some metaphors proceed from some special cultural knowledge, for example metaphors based on Euclidean geometry. People who live in cultures with no knowledge of Euclidean geometry would not understand such metaphors. Euclidean geometry gives the world a specific visual metaphorical structure, a world of relations between points, lines, and circles. In many cases, then, scientific theories and concepts about the world are founded on spatial metaphors with a physical and cultural origin. Philosophers and natural scientists use the same conceptual system as ordinary people in their own culture. In philosophical theories they incorporate the concepts available in the historical context and the general theories, models, and metaphors that are common and typical in the culture to which they belong, but they also rework these basic concepts, see new links, and draw new conclusions. It is the shared concepts and ideas that make a specific philosophical theory comprehensible to people within a particular culture. Philosophical theories can be interpreted as attempts to refine, expand, clarify, and make consistent certain common metaphors and 'popular' or 'general' theories shared by people in a culture. What a particular philosophical theory also does is to select the 'right' metaphors. Differences between philosophical views thus depend on different choices of metaphors. Each philosopher's metaphysics has its origin in what he takes as central metaphors. A 'world-view' can therefore be regarded as a consistent constellation of concepts, especially metaphorical concepts, over one or more conceptual domains.[73] The world-view is the reality for the people of its time. The task is thus to find some of Swedenborg's central metaphors, with which he sought to create a consistent natural philosophy.

In philosophical analysis and scientific theory formation, then, metaphors play an important part. Philosophical and scientific texts are more or less strewn with metaphors, analogies, metonymies, similes, and comparisons. In the history of science they have often been dismissed as unscientific and uninteresting adornment.[74] They have mostly been regarded as poetic whims, educational and rhetorical devices, or simply as superfluous linguistic expressions that obscure the view of the true logical

structure of the scientific arguments, the purely rational scientific and mathematical. Against this I claim that metaphors, the linguistic form, the tropes that modify the basic meaning of a word, are of crucial importance. They are not mere external ornament, but a major part of creative thought by establishing visual analogies and abstract ideas. For this reason they also provide valuable clues to how scientists think. Scientific reasoning uses metaphors to a great extent as conceptual tools or as theoretical models of the external world. Structural metaphors and process metaphors are particularly common in scientific reasoning, metaphors that try to get away from the emotional and subjective. In science one must form new concepts for the new phenomena one is describing, and this is often done with the aid of metaphors related to what is already known. On the basis of his knowledge about water waves, Swedenborg was able to picture sound waves and light waves; from his experience of peas and cannonballs, Polhem was able to visualize the structure of invisible particles of matter.

In Swedenborg's times there was a keen interest in metaphors. We find a baroque style characterized by a fondness for tropes in which certain semantic units are replaced by others. Throughout the baroque, metaphors and allegorical expressions were popular in art, literature, architecture, on coins, in music and science. Even in scholarly dissertations, metaphors were employed, such as the quest for knowledge and reason as a journey or a wandering, the disputation and the debate as a fencing duel or a struggle on a battlefield, the truth that is brought to light, as when a gardener removes the bark from a tree to arrive at its heart, or studies and writing as a textile craft that weaves knowledge together.[75] But they used similes, analogies, metaphors as something more than a stylistic, aesthetic decoration. These devices could reveal the secrets of creation. Emanuele Tesauro, one of the foremost theorists of literature during the baroque, explained quite simply that 'God wrote the book of nature in metaphors, and so it should be read.'[76] The philosopher of history Giambattista Vico, in his *Scienza nuova* (1725), proceeded from four basic tropes, in which man develops from thinking in anthropomorphic fables or metaphors, via metonymy and synecdoche to reflective thinking or irony.[77] Metaphor for him was a capacity in the human mind to connect things and events in the world, a way to think about unknown things. In Swedenborg this interest in metaphors is displayed in an uncommonly clear way. His Latin poems,

as Helander has shown, are model expressions of a poetic, allegorical baroque world. This baroque metaphorical thought, I would add, can also be expanded to apply to Swedenborg's entire natural philosophy, which in many respects is baroque metaphor taken to its extreme. The poet and the scientist are combined in metaphorical thinking about the world.

Besides metaphorical thought there are other palpable points of contact between the poetry, art, and music of the baroque and the science and mathematics of the age. Firstly, all creative activities are part of the history of human creativity. There is an affinity between the creativity of the mathematician and that of the poet, as Tesauro once declared.[78] In language, art, religion, and science there is an aspiration to build up an ideal world of one's own. Ideas are governed by wishes, a will or desire as to what the world should be like, an effort to arrange the world as it ought to be. This creative imagination can also be found in Swedenborg's natural philosophy, an innovative mode of thought in which the theories, as in all other researchers, are influenced by wishful thinking. Theories are the self-fulfilment of wishes. 'For what a man had rather were true he more readily believes,' wrote Francis Bacon.[79] Secondly, art and science can be said to be united in a 'baroque style', not necessarily understood as a term for an era, but rather as what Ludwik Fleck calls a 'thought style', or what the historian of ideas Gunnar Eriksson has denoted 'baroque science'.[80] The thought style has a specific direction, is dominated by certain aesthetic ideals, and involves a hierarchy between authors. In the specific baroque style, both in the arts and in natural philosophy, people sought for effect, contrasts, and rich symbolism. The baroque gave expression to vigour and passion, a magnificent metaphysics with huge pretensions, monumental buildings, grandiose trumpet fanfares, bulging female bodies, but also personal thoughts, delicate arias, and silent, introverted still lifes. A baroque work of art was supposed to be a universal artwork with internal coherence. In the baroque style there is an aspiration for completeness and variation, an ambition to see things from different perspectives and levels, parallels and antitheses. It is a world composed of correspondences, a structure that always refers to something else. In science and philosophy, the baroque style is manifested in an emphasis on the order and interconnection of reality, and a desire for theories that express simplicity, symmetry, harmony, and 'pure', abstract geometrical forms. Everything is expected to have a meaning, an ultimate purpose, and

an internal structure.

The scientific style underwent some radical changes before Swedenborg entered the stage. There was a switch from anthropomorphic to mechanical metaphors, and a dynamic mobility was introduced as a contrast to the static monumentality of the Renaissance. 'The world machine' became the central metaphor in the natural philosophy of the seventeenth and eighteenth centuries, a basic metaphor that generated new metaphors, particularly spatial, visual, and orientational ones: *space is geometry*, *matter is geometry*, and so on. The world became a machine, a world geometry in constant motion. Nature and reason were mechanized. The concepts and metaphors of geometry and mechanics steered and structured reason in the sense that reason could only be extended in one particular direction but not in others. People focused on geometrical forms but avoided what was inconsistent with the geometrical metaphor. The world was ordered, understood, depicted, and discussed in geometrical and mechanical terms. This metaphorics was not always conscious; it was an inherent part of the way of thinking about nature during the mechanistic period. Virtually all branches of human thought were affected by the metaphor of the world machine.

Machines and the machine metaphor gave people an illusion of power over nature and work. This stood for control, order, and regularity. The world machine worked according to laws and rules, transmitted forces in a continuous causality, but could be controlled and manipulated, dismantled into small parts, and abstracted from its context. The mechanistic philosophy involved a new theory of matter with geometrical particles, a new theory of cause and effect through physical contact, and a new method based on mechanical analogies. The mechanistic world-view brought a new perception of what was real, a reality defined by geometrical particles of matter in motion. Its metaphysical goal was to find the mechanics behind reality, the purely mechanical world underlying experience. With mechanical metaphors, Swedenborg and others were able to describe nature's phenomena and processes, to arrive at the rules of mechanical method in order to gain new knowledge, and to distance themselves from personal interests and emotions. It was this mechanistic, geometrical world-view that he later revolted against when he embarked on the description of a non-material spiritual world liberated from earthly geometry.

Alongside mechanics and dynamics, we notice in this age the suggestive force of infinity. The telescope and the microscope opened a perspective of infinity out into the universe and into matter. As Oswald Spengler wrote: 'The same inspired ordering of an infinite world which manifested itself in the geometrical analysis and projective geometry of the 17th Century, could vivify, energize, and suffuse contemporary music with the harmony that it developed out of the art of thoroughbass, (which is the geometry of the sound-world) and contemporary painting with the principle of perspective (the felt geometry of the space-world that only the West knows).'[81] In Swedenborg we find all this, the magnificent universal work of art, the variations, the parallels, the correspondences, the order, the harmonics, the mechanical metaphors, the dynamics and the perspective of infinity. In some sense he can be called a thinker of the high or late baroque with a style not unlike that of the inventive minds of Polhem, or the Olof Rudbeck the Elder with his Atlantis myths, or Carl Linnaeus and his systematics of the whole of nature. They are united by their Lutheran Protestantism, classical education, grandiose claims, and metaphorical thought. In this section I emphasized that man has an inherent cognitive ability to think in metaphors, which Swedenborg also used in large measure in his thinking, and this took place at a time with specific metaphors and with a general openness to the metaphorics of reality.

Seeing with the inner eye

Swedenborg—literally—saw the world differently. The nature of seeing can to some extent give us the keys to Swedenborg's special mechanistic, geometrical world-view. For there is a conceptual vision which indicates that he actually had other sensory experiences than we would have when faced with the same object, or more correctly, which meant that he made other interpretations of what he saw. In his day there was also a new way of seeing, a powerful visual culture, in which non-verbal thought was strengthened, as reading aloud and storytelling gave way to silent reading of books, thus entailing a shift from sound to visual impressions, and that the linear perspective transformed vision from a subjective to a objective, geometrical perception of the world. The Cartesian concept of space brought a new background knowledge through which Swedenborg was

able to interpret what he saw. He and other mechanists had a special way of seeing, a geometrical vision.

With new optics, such as the microscope and telescope, the role of sight was reinforced as a fundamental element in the description of reality.[82] The world had a visible geometrical structure. People had to look around for themselves, not just listen to authorities. Philosophy was not to have auditors but *spectators*, said Professor Johann Christopher Sturm.[83] This ocularcentrism appears plainly in Swedenborg's natural philosophy. In London in 1710 he acquired, among other things, a microscope.[84] Swedenborg may possibly have owned a single microscope of Leeuwenhoek's type with 42-fold magnification. He also had another microscope with accessories, according to his own list of possessions from 1770. Yet he did not perform so many systematic studies with it. At any rate he could smell a powerful odour of urine when he directed the sun's rays through his magnifying glass on to a sample of ordinary water.[85] But what did he see in the microscope? When he drew churches with the aid of a camera obscura, looked at stars in his telescope, or gazed at the plates in anatomical books, he saw something that we no longer see. In purely optical terms we would see similar things, but we would simultaneously see quite different things as well. Vision and perception are not a neutral, objective, faithful registration of reality. There is a conceptual or epistemic vision which means an identification of what we see, and this takes place when we apply our concepts to the visual impression. The concepts affect what we see, and if we lack concepts for a phenomenon, we do not see it. The world is distorted by our concepts, and the concepts are distorted by the world. The world we see around us is in fact a world that is reshaped by our concepts. The world is seen with the inner eye.

Seeing is an activity that aims to create order in the chaos of the senses; it is also conditioned by the observer's emotions and associations. Language, art, myths, and science are endeavours to master existence, to find an order in the world, which is thereby structured by human thoughts and feelings. They are not immediate representations of things but expressions of human ideas about things. Science is therefore in large measure a matter of an orientation in and ordering of the experiences of the human being, not of nature itself. In other words, there are no theory-neutral observations; what we see requires interpretation based on previous experiences, concepts, and prior knowledge. Using the theories

we already have, we distinguish forms and patterns in nature. Visual perception is a process through which a person who perceives something goes beyond the given information by organizing and interpreting the visual impressions, by stating the configuration more exactly, adding to and filling out an ambiguous image in order to create an unambiguous perception. The observer is forced to divide sensory impressions into their constituent parts and organize them in terms of figure, background, and foreground. This interpretation of sensory impressions is not determined by the impressions themselves but by the mind.[86]

Perception of space is influenced by topological and spatial factors such as inclusion, proximity, and so on. It is also selective, that is to say, attention is concentrated on certain features, and it is organized. In the same way as the observer's visual experience of an object changes according to his or her position in space, every sensory impression is changed by the concepts, knowledge, wishes, needs, values, or interests of the perceiving person. Swedenborg's prior knowledge, his cultural background, life history, and placing in time and space constitute the perspective from which he observed the world. This perspective, with its special way of discerning and organizing, determined what he perceived and how he perceived it. That is why we are often incapable of seeing what he and others saw in the scientific illustrations, in the microscope, on the firmament, although we have largely identical sensory capacities. Culture and cognition impose pattern on visual impressions.

An occurrence which changed the history of vision, and which I argue was significant for the 'geometrization' of reality, so that the world could be described with exact geometry, was the rise of perspective. The monocular linear perspective with a focal point on the horizon, which had been developed during the Italian Renaissance, differed from subjective experience and binocular, mobile, spherical vision. Sight was coerced into straight lines, and objects, space, and the world became geometrical. With a ruler and compasses it became possible to draw the world as it is and in agreement with geometry. With straight lines, one could not see round the corner, as in medieval art. From the more 'realistic' depiction of earlier art, which was a more faithful rendering of human cognitive, mental images with their value perspectives—whereby the important things stood out as being biggest and objects were portrayed from their most characteristic side—perspective was used to present that was supposed to

be a more objective picture and the same for all observers. The world ended up looking different as a result of the knowledge of perspective. It entailed a mathematical rationalization and abstraction of the psychophysiological perception of space, which led to an experience of space with an infinite extent, free of ambiguity and contradictions.[87]

The theory of perspective had mathematical and scientific consequences. Euclidean geometry did not fully agree with visual geometry. Two parallel lines, or 'track lines' like the traces left by cart wheels on a muddy road, which was Swedenborg's Swedish counterpart, meet at the horizon.[88] Girard Desargue's projective geometry, with a point in infinity where the parallel lines converge, agreed better with our visual perception of reality, a more visual geometry than the tactile Euclidean geometry. Linear perspective and graphics reinforced non-verbal reasoning in science. With perspective one could more efficiently convey one's non-verbal thought to another mind. Architects, engineers, anatomists, and other scientists gained an opportunity to demonstrate what could not be described exactly enough in words. With perspective drawings of landscapes, sections of the human body, and cross-sections of mines, reality was exposed. Interest in the surrounding world, in landscape and still life, increased during the seventeenth century. Topographical renderings, as in Erik Dahlbergh's *Suecia antiqua et hodierna* (1716), became perspectival panoramas from a given fixed point, where the angle of vision became lower, more natural, and the foreground was lined by trees and human onlookers leading the observer's gaze into the depth of the picture, what is known as repoussoir, instead of the steep bird's-eye view and the inconsistent representation of space. Fortification officers learned how to draw landscape, terrain, and bastions according to the rules of perspective, and surveyors were expected to produce correct depictions of fields and towns. The artist became a geometrician. Thanks to perspective, it was assumed, scientific illustrations became more like nature, more lucid and graphic. In fact, however, one could claim that the illustrations, as in Swedenborg's works, in many ways tell us more about the surrounding culture, its perceptions and special vision, than about nature itself. The pictures are not really true to life; they are mental artefacts, an attempt to transfer mental images to paper, they are adapted to a theory and reflect a vision dependent on knowledge. All pictures are interpretations of reality based on experiences, knowledge, and

expectations. The pictures in Swedenborg's works are thus not just illustrations but also carry meanings and provide clues to his visualization and mental images.

What people saw was not unambiguous. The optical instruments of the day suffered from chromatic and spherical aberration which distorted colours and blurred the focus. Indeterminate images forced the observer to interpret what he had seen, which called for concepts and theories. Harald Vallerius seems to have found himself in that situation. The sensory experience, he wrote in a dissertation on the deceptive property of sight, can lead the intellect to make mistakes about the number, figure, and movement of objects.[89] The laws of perspective cause a circle to appear oval when viewed from the side, a square becomes a rhombus, and with the naked eye, he continues, we cannot distinguish details from a distance because of tremulations in the air, as when one looks at a stone in a river through the waves of the water flowing past. Swedenborg's point of departure was, like that of Vallerius, a mechanistic world-view, a pre-understanding of the world as mechanical and geometrical. He projected the concepts and theories of mechanics on to the world, thus confirming his own mechanistic ideas. He sought and found what he presupposed was there: describable geometrical forms and mechanics. The concepts of vision are shaped by reason, for no one has seen an exactly straight line or a perfect circle. In some sense the mechanists created the world they were out to explain, the geometrical world. By formulating an idea of a rational, geometrical world, they were able to handle what they saw around them. Geometry had the function of organizing visual impressions and memory, like a geometrical net of consciousness through which reality must pass. The mechanistic philosopher interpreted reality in terms of the mechanical and geometrical paradigm, and thereby really did *see* small machines in his microscope, and geometrical structures that others would not have noticed. It was with this geometrical vision that Harald Vallerius saw when, in a dissertation about the meaning of parallel lines in the mathematical sciences, he found parallels in trees, forests, salts, in the cubic, hexahedral, octahedral, dodecahedral forms of the emerald, in the concentric circles of heaven, and in the strings of musical instruments.[90]

There was thus a willingness to see things as geometry, to see with other eyes, to interpret them differently, a preparedness to see something in agreement with their world-view and established thought style.

Swedenborg would thus literally see something different in the microscope from what we would see in the same situation. Through his previous knowledge, through his concepts and theories, he interpreted what he saw differently. He would concentrate on other things, interpret in other forms, find other associations, make other evaluations, and receive other mental images. The historical challenge is to try to understand and see reality in the way people did back then, to see the same things, to attempt to interpret and evaluate in similar ways, to see through the microscope in the same manner. What Swedenborg saw in the microscope was a geometrical and mechanical world.

Thinking with books

The history of reading and writing is a part of the history of distributed cognition. Swedenborg thought with the aid of books and pens. Reading gave him associations, clues, required him to make interpretations, and gave him ideas and matter for continued thinking. In his writing he was forced to make his thoughts concrete in order to find the right words for his mental images. Communication in that sense can be described as an attempt to transfer mental images from one mind to another. A key to Swedenborg's reasoning, how he arrived at his ideas, is the manner in which he communicated, read, and wrote. It is thus in large measure a question of how he interpreted texts, tried to read a meaning into them that he could use in his own thinking. In one way it could be said that the whole of Swedenborg's intellectual activity was about interpreting and creating meaning, about hermeneutic grappling with texts. His doctoral dissertation was about the meanings of the maxims and 'the wisdom of the mimeograph'. Here he is talking about the metaphorical meanings of the concrete words, as in the explanation of a maxim where he demonstrates the rich occurrence of the comparison between a bow and the mind.[91] Both can break. As the bow breaks when it is bent, so can the mind break when loosed. Exercise and meditation are like food to the mind, and if it is not nourished and sustained, it will fall. He also used spatial thinking. Compatibility makes things stronger, while incompatibility makes them weaker. Swedenborg read mineralogical and medical works in search of material for a theoretical synthesis. He made excerpts and drew his own conclusions from them. The dream crisis was an anxious quest for meaning in the chaotic dreams that were so difficult to interpret. He did

not find a sure method for interpreting the dreams until he evolved the doctrine of correspondences and his teachings on the realms of spirits and angels. The dreams of the dream crisis and the spiritual world do not differ primarily in their content, but in the method of interpretation. With his journeys to the spiritual world he acquired a narrative framework in which he could understand his visions, and with the doctrine of correspondences he found the key to the interpretation of the Bible's message. In the doctrine of spirits and the doctrine of correspondences he used a reading technique that had its origin in the reading of books, in the work with texts, particularly those on science and mathematics.

Swedenborg was faced with an incalculable amount of books, like the sand in the sea, and this huge quantity of information forced his cognitive self to assume personal responsibility for the organization of all the knowledge. The creation of order could not be left to authorities; it also called for a personal struggle with the texts. Reading for him became a form of self-formation or self-construction. Considering Swedenborg as a reader therefore involves not just looking at *what* he read, but also *how* he used and read other texts. An important first step for understanding his thought is to establish which books and sources he actually may have used, which ones he read or knew of. The next step should be to try to discover his special reading technique, what he was searching for and how he related to the texts. It is a question of how he interpreted, found semantic connections and meaning in them from his point of view and his cultural tradition.

One starting point is that the books, the writings, are something more than just a kind of materialized thoughts. They are not static but possess a semantic mobility, in that their meaning is modified by the outlook of the reader. They are dynamic, changed by new contexts. Moreover, it is not at all certain that the author's message is received intact by the reader, since the two have different codes, that is, different rules for the conveyance of linguistic meanings, based on different linguistic experiences, memories, norms, contexts, cultural traditions, and distinctive individual features.[92] The codes can overlap but are never identical. This applies, of course, not just to Swedenborg as a reader, but also to a modern-day historian. The code or the codes used by the creator of a text must in some sense be reconstructed and then correlated with the researcher's codes. A reader subjects the original material, the text, to cognitive and semiotic

manipulations. Reading includes interpretation, perception, and background knowledge. The reader gets certain associations, establishes personal links, receives personal mental images. Reality is therefore deformed not just by the author of the source, but also by the reader, the exegete, and the historian. The reception displaces and distorts, always creating something new.[93]

When Swedenborg read a particular text, it was transformed through his personal comprehension and his special interpretation. It was read in terms of his own norms—aesthetic, religious, scientific—and those of his time, his cognitive ability, metaphors, and mental images. Swedenborg was most things, but not a historian of ideas who tried to be faithful to the original text; instead he had a specific purpose and a special use for the text. He took what he needed for his own thought. What the author actually meant was more or less irrelevant. This also explains why he so often cited his sources incorrectly.[94] He had a reason for this. Correct citation was not an end in itself. The excerpts were rather material on which to build further. When he made his interpretation of the formulations in a book, the ideas no longer belonged to the original author; they now became Swedenborg's own ideas and a part of a new context. The original ideas and Swedenborg's may be very close, but they are not identical. One could thus say that Swedenborg did not read Wolff's Wolff but Swedenborg's Wolff.

The books in his library were not the true source of his ideas but are better regarded as tools for his own thinking. To overstate somewhat, one could say that Swedenborg was not influenced by anyone, if by intellectual influence one means a kind of causal connection, whereby thoughts 'cause' another person's thought, as a ball strike another and changes its direction. The history of reception in that sense is a metaphor based on spatial causality, a genealogy of series of causes and effects: The impact of an idea is a physical force that moves us from one intellectual space to another. Similarities between two thinkers thus seem to presuppose either that one has influenced the other or that they are both influenced by a common source. But I emphasize that there is always an element of interpretation and that there are basic cognitive abilities which entail that ideas cannot be transferred wholly intact. Similarities between Swedenborg's doctrine of correspondences and, for example, Kabbalah, Neoplatonism, or Wolffianism, need not necessarily entail influence or

origin in common concrete sources, written or otherwise. In many cases, a cognitive history of ideas can instead explain that the similarities proceed from very similar cognitive premisses, that they spring from analogous mental images, or use similar metaphors and categorical divisions quite independently of each other. Not every idea comes from someone else, not all ideas can be traced back to another thinker. The ideas come from minds, from brains. Swedenborg's ideas do not come direct from books and authorities, but from his own human cerebrum in its encounter with the world.

With language one can express things that do not exist, that are not present in time and place. It is a matter of one's own ideas, the internal world and not really about the external world. At the same time, there is a gap between language and cognition. The author cannot express his ideas, cognitive processes, or mental images exactly in words. The text is not capable of directly rendering an author's intention. The documents, the texts, are incomplete, containing lacunae of implicit knowledge and unconscious presuppositions. There are 'non-facts' that were not recorded because they were considered to lack significance. In every culture and genre, in every author, there are selections, conscious or unconscious, of facts that are regarded as significant. In the creation of the work, the author is also subject to intellectual, aesthetic, ethical, religious, and other norms. The work is spatially dependent and part of a chronocentric context. As an author, Swedenborg wanted to say something, aimed at meaning something, and had the intention to express something true that defies time. His writings responded to something and addressed something, contained a meaning, which was intended to be received and was received in a particular way. But his writing was not just about formulating his thoughts in words, putting across a message; not least of all it was a solipsistic act, a personal mental struggle, an articulated introspection through which the inner self was placed in relation to the outside world.[95] When he wrote about the spiritual world, he turned inwards and put his own role and his own action in relation to the world.

An understanding of Swedenborg's thought can be approached by considering how he read, interpreted, and manipulated texts. The books he read were in some sense unfinished and incomplete when he as a reader became an active part in their continuation. The books invited countless readings. Swedenborg carried on writing some of them. In actual fact, the

difference between reading and writing is not as great as one might expect; they are interwoven. There is a constant interplay between silent reading and writing. Swedenborg read with a pen in his hand and wrote with a book in front of him.

Overview—The world machine seen from above

This *Introduction* has given a survey of Swedenborg's life and an orientation in the literature about him. It has shown that there is no detailed study of his early mechanistic natural philosophy in the context of intellectual history. The present book can be described as a cognitive history of ideas, examining how Swedenborg thought. In research into his natural philosophy, some theoretical problems arise concerning the concept of space, metaphors, vision, and reading. The rest of the book is thematically structured, with a certain gradual chronological development. Each chapter concentrates on an image schema, a spatial or geometrical figure typical of his natural philosophy, and special disciplines and works of Swedenborg. The idea is also to follow Swedenborg's metaphorics from the known and visible to the unknown and invisible world. If one could for a moment observe *The World Machine* from above, one could see this:

Space is an introductory chapter about the concept of space, about Swedenborg's experiences of space gained through optical instruments and his orientation in the intellectual milieu and in the spatial world with the aid of geometry. The focus here is on Swedenborg's connection with the learned society Collegium Curiosorum, his suggested solution to the problem of longitude, and his manuscripts on geometry dating from the 1710s. The basic standpoint is that human orientation and daily actions in space, together with vision, perception, and experiences of bodily movements, are significant for human reasoning. Swedenborg's natural philosophy is characterized by a geometrization of reality based on the widespread belief that geometry is an ideal method for achieving certainty, and that the ideal objectivity belongs to a transcendent reality.

The Sign concerns the interest that Swedenborg and his contemporaries had in signs, that is, things that stand for something else, that refer to something else. The chapter treats especially some particular sign systems, such as those of arithmetic and algebra, and the division of

the world into categories, as in numeral systems, coinage, measures, weights, and volumes. There is an examination of Swedenborg's discussion with the Swedish king, Charles XII, during the years 1716 to 1718 about numeral systems based on 8 or 64 as an alternative to the traditional decimal system. The signs of mathematics can be used as metaphors to describe reasoning and the structure of the world. This arithmetical study shows that not even mathematics is free from political and rhetorical considerations.

The Wave follows Swedenborg's use of the metaphor of the wave, not only in such scientific disciplines as hydrology, acoustics, optics, and neurology but also in poetry and music. On the basis of his everyday experiences of water waves, Swedenborg was able to use this metaphor to transfer the qualities of these waves to other physical phenomena such as sound waves and light waves. In Swedenborg's time there was an interest in baroque music and the relation of sounds to mathematics. Polhem suggested a number of sound experiments intended to be carried out in the mountains of Lapland, and Swedenborg published these in *Dædalus Hyperboreus*. The two men also debated the mechanical nature of fire and colours. Swedenborg's most original idea was put forward in a manuscript of 1720 about tremulations. He maintained that life consists of waves or tremors of the nerves. The body is like a musical instrument. He was a typical proponent of iatromechanics, discovering circles and waves in the musical body.

The Sphere deals with the sphere as the figure of movement, with the relationship between technology and science, and with analogies, proportions and mental models as important tools for inventing scientific theories, especially in mechanics, physics, and chemistry. War, engineering, and mining gave Swedenborg ideas and metaphors for research into matter. In his early theory of matter, put forward in *Prodromus principiorum rerum naturalium* (1721) and *Miscellanea observata* (1722), he declared, in agreement with Polhem, that the sphere, as in the round form of peas, cannon balls, and bubbles, can give clues to the structure of the invisible world of particles. In one of his first manuscripts about mining he describes effluvia or metallic vapours rising from the rock. His mining studies, such as *De ferro* and *De cupro* from 1734, likewise display metaphors and a geometrical natural philosophy. Behind this analogical reasoning there is an assumption that 'micro-

mechanics is macro-mechanics'. The experience of artificial machines made by humans could be transferred to the invisible microcosmic world of particles.

The Point proceeds from the indivisible point of mathematics. In Swedenborg's *Principia rerum naturalium* (1734), mathematical points are given an ontological significance. The world appears when God, like an artist drawing with his pencil, gives motion to the point. The world consists of circulating points. With spider metaphors Swedenborg postulated that the world is built on mathematics, and with labyrinth metaphors he formulated the philosophers' feeling of disorientation in the chaos of nature. Behind this is a conception of the creation of the world as an exercise in practical geometry, as when one draws figures on a sheet of paper with the aid of mathematical points. The world is geometry. A comparison of an early draft of the *Principia* with the printed version shows that in the intervening years he had adopted Wolffian terminology in his description of nature.

The Spiral is the geometrical figure Swedenborg admired most. He wrote about the windings of the spirals in geometry, particle physics, astronomy, and in the nature of the soul. In his mathematical writings he treated the geometry of the logarithmic spiral, and in several astronomical writings he described the eternal spring of the world caused by the spiral movement of the earth. In the *Principia*, particles and planets circulate in perfect spirals. He describes the magnetic force in mechanical terms, as effluvia of particles. Finally, he also made a sketch of a membrane between body and soul in the form of a spiral. Through all this there is a micro- and macrocosmic perspective, in which the world of particles is conceptualized as a small solar system. The experience of water and air whirls is developed into an abstract world of solar vortices and points in spiral motion.

Infinity is limited to Swedenborg's last mechanistic work, *De infinito* (1734), where he made a strict distinction between the finite and the infinite. Infinity is God in contrast to the finiteness of man and the material world. He puts forward a number of proofs for the existence of God and describes the soul as a machine. His thoughts on infinity give a picture of his metaphysics, of the boundaries of the human mind, and of how he tried to connect science and theology, man and God, reason and revelation, before he turned to organic metaphors.

The book ends with a *Conclusion* surveying the major themes of Swedenborg's anatomical and physiological studies and his spiritual writings from the end of the 1730s to 1772. The survey covers the geometry in his neurological writings, the hierarchies of forms, the agony of the dream crisis, the geometry of the spiritual world, and the metaphorics of the doctrine of correspondences. The analysis shows that a cognitive study of his natural philosophy also sheds light on the late Swedenborg's thought. In his theological system of thought he advanced the ability to think in metaphors further than anyone else has done.

[1] Swedenborg, in Swedberg 1709b, cf. 388–392; *Ludus Heliconius*, ed. Helander, 60f.

[2] Eccles. 12:12; cf. Browallius, 10.

[3] Swedberg 1941, 239, 527.

[4] Roberg 1747, 27.

[5] Swedenborg, in *Gepriesenes Andencken*, 93; *Ludus Heliconius*, ed. Helander, 82f, commentary 164.

[6] *De telluribus*, n. 136.

[7] Archimedes, *Psammitēs*, 1.1.1–2; translation, 221; *Ludus Heliconius*, ed. Helander, commentary 149; cf. Horace, 1.28.1.1–4; Sturm 1699, I, 11.

[8] Archimedes, *Psammitēs*, 3.4.27–5.1; translation, 228.

[9] Ovid, *Ars amatoria*, 1.253f.

[10] Rudbeckius, 166; Ps. 139:18.

[11] Gen. 13:16, 22:17, 28:14, 32:12; Num. 23:10; 1 Kings 4:20; Hos. 1:10; Jth. 2:20; Ecclus. 1:2, 44:21; Rom. 9:27.

[12] Rydelius 1737, 161; Eccles. 1:15.

[13] Peringskiöld, title page.

[14] Spegel 1685, ed. Olsson & Nilsson, I:1, 189.

[15] Agricola, translation, 8; cf. Wisd. of Sol. 7:9.

[16] Brewster, II, 331.

[17] Dalin 1744, 23.

[18] Bonde, dedication; Edenborg 1997, 43.

[19] Ginzburg 1979, 93, 109; Ginzburg 1986, translation, 96–125.

[20] Boyle 1965, 194.

[21] Blake 1989, 589.

[22] Swedberg 1941, 239; SSA, CIa:10.

[23] *Then swenska psalm-boken* 1694, Ps. 389:3.

[24] Linnaeus 1742, 298.

[25] Below & Ribe. KVA.

[26] Rhyzelius 1901, 38; cf. Broberg 1990, 90–104.

[27] Preparatory notes for the dissertation from Cicero, Plautus, and Florus can be found in KVA, cod. 37; cf. *Opera* I, 202; *Letters* I, 4.

[28] *Opera* I, 201; *Letters* I, 3.

[29] Swedenborg, in Palmroot & Unge, 14; *Ludus Heliconius*, ed. Helander, 62f.

[30] Bredberg, 112, cf. 118–120.

[31] *Resebeskrifningar*, v.

[32] *De commercio animæ et corporis*, n. 20.

[33] Prosperin, 11.

[34] Spear; Suzuki.

[35] Munich, January 1818; Cited in Horn, translation, 32.

[36] Schubert, 10; Jonsson 1983b, 169.

[37] 'Emanuel Swedenborg', Borges 1989, 287; Borges 1982; translation, 16; Báez-Rivera, 73; Kutik, 79.

[38] Tafel, 5–6; Holmquist 1909b; Eby; Söderberg 1989, 53–72; Williams-Hogan 2002, 227–244; Rose 2004, 7; Rose 2005.

[39] See also Stroh & Ekelöf; Wainscot; Woofenden 2002.

[40] Stroh 1912; Stroh 1918; see also Potts; concerning Swedenborg's Latin, Chadwick; Berggren; Chadwick & Rose.

[41] Svante Arrhenius wrote about Swedenborg as an astronomer, Gustaf Retzius and Martin Ramström about his research on the brain, Hjalmar Sjögren about geology, Gustaf Eneström about mathematics, and Wilhelm Oseen published Swedenborg manuscripts. These are only short essays; see Ramström, Retzius; Nordenmark 1933; Stroh 1908; *Transactions of the International Swedenborg Congress 1910*; cf. Broberg 1983, 120f, 127.

[42] Lamm 1915, translation, xxiii.

[43] Jonsson 1961, translation, 10, 175; cf. Lamm 1915, translation, 184; otherwise there are four dissertations about Swedenborg: Schlieper; Kirven; Calatrello; Woofenden 1970.

[44] Since Sandels, the ones that have attracted most attention are: Kleen; Toksvig; Benz; Sigstedt; cf. Lenhammar 1988.

[45] Jonsson 2002, 312f; see also Crasta 2002; N. Newton 1999; Holmquist 1909a; Holmquist 1913; Lindh 1927–1929; Piotrowska, 29–38; Brock; Hoppe; Jonsson 2008.

[46] Works have been written about such readers of Swedenborg as Oetinger, Kant,

Goethe, Blake, Coleridge, Schelling, Boström, Balzac, Emerson, Whitman, and Baudelaire. See e.g. Florschütz; McNeilly 2004; McNeilly 2005; Rix; Stengel; Wilkinson; dissertations about the reception of Swedenborg and about Swedenborgianism are, among others: Lenhammar 1966; Williams-Hogan 1985; Sjödén; Hallengren 1994; Häll; see also Garrett; Hallengren 1989; Hjern; Hanegraaff 1996, 424–429; Sanner; Gabay; Hanegraaff 2007; Williams-Hogan 2008.

[47] Miłosz 2000, 137; Miłosz 2007, 1–16.

[48] Atran; Tomasello 1999; Turner; Richardson & Steen; Tomasello 2005, 203–217; Atran & Medin; Boyd; Dutton.

[49] Mithen; Renfrew, Frith & Malafouris.

[50] Nersessian 1992, 4–7, 36–38; Nersessian 1995, 194–211; Nersessian 2005; see also Lawson 1994, 481–495; Gooding; Tweney, 141–173; Carruthers, Stich & Siegal; Heintz, 391–408; Lawson 2004, 1–5; Whitehouse, 307–318.

[51] Olson; Netz 1999; Andersen, Barker & Chen; Martin & Sørensen.

[52] Lakoff, 371.

[53] Lotman 1990, 271.

[54] Lakoff & Johnson 1999, 3, 7, 10; Johnson; Varela, Thompson & Rosch; Krois et al.; Calvo & Gomila.

[55] Bergquist 2000a, 22; Lakoff & Johnson 1999, 556f.

[56] Skinner, 15–19, cf. 48; Rorty, 73.

[57] *Resebeskrifningar* 21 June 1733, 17; *Documents* II:1, 22, cf. 67f.

[58] Lakoff & Johnson 1999, 38; cf. Gärdenfors 2000b.

[59] A. Clark; Clark & Chalmers, 7–19; Brinck, 407–431.

[60] Gärdenfors 2008b, 81.

[61] Giere, 285–299; Giere & Mofatt, 1–10.

[62] Gärdenfors 1992, 95–108.

[63] Gärdenfors 2008a, 28.

[64] Lakoff & Johnson 1999, 36; Johnson, 101–138; Lakoff & Núñez, 34.

[65] Cassirer 1953, 65, cf. 286; Cassirer 1923, I, 146–166; an unconvincing attempt to prove similarities between Cassirer's symbol theory and Swedenborg's doctrine of correspondences can be found in Gardiner.

[66] H. Vallerius & Rimmius, 15; see also H. Vallerius & Bohm, 13.

[67] Lotman 1990, 131–133, 136.

[68] Lotman 1990, 273.

[69] Aristotle, *Peri poiētikēs*, 21.1457b6–32.

[70] Lakoff & Johnson 1980, 14, 17, 25, 30; cf. Gärdenfors 2000a, 2, 255.

[71] Lakoff & Johnson 1999, 59; Lakoff & Núñez, 41.

[72] Danesi, 73f, 78.

[73] Lakoff & Johnson 1999, 338–341, 511.

[74] There are of course exceptions, see Crombie, part IV; Spranzi, 451–483.

[75] Sellberg 2002, 104f; Örneholm, 78–81.

[76] Mazzeo, 54; Helander 1988, 30.

[77] Vico 1744; Danesi, 62; Marshall.

[78] Jonsson 1983a, 88.

[79] Bacon 1620, § 49.

[80] Fleck, translation 99; Eriksson 1994, 149–162; Choluj & Joerden.

[81] Spengler, 89; translation, 61.

[82] Wilson; Ratcliff; cf. S. Clark.

[83] Ornstein, 175.

[84] Swedenborg to Benzelius, London, October 1710. *Opera* I, 207; Spaak & Althin, 44, 49.

[85] *Prodromus principiorum*, ed. Opera III, 23, 95; translation, 27, 120.

[86] Reisberg, 57f, 91f, 352.

[87] Panofsky, translation, 124; Kemp, 41; Edgerton 1980, 179–213; Edgerton 2009; perspective artists are mentioned by Swedenborg, *Resebeskrifningar* 13 July 1733, 28; *Documents* II:1, 35f.

[88] *Regel-konsten*, 4f.

[89] H. Vallerius & Rosell, 18, 20; cf. H. Vallerius & Schultin; H. Vallerius & Bredenberg.

[90] H. Vallerius & Swebilius, § XII.

[91] *Selectæ sententiæ*, 24, 28; translation, 17f, 21.

[92] Lotman 1990, 13, 218; Lotman 1967; Portis-Winner, 35f.

[93] Chartier, 8f, 21f; Lotman 1996, 64.

[94] Swedenborg's inaccurate quotation technique has been demonstrated by Jonsson 1961, translation, 113.

[95] Ong, 101f.