Metaphor, Narrative and Reality in the Life Sciences

Carolyn Leslie | **CETAPS – Centre for English, Translation and Anglo-Portuguese Studies | Universidade Nova de Lisboa**

Introduction

In our daily lives, we take the reality of our world, both the social and physical dimensions, very much for granted. Most people understand reality to mean the sum of the things we see around us – the trees, animals, planets, people and so on. What we might call our external reality. We might also include some more abstract ideas such as space and time. When we wake in the morning, we expect the sun to rise, and we assume that what we experience everyday exists independently of our ability to conceive it or form theories about it. As Lorenz states:

> What causes us to believe in the reality of things is in the last analysis the constancy with which certain external impressions recur in our experience, always simultaneously and always in the same regular pattern, irrespective of variations in external conditions or in our psychological disposition. (Behind the Mirror 3)

Scientific laws help explain such consistencies through concepts such as 'cause and effect'. The sun will rise in the same place tomorrow because science has shown us that the earth rotates on its axis as it moves around the sun and we believe scientists when they tell us that objects in our physical world are made up of tiny particles which we cannot see, like atoms, molecules and electrons. Furthermore, we believe that such scientific theories are constantly being refined to bring us closer to a better understanding of our world and how it really functions.

But are we being somewhat naive in this view of reality? Great philosophers have puzzled over the nature of reality for centuries. The Greek

philosopher Plato proposed that our perception of an object is merely a shadow of the true object, and that we can never hope to perceive reality because the 'things in themselves' exist in a perfect world of ideas, which is outside our ability to perceive. Conversely, Aristotle believed that we perceive objects in the natural world, and then form abstractions and ideas about them in our mind. Throughout the ages philosophers such as Descartes, Berkeley, Hume and Kant have all pondered the true nature of reality (Baggott 69-98). More recently, research carried out by quantum physicists has called into question the nature of reality once more. This research has revealed that particles at the quantum level behave in inexplicable ways. Particles such as photons are capable of being in two places at the same time and can behave as both particles and waves depending on what type of measurement scientists decide to make (Penrose 35), and modern physics seems incapable of explaining why the theories of Newton and Einstein, which are so accurate at describing our physical world, simply do not apply at the quantum level. The "Copenhagen Interpretation" is the name given to the interpretation of the relationship between quantum theory and physical reality by Danish physicist Niels Bohr and colleagues. This insists that the properties of particles like photons do not exist unless they are exposed to something with which they can interact, such as a measuring device, and that we can never discover the true nature of physical objects. This has led modern day philosophers speculate that "there is no ultimate theory that captures reality… because there is no true image of reality as such, but only reality under a certain description in a determinate conceptual framework" (Alves 365).

The Role of the Language of Metaphor and Narrative in Reality

How does language relate to reality? Bohm suggests that knowledge is "the ground both of reality and the knowledge of this reality" and that all knowledge is "produced, displayed, communicated, transformed and applied in thought"

(63-64). Hopp argues that the division between language and thought is mistaken, as "both are in reality two aspects of one and the same thing (qtd. in Lorenz, Behind the Mirror 183). In this way language and our knowledge of reality are inextricably interwoven. Indeed, Bohm is so convinced that the subject-verb-object structure of language is responsible for our view of the world, with each subject being considered a separate entity that he proposes a new form of language, the rheomode, in which a basic role is given to the verb rather than the noun. This, he proposes, would change our world view from one of fragmentation to one of flow, where actions merge into one another in an unbroken movement of existence, which he believes is the true nature of reality (37).

Here, several aspects of language and reality in relation to the life sciences will be addressed. The first of these is the use of metaphor which Lakoff believes is the principle mechanism through which we understand abstract ideas and carry out abstract thought (244). In this way we use metaphor in our speech to describe what happens in our world and to reflect our world views. Then, how narratives act as codes through which messages about our "shared reality" (White 6) can be transmitted will be examined. This relationship between metaphor, narrative and reality will be exemplified using ideas from the life sciences. Firstly, metaphors in the area of microbiology and genetics will be explored, and the wisdom of using metaphor to express our theories about science will be discussed. Then, the use of narrative in science will be considered, and some historical accounts of disease and their relationship to reality discussed.

METAPHOR AND THOUGHT

Aristotle defined metaphor as "… giving the thing a name that belongs to something else; the transference being either from genus to species or from species to genus". (qtd. in Ricoeur 13).This classical theory assumed that metaphor was confined to poetic language where "one or more words for a concept are used outside of their normal conventional meaning to express a 'similar' concept" and that everyday language had no metaphor (Lakoff 202). However, Reddy (322) showed that everyday English was predominantly metaphorical and that metaphor was conceptual rather than linguistic in nature. The word metaphor is now used to mean a "cross-domain mapping in the conceptual system" which involves "understanding one domain of experience…in terms of a very different domain of experience" (Lakoff 206). Metaphors are therefore a way of helping us to understand abstract or unstructured ideas in terms of more structured, concrete concepts, and Lakoff (204-205) believes that the discovery of a "huge system of everyday, conventional, conceptual metaphors" reveals that it is metaphor that structures our everyday conceptual system, and that when talking of abstractions or emotions "metaphorical understanding is the norm". As an illustration of this he gives many examples of how metaphor is used to convey more abstract ideas of time, state, causation, action, purpose and means through more familiar concepts such as motion, entities and locations (Lakoff 220-224).

He gives the example of love being conceptualized as a journey in expressions such as "our relationship has hit a dead-end street" or "look how far we've come" (206). Here, he talks of the metaphor as being a mapping from the source domain, which in this case is journeys, to the target domain, here, love. Lakoff describes the correspondences that characterize the LOVE-AS-A JOURNEY MAPPING as, "the lovers correspond to *travellers*, the love relationship corresponds to *the vehicle*, the lovers' common goals correspond to their

common *destinations* on the journey, difficulties… correspond to *impediments to travel*" (207).

Metaphors in Science

Being a means of conveying abstract ideas, metaphor plays an important role in scientific discourse, and scientists use metaphor to help convey their world view of reality (Hoffman 393). One example of this would be the metaphor used to explain how genetic information contained in the deoxyribonucleic acid (DNA) molecule can be 'read' and its message transformed into 'information' which is then used by the organism. In this process, the segment of DNA that contains information in sequences of chemicals known as nucleotides is called a gene. Each gene contains the information to create a protein. Proteins, to use another metaphor, are often referred to as cellular building blocks, as they are necessary components in all cells. In this protein making process, a chemical known as an enzyme binds to one strand of the DNA double helix. This enzyme moves along the DNA producing a strand of RNA (ribonucleic acid) which is complementary to the DNA strand and is known as messenger RNA (mRNA). This process stops when the enzyme reaches a sequence which signals the end of the gene. This complementary copy of the DNA is then transferred from the nucleus to another part of the cell where the corresponding protein is made in structures called ribosomes (Pelczar, Chan and Krieg 355-359).

Here, it would appear that a metaphor to describe this process could be, THE GENETIC CODE IS A TEXT. Here, the source domain is a text, the target domain is the genetic code, or DNA, and the correspondences which characterize the mapping are:

The 4 nucleotides which make up DNA are represented as *letters (*A, T, G and C, which stand for adenosine, thymine, guanine and cytosine). Groupings of these nucleotides into genes correspond to *messages*. Copying the information on the

DNA onto the mRNA corresponds to *transcription*. The process by which the information on the mRNA is used to make proteins corresponds to *translation* (Pelczar, Chan and Krieg 355).

This metaphor is realised by using vocabulary associated with reading texts to talk about the transformation of DNA into protein. For example, transcription, which would normally be associated with copying texts, is used to refer to the process of copying the DNA. Similarly the process of transforming DNA into a protein is known as translation, which most commonly refers to communicating the meaning in one language text to an equivalent meaning in another language text.

A further analogy could be made between the way the mRNA molecule carries the message to the ribosome where processing takes place and proteins are formed, and the process of reading. Here the mRNA is analogous to the optic nerve transmitting an electrical signal produced when light enters the retina while reading. The ribosome, where the protein is made, is analogous to the brain where the electrical signals are transformed into images. In addition, it could be suggested that in the same way as the literary work is created through an interaction between the text itself and reaction of the reader to the text (Iser 281), so the individual is a product not only of the genetic text but also of his or her personal experiences in the world.

Other metaphors which could be applied in biology are that of THE BODY IS AN ENVIRONMENT and INFECTION IS WAR. The first of these metaphors can be understood as a mapping from the source domain, an environment, to the target domain, the body. Here, the organisms generally found in the healthy human body correspond to *residents*. These indigenous microorganisms, which under normal circumstances do not cause disease, correspond to the *normal flora*. Particular areas where organisms grow correspond to *ecologic niches* in the human body. Growth of pathogens i.e. organisms which cause disease after

removal of the normal flora through, for example, antibiotic treatment corresponds to *colonisation* by pathogens, resulting in disease (Pelczar, Chan and Krieg 454-470).

In the INFECTION IS WAR metaphor infection by a microorganism corresponds to an *invasion* or *attack*, which the host organism tries to *resist* or *combat***.** External defence mechanisms, for example, the skin, correspond to *barriers.* The initial response of the body corresponds to the *mobilisation of an array of defence mechanisms* against the invasion. The function of lymphocytes, a type of white blood, corresponds to the *killing* of undesirable cells by *punching holes* in their membranes. Defence equipment of cells corresponds to an *arsenal* of antimicrobial substances. Initially the body uses nonspecific mechanisms but these are replaced by mechanisms of specific immunity which correspond to *reinforcements***.** The recovery of tissues which suffered breakdown after infection corresponds to *rebuilding* or *repairing.* Unsuccessful resistance corresponds to *death.* (Pelczar, Chan and Krieg 475-495).It is interesting to speculate that these last two metaphors could result from the use in the biological sciences of an explanatory framework based on the Darwinian theory of the survival of the fittest. Here man is locked in a constant struggle for survival in a world full of microorganisms, with the ultimate winner being the one which has best evolved to suit its environment.

Metaphor and Reality

Although some scientists are against the use of metaphors in theory, most are favourable. Indeed the physicist James Clark Maxwell stated that metaphors are not only "legitimate products of science, but capable of generating science in turn" (qtd. in Hoffman 396). Merleau-Ponty (88) exemplifies our necessity to put our ideas into words, and in this way clarify them suggesting that "there is a 'languagely' meaning of language which effects the mediation between my as yet

unspeaking intention and words and in such a way that my spoken words surprise me myself and teach me my thought".

However, we should perhaps be wary of accepting the metaphors we create to explain our world view, the phrase Bohm (xi-xii) uses to describe our "general notions concerning the nature of reality". Shotter (88) suggests that ways of talking fundamentally influence what we can 'see' in the world and Wittgenstein similarly refers to how the language we use might portray an erroneous image of the world when he says "A picture held us captive. And we could not get outside it, for it lay in our language and language seemed to repeat it to us inexorably" (qtd. in Shotter 79). Such talk of pictures, world views, images and our ability to 'see' the world would lead us to believe our sight and mental images are of utmost importance in our perception and understanding of the world. Indeed the English word *theory* has its roots in the Greek word meaning *spectator.* However, Rorty warns that "it is pictures rather than propositions, metaphors rather than statements, which determine most of our philosophical convictions" (12) suggesting that our philosophical enquiries into our reality are shaped by visual or reflecting metaphors rather than the nature of our mental activities themselves. He goes so far as to say that if we desire to change our perception of the world, "we have to get the visual, and in particular the mirroring metaphors out of our speech altogether" (Rorty 371). Indeed, in recent years quantum mechanics has made us consider carefully how, simply by the act of observation, we can change that which is being observed. Alves (386-387) states that all reality is submitted to interaction with a measuring device, be this a type of machine or our eye, and that this disturbs the knowledge acquired. He further states that the measuring apparatus itself produces phenomena of a special kind depending on the parameters used in the measurement, and that properties of physical systems result from interactions between the systems themselves and the apparatus. He suggests that the idea that things are not

altered by our visualisation of it is a *fiction*, which he describes as being "a rather useful device to deal with complex realities in the absence of a true knowledge or a sound theory about its nature" (Alves 381). The Greek root of the English word fiction is *fingō*, which means 'to invent,' and over time, man has invented stories, or narratives to transmit messages about "the nature of a shared reality" (White 6). Let us now turn our attention to narrative and reality.

NARRATIVE AND REALITY

> Narrative is a primary cognitive instrument – an instrument rivalled, in fact, only by theory and metaphor as irreducible ways of making the flux of experience comprehensible (Mink, 132).

As Mink states, the temptation to make sense of our activities and those of others by reconceptualising them within an ordered, coherent text of our own is very great. White suggests that narrative is "a human universal on the basis of which transcultural messages about the nature of a shared reality can be transmitted (White 6). Furthermore Scholes (207) claims that humans love telling stories and that "our need for chronological and causal connections defines and limits all of us – helps to make us what we are." White also claims that narratives not only represent events occurring in chronological order, but that they transmit meaning (9).

Narrative and Science

The fact that narratives transmit meaning explains why they have been used by scientists to transmit their theories. Landau (262), points out that, "any set of events than can be arranged into a sequence and related can also be narrated" and remarks that scientists may often not realise "the extent to which they use narrative in their thinking and in communicating their ideas" (264-265). She

explains how Propp identified thirty one actions, or functions, which were constant elements of the fairy tale. For example, the hero may "build a castle to pass a test, protect himself or celebrate his marriage", (qtd. in Landau 263). Propp further suggests that narrative can be represented as a string of such functions and that all stories can be described as variations of this deeper structure (qtd. in Landau 22). In addition, Landau (264) claims that that various writers on the subject of human evolution have proposed a series of events to describe man's transition from tree dwellers to civilised moral beings which reflects these events, common in fairy tales. In this scientific narrative, our human ancestor, the hero of the story, is portrayed as a humble tree dweller, who either through choice or necessity departs his home (the trees), and starts on an adventurous journey by becoming bipedal. He then moves to a new realm where he must survive a series of tests in the form of harsh climate or predators. However, through his special gift of intelligence man finally triumphs and rules his domain. Although it would seem highly unlikely that anthropologists would deliberately try to fit theories of human evolution into a narrative framework, Barthes (79) notes that narrative "is simply there like life itself… international, transhistorical, transcultural", and for this reason, it may be impossible to present scientific theories as anything but narrative.

Historical Accounts of Disease: Fact of fiction?

It would seem reasonable to suggest that man has always 'invented stories' to explain the unknown. Historically, scholars speculated over the origin of living organisms and believed that they could develop spontaneously from non-living matter. This theory was only discredited in the 15th century, and it was only in the 17th century that the role of microorganism in disease was proved. Before this, disease was believed to be caused by "an imbalance between the four humours (blood, phlegm, yellow bile [choler] and black bile [melancholy]",

supernatural forces, or poisonous vapours (Prescott, Harley and Klein 8). Bubonic plague, which ravaged Europe for the first time in 1347/48 after it had been introduced into Europe via infected black rats carried on boats with returning crusaders, is caused by the bacterium *Yersinia pestis.* The resulting pandemic, known as the Black Death, was responsible for the death of about a quarter of the population of Europe (Cruickshank *et al.* 357). However, due to ignorance of this mode of infection, Jews throughout Europe were accused of starting the disease by poisoning streams, wells and food during the period of 1348 to 1351, and were "exterminated em masse" (Cohn 4).

White examines the value of narrative in the history of historical writing, of which there are three basic types, the annals, the chronicles and the "history proper" (9), and asks how we find the true story behind historical records. In annals, events are ordered in chronological order, but no attempt is made to structure these events to give them an order of meaning, nor do annals possess a central subject, beginning, recognizable end or presence of a social system (11-14). A chronicle, on the other hand is a narrative and "…has a central subject… a proper geographical centre… a proper social centre…a proper beginning in time" although the order of events is still chronological and it simply ends, without concluding (20-21). However, White (20) warns that the chronicle is marked by a "desire for a kind of order and fullness in an account of reality that remains theoretically unjustified" and that the impulse to narrate could be a result of a wish to represent an authority "whose legitimacy hinged upon the establishment of 'facts' that were of a specifically historical order" (22). The manner the story is told is therefore not unbiased and relates tales of particular human communities from a particular point of view, selecting events the writer considers important, but omitting others, and the aim is ultimately "to moralize reality, that is, to identify it with the social system that is the source of any morality that we can imagine" (18).

Ergotism and the Finnmark Witch trials

One such narrative is related to witch trials in Northern Norway during the 17th century. This narrative, presented principally in chronicle form, was written by Hans Hanssen Lilienskiold, the district governor, who firmly believed in the reality of witchcraft (Alm 404).It has as its central subject the witch trials, its geographical centre, Finnmark in northern Norway, its social centre, the legal system and court cases against those accused of witchcraft and a proper beginning in time, 1610. This manuscript was written at the time of the witch trials and is largely based on court transcripts with some personal commentary by Lilienskiold, the central authority in the story. It tells of the trials of 137 people, mostly women, 92 of who were sentenced to death by burning or hanging (Alm 405). Those accused confessed under torture of being visited by Satan in the shape of animals and to have the ability to inflict harm on others, especially by causing their limbs to become painful and wither. Others confessed to causing tingling sensations and convulsions in others and to have themselves been bitten by the devil in the fingers, arm or foot. Yet others believed they could fly, some became so deranged they believed they were in hell, and some were involved in the deaths of others (Alm 409 -411). In this puritanical, protestant society, it is unsurprising that inexplicable behaviour be attributed to the devil, especially when some of those confessed alluded to flying, a skill attributed to witches. Lilienskiold's records show that these accusations started in 1638 and continued till 1692.

One could pose the question as to why such individuals were thought to be witches. Lorenz (On Aggression 84) suggests that all cultures have a normative pattern, and that "man's fidelity to all his traditional customs is caused by creature habit and by animal fear at their infraction". The aberrant behaviour of those accused of witchcraft in Finnmark could only have come about due to this fear of what is different or unknown. This narrative of

witchcraft told to explain what happened in Finnmark could also be compared to one of the oldest narratives, that of Adam and Eve. In the biblical story, the Devil comes to Eve in the form of a snake and persuades her to eat of the forbidden fruit – an apple from the tree of knowledge. In Lilienskiold's records, mention is made of the Devil in the form of animals such as cats, dogs and birds (Alm 408-409), and the witchcraft, or sin, is consumed in foodstuff. In the Christian biblical story, the devil convinces Eve that if she eats the apple, she will become more God-like with special powers, and in the story of witchcraft, those who have acquired the magic do indeed appear to have special powers to cause illness and even death in others (Alm 409). This combined with the fact that the vast majority of those convicted in the Finnmark trials were women (only 7 from a total of 83 were men, and all but one of these was of a different ethnic origin), could lead us to believe that comparison between events in the 17th century and those in the Bible would lead authorities present at the trial to announce the same fate for those found guilty as was promised for Adam and Eve – death.

However, modern science provides us with another possible explanation for these extraordinary events. Finnmark is situated in the far north of Norway where grain production was very low, and most grain, in the form of rye, was imported. Wild grain was also used in times of hardship (Alm 411-412). However, both these grains are notorious for their susceptibility to infection with *Claviceps purpurea* a fungus which grows on grain, especially rye, during wet seasons. Its growth caused the formation of an ergot, which comes from the old French word for cock's spur, argot (van Dongen and de Groot 109), and which appears as a black spur on the ear of grain. It this was not removed before being eaten, it caused ergot poisoning, which takes two distinct forms, gangrenous and convulsive. This is caused by the production of chemicals known as alkaloids, by the fungus, some of which are very poisonous and others psychoactive. These cause a variety of symptoms such as tingling in the skin, vertigo, headaches,

muscular contractions, stomach pains, convulsions, and neurological and visual disturbances, often experienced as the sensation of flying (van Dongen and de Groot 111). Other alkaloids cause vaso-constriction which may eventually lead to gangrene (Alm 404-405). These effects are consistent with the symptoms mentioned by those involved in the Finnmark witch trials, with the withering and eventual loss of limbs being caused by gangrene. Another reason to believe that ergotism is a plausible explanation for the happenings in Finnmark is that the defendants often mentioned consuming witchcraft in bread, porridge or beer, which could all have been produced with rye infected with *Claviceps.* Indeed many of the statements mention that they consumed food containing something black "the size of a barley grain" which could be the infected ergot. The fact that many other trials were being held throughout Europe during the period of the Finnmark trials (1638 – 1692) in countries such as Germany, France and Switzerland suggests that climatic conditions in Europe could have favoured the growth of the fungus during this period (Alm 414), and a possible reason for the eventual decline in prosecutions after 1672 could be a change in climate after this period. Interestingly ergotism has also been by implicated in the Salem witch trials in the USA, (Alm 404), and could also be a possible explanation for witch trials held in Scotland (Alm 404).

Yet another related 'narrative' is that of the disease known as St Anthony's fire. The convulsive form of ergotism was more common in Norway and other Northern European countries, but the gangrenous form was more common in Southern and Central Europe (Alm 405). The first mention of this type of ergotism can be traced to Germany in 857AD, when Fuchs mentioned that "A great plague of swollen blisters consumed the people by a loathsome rot so that their limbs were loosened and fell off before death" (qtd. in van Dongen and de Groot 110). As mentioned above, victims of gangrenous ergotism suffered burning pains, especially in the limbs, gangrene and accompanying

blackening of tissue, and eventual loss of mummified tissues and limbs (Bryden 46). The frequent epidemics of this form of ergotism were known as St. Anthony's Fire, 'Holy Fire' or *Ignis Sacer* because of the intense burning sensation in the limbs, with this 'holy fire' being considered a sign of divine wrath (Bryden, 46). The Catholic church devoted a patron saint, St. Anthony, to those affected, and during the 12th and 13th centuries people flocked to the hospitals of the Antonines where they were treated with cooling elixirs. The fact that many recovered was probably due to the hospitals providing non-contaminated bread (van Dongen and de Groot 111). Descriptions of the suffering of St. Anthony would appear to suggest that he himself suffered from ergotism, causing pain, but in this case religious, rather than demonic visions.(Alm 405). This condition was illustrated in the art of medieval times and the famous St Anthony Triptych painted by Bosch and housed in the Museu Nacional de Arte Antiga, in Lisbon, shows many of the treatments for ergotism and includes strange flying beasts and other strange scenes, which could have reflected those experienced by those suffering ergot induced hallucinations (van Dongen and de Groot, 111).

Why would those suffering from the hallucinatory form of the disease, such as those in Finnmark be burnt as witches, whereas those suffering from the gangrenous form of the disease be appointed a saint to whom they could pray to help alleviate their symptoms?

It could be that the hallucinogenic form of the disease more obviously transgressed the social customs Lorenz refers to, thereby causing greater fear in the population and a greater response from the authorities. It could also be that those who suffered the gangrenous form of the disease could already be seen to be suffering divine wrath in the form of the unbearable burning sensation in their limbs, the Ignis Sacer, or Holy Fire, which could in itself be seen as in some way purifying.

Scientific Theories and Reality

It was mentioned in the introduction that we believe that scientists are constantly refining scientific theories to bring us closer to a better understanding of the world and how it works. If we consider the story above of the Finnmark witch trials then this would indeed appear to be the case. What was attributed to demonic possession in the 17th century is now known to be caused by a fungal toxin. However, if the authorities of the day could be so convinced of the reality of witches that they were prepared to sentence those accused to a very cruel death, could it be that our scientific theories of the present are simply part of another socially constructed reality? Thomas Kuhn suggests that 'normal science' is based on the assumption that scientists know how the world is (5) and that because of this "normal science often suppresses fundamental novelties because they are necessarily subversive of its basic commitments". Only when an anomaly "subverts the existing tradition of scientific practice" do we have a scientific revolution (6) when past scientific achievements, or paradigms (10) are declared invalid and an alternative paradigm takes its place (77). When this paradigm shift is complete, the profession changes its goals, methods and views of the area under research (85). In this way, scientific reality is simply whatever we decide it is in relation to our historical development of scientific understanding, and our current scientific theories of the world could seem as preposterous to scientists in the future as demonic possession seems to us today.

Conclusion

It was suggested in the introduction that although we take the reality of our world very much for granted and few people even stop to consider what reality is, this is a naïve world view, and that reality is something much more complex. But will we ever discover the true nature of reality? Can we ever expect to arrive

at one true theory of everything? Perhaps what science has taught us is that absolute certainty is "an idol" (Popper 280), that "we do not know: we can only guess" and that our guesses are guided by "faith in laws, in regularities which we can uncover- discover" (Popper 278). Alves (384) states that the concept of "bare reality" is meaningless and that our perception of reality is always necessarily "an anthropological, culturally laden, conceptual and sensible presentation of reality" (366). It would seem that our quest for the true nature of reality may be never-ending, especially if we believe Albert Einstein when he said "Reality is merely an illusion, albeit a very persistent one"

Biliography

Alm, Torbjørn. "The Witch Trials of Finnmark, Northern Norway, During the 17th Century: Evidence for Ergotism as a Contributing Factor." *Economic Botany* 57 (2003):403-416.

Alves, P.M. " Theses towards a New Natural Philosophy." *A New Vision on PHYSIS – Eurhythmy, Emergence and Nonlinearity*. Eds. J.R. Croca and J. Araújo. Lisbon :CFCUL, 2010. 359-395.

Baggott, Jim. *A Beginner's Guide to Reality.* London: Penguin Books, 2005.

Barthes, R. "Introduction to the structural analysis of Narratives." *Music, Image, Text.* Ed. S. Heath. New York: Hill and Wang, 1977. 79-124.

Bohm, David. *Wholeness and the Implicate Order.* Abingdon: Routledge, 1980.

Bryden, W.L. "Fungal Neurotoxins." *Proc. Nutr. Soc. Aust.*14 (1989): 45-53.

Cohn, Samuel K. "The Black Death and the Burning of Jews." *Past and Present* 196 (2007):3-36.

Cruickshank, Robert, Duguid, J.P., Marmion, B. P., and Swain, R.H.A. *Medical Microbiology.* Edinburgh: Churchill Livingston, 1973.

van Dongen Pieter, W.J., and de Groot, Akosua, N.J.A. "History of ergot alkaloids from ergotism to ergometrine." *European Journal of Obstetrics & Gynecology and Reproductive Biology* 60 (1995): 109-116.

Hoffman, Robert, R. "Metaphor in Science." *The Psycholinguistics of Figurative Language* .Eds. R.P. Honeck and R. Hoffman. Hillsdale, NJ: Lawrence Erlbaum Associates, 1980. 393-423.

Iser, Wolfgang. "The Reading Process: A Phenomenological Approach." *New Literary History* 3 (1972): 279-299.

Kuhn, Thomas, S. *The Structure of Scientific Revolutions*. London : The University of Chicago Press,1996.

Lakoff, George. "The Contemporary Theory of Metaphor." *Metaphor and Thought.* Ed. A. Ortony. Cambridge: Cambridge University Press, 1993. 284-324.

Landau, Misia. "Human Evolution as Narrative." *American Scientist* 72 (1984): 262-268.

Lorenz, Konrad. *On Aggression*. San Diego :Harcourt Brace & Company, 1963.

- - - . *Behind the Mirror*. Orlando : Harcourt Brace Jovanovich, 1973.

Merleau-Ponty, M. *Signs*. Evanston: Northwestern University Press. 1964.

Mink, L, 0. "Narrative form as a cognitive instrument." *The Writing of History :Literary Form and Historical Understanding*. Eds R. H. Canary, and H. Kozicki. Wisconsin: Univ. of Wisconsin Press, 1978. 129-149.

Mitchell, W.J., ed. *On Narrative.* Chicago*:* Univ. of Chicago Press. 1981.

Pelczar, Michael, J., Chan E.C.S., and Krieg, Noel, R. *Microbiology Concepts and Applications.* New York :McGraw-Hill,1993.

Penrose, R. *"*The Big Questions: What is reality?" *New Scientist* 2578 (2006): 32-39.

Popper, Karl. *The Logic of Scientific Discovery*. London :Routledge, 2009.

Prescott, Lansing, M., Harley, John, P., and Klein, Donald, A. *Microbiology*. Dubuque, IA :Wm. C. Brown Publishers, 1996.

Reddy, Michael J. "The Conduit Metaphor – A Case of Frame Conflict in Our Language about Language." *Metaphor and Thought* .Ed. A. Ortony. Cambridge: Cambridge University Press, 1993. 284-324.

Ricoeur, Paul. *The Rule of Metaphor*. London :Routledge, 2003.

Rorty, R. *Philosophy and the Mirror of Nature*. Oxford : Basil Blackwell, 1980.

Scholes, R. Language, narrative, and anti-narrative in Mitchell. Chicago: Univ. of Chicago Press. 1981,200-208.

Shotter, John. *Conversational Realities*. London : Sage Publications, 1993.

White, Hayden. "The Value of Narrativity in the Representation of Reality." *Critical Inquiry* 7, (1980):5-27.