How Science Reveals the Universe, and How Humans Perceive the Universe to Be

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Introduction

This issue of *Alternation* contains five contributions that are written within the theoretical framework of an emerging comprehensive discipline known as Cognitive Rhetoric. They are the one that you are reading now, Mark Turner and Gilles Fauconnier's 'A Mechanism of Creativity', two further essays by myself, 'In the Mind's Eye' and 'Untangling the Web', and Elsa Klopper's 'The Use of Conceptual Metaphor in Karel Schoeman's *Another Country*'. As is the case with specialist contributions, the latter four essays focus on particular aspects of Cognitive Rhetoric without really giving a systematic overview of this approach.

In this essay I am, therefore, providing a concise overview of Cognitive Rhetoric to provide the backdrop against which readers can read the above-mentioned four contributions. I shall show that an individual's subjective perceptions of the universe differ significantly from how science objectively reveals the universe to be, and that Cognitive Rhetoric provides us with a coherent framework for understanding how humans subjectively perceive the universe to be.

Before I however get round to characterising Cognitive Rhetoric, I want to focus on the attitude that theorising is superfluous in the so called 'soft' human sciences by taking readers on a brief tour of 'hard' science theories that have been formulated prior to or subsequent to Albert Einstein's epoch-making special and general theories of relativity. Einstein's theories, and all major subsequent developments in physics—from the sub-atomic to the cosmological level—aim to develop a unifying theory to give a coherent account for all phenomena in the physical universe. After briefly discussing a number of surprising implications of these scientific theories I outline Cognitive Rhetoric as a theory of knowledge.

To be Human is to Theorise

I have decided to highlight the process of theory-formation in both 'hard' science and the 'soft' sciences because there is a new mood discernible in this country that can be

best summarised as impatience with theorising in the human sciences. This impatience is expressed in the demand that learning should empower people to achieve more than a mere passive understanding and appreciation of language, literature, social institutions and human culture.

It is pointed out with some justification by critics of the humanities that the theories of 'hard' science have a technological impact on the lives of ordinary people, but that the theories of the human sciences seem to be largely non-productive in this respect.

Are theories in the human sciences, therefore, superfluous relics of the past, clung to by redundant academics, or do we need theories to make sense of language, literature, interpretation and other aspects of human existence? We know that people communicate without conscious effort and instinctively understand the meaning of symbols. Why then do we need theorising at all? Why do we not simply focus our scarce resources on technological training and life skills training that will put bread on the table and butter on the bread?

There is a short answer, and a long answer, to this question. First the short answer: if we merely train people in mastering technological skills to the exclusion of systematically studying humanity's place in the natural order, particularly our cultural, intellectual and spiritual institutions, it will take only one generation to ensure that the highest achievement that any individual can obtain, will be to become a well-skilled technician. We will be a society of consumers, tinkerers and fixers of broken things if we do not generate fundamental knowledge in both the 'hard' sciences and the 'soft' sciences.

The more significant answer to the above questions is that we cannot come to any conclusions about anything at all if we do not apply the same process of association, between apparently unrelated entities, that is used to form scientific hypotheses and theories. All knowledge—simple or complex—is based on an associative process of concept formation[1], concept conflation[2] and categorisation[3], which in each individual culminates in an extensive associative theory of mind that entails the sum total of her/his ideas about how things coexist in the world. This

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[1] Humans form basic concepts like SELF, OTHERS, HERE, THERE, LINE, CIRCLE, SOURCE, GOAL, CONTAINER, INSIDE, OUTSIDE, SOLID, LIQUID, UP, DOWN, ROUGH, SMOOTH, TRUE, FALSE, REAL, IMAGINARY, etc. to form an understanding of ourselves in the real world.
[2] The term 'conflation' relates to how we combine concepts to form symbols. Words form one type of symbol. When we for instance use the word *run* as in *the man is running* we conflate the concepts move, self-control, intentional, using legs, regular and repeat sequence.
[3] We for instance categorise *tables, chairs, desks, cupboards, sofas, TV cabinets* etc. as types of *furniture.*

complex theory is sometimes appropriately referred to as *The-Great-Chain-Of-Being* theory. Regardless of whether we deal with so called hard science, the human sciences, or a person's everyday precepts of himself, his mind and nature, we use the same process of associating apparently unrelated entities, which actually do have a significant, but non-obvious relationship with one another, to form new insights about those entities.

Wellman (1992) details the stages that children go through to form their individual theories of mind to account for themselves as beings, their precepts of the natural order, as well as the fact that they actually have a theory of mind to account for such matters. Wellman provides empirical evidence that even three year olds have a basic theory of mind that distinguishes between mind and world, the difference between beliefs and desires, the interaction of beliefs and desires during actions, the intentional nature of individual behaviour, the nature of belief-desire-dependent emotional reactions, the grounding of belief on perception, and of fantasy on imagination. Lastly, Wellman shows that a typical three year old will have the insight that her/his particular mind is a sort of container that stores idea-copies of things that exist in the real world. If human beings as young as three years old form theories of mind to account for themselves in the greater scheme of things, how can we give an account of humanity and his artefacts within the natural order without doing so within a coherent, comprehensive theory of mind?

Let us take an example from everyday life to show that all our conclusions are based on theory formation. You are at home, expecting a visitor. There is a knock on your front door. Chances are that you will associate the knock with the person that you are expecting. By doing this you have formed a hypothesis—an assumption—that your guest has arrived. If you open the door and it is your guest, you have confirmed your hypothesis. A hypothesis that has been confirmed is known as a theory in the terminology of science. If the person at the door however is not the one that you expected, you have refuted your hypothesis. Both scientific proof and everyday reasoning therefore work according to the following simple six-step reasoning process:

1   You *perceive* a relationship of significance between two associated entities.

2   You *believe / assume* that you are correct.

3   You *test* the validity of your assumption by looking for counter-examples to disprove your assumption.

4   If you find counterexamples to your assumption you *know* that it was wrong.

5   If you fail to find counterexamples you tentatively *assume* that your hypothesis is correct.

6   Your assumption is considered to be factual knowledge until you or someone else finds counterexamples to *disprove* it, or to limit the scope of the facts.

If we associate entities with one another and subsequently verify that they are related in a significant way by failing to find counterexamples, we have *knowledge* that the relationship between them is significant. If we do not attempt to verify the significance of assumed relationships we can at best base our conclusions on personal *belief*. If we persist in believing something in spite of finding counter-examples to our assumption we are basing our belief on *superstition*.

If all human thinking is based on the above-mentioned process of theory formation, how can we insist that the human sciences must be devoid of theorising? By doing so we insist that all our conclusions about language, literature, society and human culture in general may only be based on personal belief, that our students must merely believe in our subjective value judgements. Doing so does not only weaken the human sciences, it also opens the way for flooding the human sciences with superstition and ignorance. Without systematically testing the validity of our assumptions about the relationships between entities, it is impossible to establish the boundary between ignorance and knowledge, it is impossible to determine which of our assumptions are based on superstition rather than reason.

How Science Reveals the Universe to Be
In this section I briefly look at particular aspects of physical science at the beginning of the twentieth century, particular developments in these fields over the past hundred years and the mental model that we have of them at the end of the twentieth century. This section is not intended as a review of the development of science in the course of the twentieth century. I am referring to particular aspects of physical science to show that systematic scientific observation reveals the universe to be a far stranger place than humans perceive it to be in the course of everyday experience and observation.

Science at the Beginning of the Twentieth Century
The Newtonian framework of science, as it had been developed up to the beginning of the twentieth century, portrayed the universe as a static, clockwork-like entity in which total order and predictability prevails. According to this view it was believed until the 1920s that the electrons of a particular element orbit their atomic nucleus in the same way that planets revolve around their suns in solar systems, which in turn revolve around their galactic cores to form a limitless, eternal, clockwork universe.

In the rest of this section I will outline a number of scientific breakthroughs during the twentieth century that have steadily altered the human perspective of the nature of the universe and humanity's place in it.

Quantum Mechanics

Max Planck's work at the turn of the previous century on the quantum nature of radiation gave the first indication that twentieth century science would be radically different from the Newtonian model that had dominated western science during the preceding 200 years. Our altered perspective probably started with Planck's theory of black body radiation, which suggested that matter can radiate or absorb energy only in small, discrete units called quanta. Planck's theory was refined by Einstein who postulated a dual manifestation of light, namely that it exists as discrete streams of quanta and as electromagnetic waves.

Building on work by Louis Victor de Broglie, Heisenberg, Born, Jordan and Dirac in 1925 presented the theory of Quantum mechanics. Shortly thereafter Schroedinger extended Quantum Mechanics by showing that discrete quanta manifest themselves as electromagnetic waves of radiation. Consequently Wave Mechanics posits that the negatively charged electrons orbiting the positively charged nucleus of an atom consists of a series of set electromagnetic waves, and that electrons change wave length orbits when they radiate or absorb energy.

Matrix Mechanics and the Uncertainty Principle

Applying the principles of Quantum Mechanics, Werner Heisenberg had formulated his theory of Matrix Mechanics, which postulated infinite matrices to represent the position and momentum of an electron inside an atom. One would only be able to probabilistically calculate either the position or velocity of an electron in orbit around the atomic nucleus because at any given instant it could occupy any position on the matrix. This meant that it was impossible to mathematically calculate the precise location of an electron on its set wave length orbit around the atomic nucleus. This insight was formalised in 1927 as the uncertainty principle, which stated that it is impossible to simultaneously specify the precise position and the momentum of any sub-atomic particle in its orbit around an atomic nucleus because the orbit exists as an array consisting of an infinite number of rows, each row consisting of an infinite number of quantities.

It has however proved to be difficult to calculate exactly the probabilistic orbits of electrons either as particles or as waves around their nuclei. According to Microsoft Encarta 1998:

Even for the simple hydrogen atom, which consists of two particles, both mathematical interpretations[4] are extremely complex. The next simplest atom, helium, has three particles, and even in the relatively simple mathematics of classical dynamics, the three-body problem (that of describing the mutual interactions of three separate bodies) is not entirely soluble.

Although no fundamental deficiencies have been found in Quantum Mechanics and Wave Mechanics, or in the Theories of Relativity since 1925, physicists have concluded that these theories are incomplete. These theories nevertheless form the basis of current attempts to account for a sub-atomic phenomenon known as the strong nuclear force, and for attempts to develop a unified theory for all the fundamental interactions that determine the nature of matter.

The Theory of Relativity[5]

A further major shift from Newtonian science was induced by Einstein's famous and complex Theory of Relativity, which is symbolised by the equation $E=mc^2$ in the popular mind. Einstein's theory predicted that the motion of entities in space is not absolute as Isaac Newton thought 200 years before, but is affected by the gravitational variations of curved space-time because each entity warps the fabric of space-time around itself. In line with Max Planck's work in Quantum Theory, the Theory of Relativity also predicted that light is a form of electromagnetic radiation consisting of tiny, discrete electromagnetic quanta that are affected by the electromagnetism radiated by larger aggregates of quanta like planets and stars. This is why a ray of light, passing near a star, is bent towards the star.

Since its final formulation in 1916 Einstein's Theory of Relativity has dominated almost all aspects of science during the twentieth century, from our knowledge of entities on sub-atomic level to our present understanding of the origin, nature and development of the universe. It not only contributed to the development of nuclear science, but also laid the foundation for the discovery and understanding of cosmic events like the Big Bang and cosmic entities like Black Holes and Quasars, to mention but a few.

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[4] Those for Wave Mechanics and Matrix Mechanics.

[5] Einstein formulated a special theory of relativity that deals with physical phenomena on sub-atomic level, and a general theory in which he extended the principles of the special theory to physical phenomena on cosmological level. I am collectively referring to the special and general theories as 'the theory of relativity' because it isn't necessary to differentiate between them for the purposes of this discussion.

Superstrings

Although humans perceive space-time in four dimensions[6], *superstring theory*[7], a recent cosmological theory derived from quantum mechanics, postulates ten different dimensions. Superstring theory is based on the premise that matter in the universe does not consist of individual material particles, but of different manifestations of fundamental energetic entities called superstrings.

According to this theory superstrings are non-dimensional energy loops or knots that have different material manifestations depending on their states of oscillation. All forms of matter in the universe are manifestations of such superstrings in different states of oscillation. The manifestations of multiple strings exist in ten different dimensions, not only in the above-mentioned four dimensions that humans can directly perceive. According to superstring theory, what we perceive as distinct elementary particles[8] fundamentally consist of a little loops or knots of energy that oscillate differently for each type of particle that we observe. The energy oscillations of multiple superstrings therefore 'materialise' as different elementary particles in the three spatial dimensions that we can perceive. Different types of 'matter' are ultimately composed of many strings that are in different phases of oscillation. We perceive the different states of oscillation as discrete particles with different mass and different 'size'. A string that is oscillating more will form a particle with more energy and a greater electromagnetic charge than a particle that is formed by a string that oscillates less.

According to superstring theory, ten dimensions existed when the universe was formed during the Big Bang about nine billion years ago. The ten dimensions consisted of nine spatial dimensions and one time dimension. In the instant after the Big Bang, six of the nine spatial dimensions shrank without completely disappearing. Three spatial dimensions grew, and time remained, to form the four-dimensional space-time universe, as we know it today. The six 'extra' dimensions that shrank still exist, so tightly wrapped up around the known three spatial dimensions that we can't be directly aware of them, although they still play fundamental roles in the laws of physics.

Chaos Theory

While researchers in Quantum Mechanics, and Relativity were describing the electro-

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[6] Three spatial co-ordinates: height, length and depth, plus our psychological awareness of time as the fourth dimension.

[7] See Bogojevic, Jevicki & Meng (1988); Davies & Brown (1992); Green, Schwartz & Witten (1987); Greene, Aspinwall & Morrison (1993); Schwartz (1985) and Yau (1992).

[8] The electron, quark, neutrino, W-boson, gluon, photon etc.

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magnetic nature of all things physical, and attempted to formulate a comprehensive theory incorporating the fundamental forces that determine the nature of matter, a new mathematical theory, known as Chaos Theory[9], was formulated in the 1970s and 1980s in an attempt to determine underlying patterns of regularity and predictability in the seemingly unpredictable and random interactions of complex natural and conventional or humanity made systems.

A basic insight of Chaos Theory is that a minute change in the input of any complex, non-linear system could produce an unpredictable, massive change in its output. Chaos Theory is used to model how minor patterns originate in one sub-region of a complex non-linear system and subtly propagate through the whole system to cause unpredictable, chaotic interactions in a totally different region of the system. Some proponents of Chaos Theory refer to this as the butterfly effect, implying that changes as minute as a butterfly's wing-beat in China may have subtle but significant air pressure effects on global weather patterns resulting in a raging hurricane over the Caribbean islands. Chaos theory modelling is applied to diverse fields of inquiry such as cosmogenesis[10], cognition, short-term weather forecasting and global investment trends.

The application of Chaos Theory in weather forecasting reveals that non-linear interactive systems are too complex to model accurately with the current mathematical and quantitative tools at our disposal. A good example of this limitation is the degree of accuracy obtained by the biggest weather forecasting computer in the world, at the European Centre for Medium-Range Weather Forecasting. According to a recent news report this computer is fed 100 million separate weather measurements from around the world every day, which it quantifies at a rate of about 400 million calculations per second in three hourly session, to produce a ten day forecast. Its forecasts are considered to be fairly dependable for up to two days. Beyond that its forecasts become speculative and undependable. Chaos Theory applied to weather forecasting reveals the limits of our ability to predict complex non-linear interactions by means of mathematical modelling.

Although I have not been able to trace more than anecdotal claims regarding the utility of Chaos Theory to forecast global stock market trends, the unexpectedness of occasional 'corrections' and 'slumps' on global stock markets perhaps indicates the limitations of Chaos Theory to model the dynamics of stock market trends and weather conditions.

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[9] This discipline is also known as Complex Systems Theory, Complexity Theory, Dynamical Systems Theory, and Complex Non-linear Systems Theory. See Gleick (1988); Lewin (1993); Prigogine & Stengers (1985); Rees-Mogg & Davidson (1992) and Waldrop (1992).

[10] A study of the origin and development of the universe.

The Fractal Patterns Inherent in Time-stable Phenomena

It is clear that proponents of chaos theory are still going through the learning curve when it comes to the application of this form of modelling to dynamic non-linear systems. When the theory is however applied to model the nature of time-stable phenomena it has proved to be more successful. Chaos Theory has for instance revealed to us that material phenomena show self-similar geometric patterns that are replicated at the same degree of complexity and detail at any level of magnification. This means that any particular segment of a fractal can be viewed as a reduced-scale replica of the whole.

Applying fractal design to information coding is causing a revolution in information transfer and storage. By detecting fractal patterns in digitised images and sound recordings by means of mathematical algorithms information can be compressed to a fraction of their original volumes and later re-expanded by using the same algorithms.

Fractal theory holds much promise to reveal hidden patterns of order within the apparent chaos of dynamic events. Furthermore, the utility of fractal theory in digital data compression begs the question whether language as a comprehensive process of information coding is not organised on fractal principles. In a subsequent section of this essay I will briefly look at the possibility that language-related cognitive phenomena such as categorisation and sentence patterning are organised on fractal principles.

How Science Models the Universe at the End of the Twentieth Century

At the end of the twentieth century we have abandoned Newton's model of the mechanical universe. Our mental model of the universe characterises it as a place organised on self-same patterns from the cosmic to the atomic level. On subatomic level our mental model of the universe is however characterised by indeterminacy. Subatomic particles are oscillating superstrings that manifest themselves either as particles or as electromagnetic waves that have probabilistic orbits around their nuclei.

On cosmic level our mental model of the universe portrays it as a dynamic expanding entity, limited in both space and time[11], having been formed and constantly being driven by catastrophic events such as:

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[11] One school of physics argues that contrary to our deepest intuitions time does not exist—that Einstein's theory of general relativity can only be unified with quantum mechanics if we abandon the concept that time is a fundamental aspect of the universe (Barbour 1999).

1   The *Big Bang* that caused the origin of the universe between 9 and
     11 billion years ago;

2   Suns dispersed through the universe that spend their nuclear fuel
     after which they briefly flare up into *supernovas* before they burn
     up and collapse;

3   *Black holes*—countless imploded suns that have become
     gravitational sink holes in which matter is so super-compressed that
     a teaspoon of it would weigh the same a mountain—consuming all
     matter in their vicinity and even tugging at the edges of
     neighbouring galaxies. Astrophysicists for instance tell of one such
     massive structure, which they have named The Great Attractor and
     The Great Annihilator, that is stringing out and steadily swallowing
     up our galaxy, the Milky Way. Eventually also this sector of the
     universe will be closing down;

4   Regions in space termed *stellar hatcheries* or *stellar maternity
     wards* where suns are formed from stellar dust;

5   *Galaxies that drift through one another* and intermingle briefly (on
     a cosmic time scale) before proceeding on their altered courses to
     their eventual destinations;

6   Finally the envisaged *Big Crunch* where the whole universe will
     collapse inwardly on itself, where all matter will be super-
     condensed in pure radiation and disappear into a singularity.

We now perceive the universe not as a giant clockwork, but as a dynamic super-
system driven by catastrophic events with random and chaotic results that cannot be
easily described and predicted. We also know that our current analytic procedures do
not allow us to model the behaviour of dynamic non-linear systems such as weather
patterns or stock market trends.

Ordinary People's Perspective on the Scientific Model of the Universe: Hard Science, Weird Reality

Perhaps the major lesson of twentieth century science for ordinary people is that
nothing is as it seems, that reality differs markedly from the personal mental models
that we individually construct to make sense of our place in the natural order of
things.

       In ordinary mental models the sun rises in the east and sets in the west every
day. A person reclining against a rock under a tree on a cloudless, windless day,
looking at a field where not even a blade of grass stirs, such a person perceives
everything around him to be motionless. He does not have the sensation of spinning

around the axis of planet earth, which in turn revolves around the sun, which in turn is thundering around the core of the milky way at thousands of kilometres an hour.

Furthermore, nothing in the universe is situated where we perceive it to be. Because light travels at a constant speed of 300,000 km a second we see the sun where we were in relation to it[12] eight minutes earlier. We see the nearest star system where it was three and a half years ago, and remote galaxies in space where they were millions of years ago.

Because matter is energy that distorts the space-time fabric of the cosmos around itself according to the theory of relativity, astrophysicists consider the spatial fabric of the universe to curve back on itself, never reaching any kind of outer limits. This would mean that a ray of light travelling through the universe in a straight line would eventually end up back where it started[13]. The universe itself is consequently considered by some cosmologists to act as a super convex lens that distorts light. This causes us to observe multiple ghost images of distant galaxies from our particular vantage point in the universe[14].

If very few things in the cosmos are where we perceive them to be, if a light ray can travel in a straight line and end up where it started, if we perceive regions of the cosmos that are mere ghost images of galaxies that are actually situated vast distances away from them, if we can perceive only four of ten dimensions of physical reality, then the cosmos is a far spookier place than we have imagined it to be in our myths and fantasies. Then science has made a 360° turn and is overtaking metaphysics from behind.

How Humans Perceive the Universe to Be

Ordinary people use personal mental models to conceptualise the natural order of things. Our everyday perceptions of how things are differ markedly from the mental model of reality that science reveals to us. These models are based on each individual's perception of reality and are structured according to set cognitive principles. In the course of the twentieth century humanity has formulated a number of theories of knowledge to give an account for our understanding of reality.

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[12] In popular belief the sun rises in the east and sets in the west. We however know that the apparent movement of the sun across the sky, and day and night, are due to the fact that the earth rotates on its axis once every 24 hours.

[13] On 29 April 2000, cosmologists revealed that the universe is flat according to observations made over Antarctica with the Boomerang telescope, and that light consequently radiates only in straight lines, never bending back on itself (see Bernardi 1999; Reuters 2000; and Staff & Wire Reporters 2000).

[14] See the feature article 'Ghosts in the sky' in *New Scientist*, 19 September 1998.

The Rise and Fall of Theories of Knowledge
Given how incredible the physical reality of 'hard' science is, humans obviously need a sound theory of knowledge to give a coherent account of how we perceive reality, how we form concepts of our perceptions, how we combine those concepts into language and how we interpret language during the process of communication. Unfortunately the major epistemological[15] theories of the twentieth century have proven inadequate to give an account of how we know things and how we communicate our knowledge. The theories that I am referring to are: *Hermeneutics* (the science of interpretation, especially of Scriptural exegesis; the study of human beings in society), *Phenomenology* (a description of phenomena; the science concerned with describing personal experiences without seeking to arrive at metaphysical explanations of them), *Structuralism* (the belief in, and study of unconscious, underlying patterns of thought, behaviour, social organisation, etc.), *Semiotics* (the study of signs, signals and symbols, especially in language and communication), *Generative grammar* (the description of language as a finite set of grammatical rules that enable humans to generate an infinite number of grammatical sentences), *Reception Aesthetics* (the study of how an author writes a text with an idealised reader in mind, and how actual readers interpret that text), *Deconstruction* (a method of critical analysis applied especially to literary texts, asserting that no text can have a fixed and stable meaning because language cannot adequately represent reality and because people who are interpreting a text superimpose their individual assumptions on the text during the process of interpretation), *Post Modernism* (a style of analysis and criticism in any of the arts that comes after an era known as the modernist era and that reacts against any modernist style, theory, or approach by returning to traditional materials and to some earlier, especially classical style).

Why have our theories of knowledge-construction failed us? Why does the study of language structure and literature have so little in common, let alone the study of social conventions and cultural symbols? If Einstein's theory of relativity has provided the tools to unify 'hard' science from the sub-atomic to the cosmological level, is it not possible to construct a similar unifying theory for the fragmented 'human' sciences?

In the previous sections I have indicated that scientific hypotheses have revealed the physical universe to be a more surprising place than we imagined it to be. I have also indicated that the major theories of knowledge of the twentieth century have failed to provide a coherent framework for the so called 'human' sciences. The reason for this, I believe, is because, broadly speaking, these theories

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[15] *Epistemology:* the scientific study of how humans acquire and communicate knowledge. From the Greek words *episteme* knowledge, and *logos* discourse. This, and all further definitions in this section are taken or adapted from Larousse (1994).

have attempted to give an objective account of reality—reality as it is 'out there', not an account of how we subjectively conceive reality 'in here'. What is needed is not merely an account of how the physical universe is, but rather an account of the subjective mental model of reality that each of us conceptually constructs of the physical universe. An emerging theory of knowledge that attempts to give such an account of how humans conceptualise reality is Cognitive Rhetoric.

Cognitive Rhetoric

Language should not be equated to cognition, for it merely forms part of a broader spectrum of types of cognition. Cognitive Rhetoric primarily deals with those aspects of symbolisation that form the basis of humanity's language capacity, the actual processes involved in spoken and written communication. In short, Cognitive Rhetoric reveals to us not how the universe is, but how humans perceive the universe to be, how humanity associates those perceptions to form concepts, which he expresses as language during communication. The essential features of Cognitive Rhetoric are summarised in the following twelve sections.

The Perceptual Basis of Humanity's Language Capacity

1   Humanity's language capacity forms part of his more general capacity to conceptualise and use symbols to represent entities observable by the human senses (visual sensations, sounds, smells, tastes and touch-sensations) as well as abstract entities (like emotions and ideas).

2   Our language capacity does not exclusively reside in specialised, dedicated neurological modules. One reason for this point of view is that many of our neurological structures are shared by language and other forms of cognition. A person's language capacity and his musical capacity for instance reside in partially· shared as well as capacity-specific neurological structures.

3   The same basic cognitive process of conceptual integration is used for language[16] and other forms of cognition such as music and calculating.

The Role of Image Schemas in Concept Formation

4   Because all elements of language are symbolic (meaningful), a theory of language may not posit non-meaningful abstract grammatical structures, rules, devices or features merely to justify another aspect of the theory.

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[16] Dirven & Verspoor (1998); Langacker (1987; 1990; 1991); Mandelblitt (1997); Ungerer & Schmid (1999).

5   Humans build up concepts about things around them by combining basic image schemas like point, line, centre, periphery, circle, square, triangle, long, short, horizontal, vertical, diagonal, close proximity, distant proximity, in front of, behind, smooth, coarse, regular, irregular, move, rest, source, route/path, target etc. These image schemas emanate from our physiological makeup and our vertical orientation when we are active[17]. By combining basic image schemas into complex image schemas humans derive dynamic concepts. If one for instance combines the image schemas long and vertical in relation to an entity that is perceived as a single whole one conceptualises the word *tall*. By combining the image schemas centre, periphery, vertical, move, regular sequence, same direction and balance one conceptualises words like *rotate, spin* and *pirouette*.

The Fundamental Role of Categorisation in Concept Formation
6   Categorisation forms a crucial part of humanity's language capacity. Humans use the shared and differentiating attributes of entities in inter-linked neural pathways in the brain[18] to categorise things, processes and events. We discern attributes such as COMPACT, DIFFUSE, ROUND, SQUARE, SMOOTH, COARSE, BRIGHT, DULL, DARK, SWEET, SOUR etc. by means of our senses (sight, hearing, taste, smell and feeling), and we use such attributes to categorise and inter-link words.

7   Humans categorise entities on at least three levels, namely a superordinate level (*plant*), a basic level (*tree*) and a subordinate level (*oak tree*). We have pictographic gestalts for entities at the basic level, but not at the superordinate and the subordinate levels. We can doodle a *tree*, but not a *plant* or an *oak tree*. Similarly we can doodle a *woman* but not a *human* or an *aunt*. Babies learn basic level words before they learn superordinate or subordinate level words. They for instance learn *cat* and *dog* before they learn *animal* or *Siamese cat* and *bull terrier*. Basic level words tend to form part of figurative language more often than superordinate level or subordinate level words. Humans for instance represent their ancestry by means of *family trees*, not by means of *family plants* or *family oak trees*.

Prototypical and Atypical Members in Categories
8   Categories have prototypical members that share all major attributes, and atypical members that share only some attributes[19]. *Mammals* for instance are warm-blooded, hairy, earth-bound animals with four limbs and teeth, whose offspring are

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[17] Johnson (1987).

[18] Lamb (1998).

[19] Taylor (1992); Ungerer & Schmid (1999).

born alive from the female member of their species, and who obtain nourishment by suckling her mammary glands during the early stages of their existence. By this definition *antelope, lions, rhinos, wolves* and *humans* are prototypical mammals, but *bats* are not because they are flying mammals, nor are *beavers, seals, walruses, whales, dolphins,* or *manatees* because they are aquatic mammals.

9   Meaningful language symbols are known as lexemes. Lexemes are associated with particular grammatical categories. A word like *crazy* is a prototypical adjective, while a set expression like *off his rocker* is an atypical one.

The Conflation of Concepts in the Formation of Lexemes

10   Words are associated with lexical categories like nouns (*woman*), verbs (*break*), adjectives (*tall*), adverbs (*forwards*), pronouns (*you*) and prepositions (*on*).

11   Each lexeme consists of a number of concepts that are conflated (combined) and associated with a particular sequence of speech sounds or written letters. The sequence of speech sounds [m]+[æ]+[n], and the letters *m+a+n* are neurologically associated with the concepts [LIVING, MALE, ADULT MEMBER OF THE HUMAN SPECIES].

Conceiving Entities and Events in Schematic and Detailed Formats

12   Humans have the ability to conceptualise entities in very schematic (general) or in detailed terms. One can for instance say: There is *something* under the table, or There is *a little red metal toy motor car with plastic windows and scratched bumpers* under the table.

13   Elements of language, including grammatical structures, are *symbolic* (meaningful). Particular grammatical structures have *schematic* (general) background meanings that give them the valence (binding potential) to accommodate particular words. In *transitive* clauses for instance the major grammatical structures have the following schematic meanings: *Subject*: the party that supplies the energy for an interaction and that actively controls the course of an event which affects another party. *Transitive verb*: an interactive event during which energy is transferred from an active, controlling party to a passive, affected party. *Object*: the passive party that is controlled and affected by the actions of an active party. Because a transitive clause has the above-mentioned schematic meanings it casts a semantic shadow that enables it to accommodate a great variety of utterances like for example: *The dog is chasing the cat, my aunt is writing a novel, James cooked dinner tonight* and *the boy is slicing the salami.*

14   The clause contains only one verb, but can contain a number of nouns such as in [$^{\text{SENTENCE}}$ [$^{\text{NOUN 1}}$ *the dog*] [$^{\text{VERB}}$ *chased*] [$^{\text{NOUN 2}}$ *the cat*] up [$^{\text{NOUN 3}}$ *the tree*] [$^{\text{NOUN 4}}$ *this morning*]]. In order to distinguish such nouns from one another in a clause we conceptually label them with semantic roles like Agent, Patient, Experiencer and Stimulus. Other semantic roles used to identify entities during interactions are Source, Target, Path, Goal, Benefactor, Beneficiary, Instrument, Locus/Place and Time. During conversation participants automatically assign semantic roles to the nouns in a clause like *the dog chased the cat up the tree this morning*, which will give the following representation: [$^{\text{SENTENCE}}$ [$^{\text{NOUN 1, Agent}}$ *the dog*] [$^{\text{VERB}}$ *chased*] [$^{\text{NOUN 2, Patient}}$ *the cat*] up [$^{\text{NOUN 3, Locus}}$ *the tree*] [$^{\text{NOUN 4, Time}}$ *this morning*]].

15   Humans experience a great variety of interactions between entities in real life, but only use 5 basic patterns to express our thoughts about such events:

Agent Dominates Patient
(a)   The boy broke the plate
(b)   The lady is wearing a blue dress
(c)   John wrote a poem
(d)   Sally sang a song

Co-agent Co-operates with Co-agent
(a)   John and Peter are taking (with/to one another) *or* John is talking to Peter
(b)   John and Peter are helping one another or John is helping Peter

Counter-agent Competes with Counter-agent
(a)   Sue and Jane are competing/arguing/debating (with one another) or Sue is competing/ arguing/debating with Jane
(b)   The dog and the cat are fighting (with one another) *or* The dog is fighting with the cat

Experiencer Experiences Stimulus
(a)   Jack loves Judy
(b)   Andy hates peas

Stimulus stimulates Experiencer
(a)   Peas nauseate Andy
(b)   Horror movies frighten young children

Figure and Ground Relations in Perception, Cognition and Language
16   Figure and ground contrast forms the basis for all perceptual discrimination.

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While reading this sentence, the individual words form the foreground, while the paper that they are printed on forms part of the background information. You can profile any background element and bring it to the foreground by focusing your attention on it. You can for instance inspect the texture of the paper, the width of the margins, or any of the background sounds that usually surround us.

17   Every time a neurological operation is performed it becomes more entrenched, less susceptible to conscious awareness, and therefore more part of the background. Novel neurological operations however require more concentration than entrenched ones. Novel neurological operations therefore form part of the perceptual foreground. Typical examples of novel neurological operations that require a lot of concentration until they become entrenched are when one learns to ride a bicycle or to drive a car. After some practice such activities become routine (entrenched), background operations.

18   Humanity has the ability to conceptualise parts of greater wholes as independent entities. One can focus one's attention on a *hand*, ignoring the fact that it is part of an *arm*, which in turn is part of a *body*. When one conceptualises a part such as *hand* as if it is on its own, entities like *arm* and *body* form part of the conceptual information 'at the back of ones mind' as the saying so aptly goes. Because the whole forms part of conceptual background information one can metonymically say *John has safe hands* when we mean that he as a whole being is good at catching a ball.

19   In each utterance the grammatical structures that accommodate particular words are based on entrenched neurological operations, while the words themselves convey novel information that require concentration. Grammatical relationships therefore form entrenched background knowledge while the meanings of particular lexemes form novel foreground knowledge.

20   The conceptual process that we use to assign semantic roles to is called *grammatical blending* (Mandelblit 1997) which is based on the more general cognitive process called *conceptual blending*. Conceptual blending is also used when we conceive metaphor or when we make calculations. Conceptual blending entails projecting well-known (neurologically entrenched) information onto novel information to render the new information more readily understandable. In the case of a sentence such as *Jack ate the grapes*, semantic role pairs such as AGENT DOMINATES PATIENT form the image schematic background that enables us to blend (associate) the statement with grammatical functions such as *subject* and *object*. Because the grammatical functions *subject* and *object* and semantic role pairs AGENT

DOMINATES PATIENT are neurologically entrenched through constant use, they form the schematic background to the words of the sentence *Jack ate the grapes* that command our attention on the foreground:
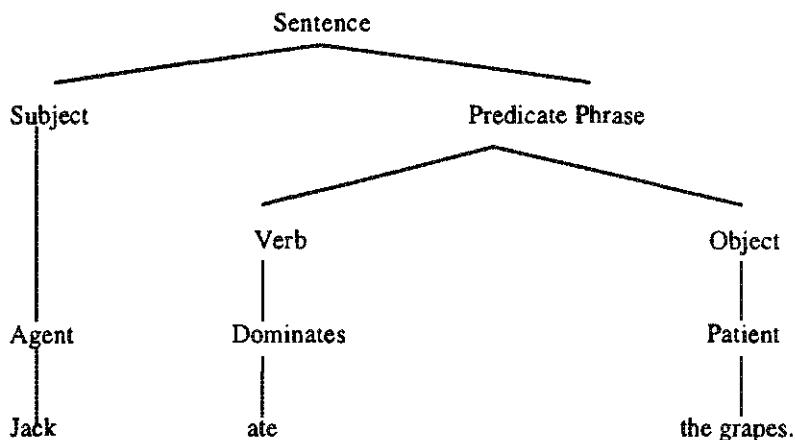
21   In the case of metaphors, a well-known object like a ship can be used to render a lesser-known object like a camel more understandable by calling it 'the ship of the desert'.

22   The five semantic role pairs (AGENT-PATIENT, EXPERIENCER-STIMULUS etc.) that I outlined in the previous section form prototypical patterns that operate on the foreground of our attention when we conceive events. They are obligatory concepts in utterances.

23   Semantic roles like Instrument, Locus and Time are optional and normally operate in the background of our attention when we conceive events. They can be left unspecified in utterances: [SENTENCE [NOUN 1, Agent *Sue*] [VERB *tickled*] [NOUN 2, Patient *the baby*] (...)] unless we choose to bring them to the foreground: [SENTENCE [NOUN 1, Agent *Sue*] [VERB *tickled*] [NOUN 3, Patient *the baby*] *under* [NOUN 4, Locus *his chin*] *with* [NOUN 5, Instrument *a feather*] *in* [NOUN 6, Locus *the bedroom*] [NOUN 7, Time *this morning*]].

Event Frames
24   All of the foreground and background concepts that one uses to conceive a coherent event together make up an *event frame*.
25   We use semantic roles to conceive *event frames* that contain all the essential foreground and background knowledge for a particular event. Events are interactions

between entities. If one for instance conceives an event where an active party dominates a passive party, both the Agent and Patient roles are needed to properly frame that event. The instruments used during the event, as well as the time and place of the event will be available as background knowledge if we want to include that as part of our framing of the event. Knowledge about the intrinsic nature of the entities that we refer to will also form part of background knowledge to the event frame. Because we know that glass is brittle, and we know that humanity has the ability to break things, we effortlessly use the schema AGENT DOMINATES PATIENT to structure the clause *John broke the glass.*

26   Most events are interactions between entities that cause a change of locus or a change of state. The clause *John picked up the glass* entails that the glass, is moved from one Locus to another. The clause *John broke the glass* entails that the glass is changed from a state of wholeness to a state of being splintered.

27   When we construct event frames in the course of thinking and talking, the meaning of each verb triggers the semantic roles appropriate to that event in the minds of language users. The verb *eat* will for instance trigger the AGENT DOMINATES PATIENT schema for a clause like *The boy ate all the sweets*. The verb *taste* will however trigger the EXPERIENCER EXPERIENCES STIMULUS schema for a clause like *The boy tasted the sweets and didn't like them.*

Conceptual Metaphors

28   Figurative language in general, and metaphor in particular form a pervasive part of everyday language. The EXPERIENCER EXPERIENCES STIMULUS schema for instance forms the basis for sentences that refer to literal events as in *Jane saw/heard/smelt/tasted/felt the meat boiling on the stove*. All of these verbs can however also be used figuratively with the greatest of ease as in *I see what you mean* (I understand what you mean), *I hear you* (I agree with you), *John smelt a rat* (John suspected that something was wrong), *Our team tasted victory* (Our team won), and *Sue feels insulted by what Andy said* (Sue was emotionally upset by what Andy said). Very basic metaphors, known as conceptual metaphors, play an important role in structuring our perceptions about the events of everyday life[20]. Typical examples of such conceptual metaphors are *life is a journey* and *argumentation is warfare.*

29   Since the time of Isaac Newton science has been dominated by the conceptual metaphor that the universe is a mechanical construct. Under the influence

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[20] Fauconnier & Turner (1994); Fauconnier (1985); Lakoff & Johnson (1980a; 1980b); Lakoff & Turner (1989); Turner & Fauconnier (1995); Turner (1991).

of the mechanical universe metaphor we have dammed up rivers and transplanted body organs. The Newtonian mechanical universe conceptual metaphor is at the moment however being supplanted by an organic universe metaphor that sensitises us to the vital interrelationship between things. Using this metaphor we begin to understand the consequences for life on earth if we fill the atmosphere with green house gasses, if we convert rain forests to houses, furniture and packing crates. The organic universe metaphor probably also plays a role in new attitudes about primary health care, namely that it is better to prevent disease by a healthy lifestyle, than to replace diseased organs. Under the organic universe metaphor we are also seeing advances in the engineering of new breeds of animals, new sequences of genes to cure genetic ailments, and the cloning of life forms.

Semantic Roles and Event Frames in Narrative Scripts
30   Humans create narratives by using semantic roles like *Agent, Patient, Stimulus, Experiencer* and *Instrument* to link sequences of event frames as coherent narrative scripts. Individual events such as *A poor man had only one lamb* and *the poor man took care of his lamb* are linked to form a coherent narrative script because one can see that *man* is the same *Agent* in both events, and that *lamb* is the same *Patient* in both instances.

31   When we combine role sequences for persons in such narratives we form images of heroes, villains and victims: An Agent who helps a victim is a hero. An Agent who harms a victim is a villain. A Patient who is harmed by a villain and helped by a hero is a victim.

Image Schemas, Conceptual Metaphors , Event Frames and Scripts in Artificial Intelligence
32   Work is in progress to combine image schemas, conceptual metaphors, event frames and scripts in the form of *X-schemas* in artificial intelligence routines that will enable self-programmable parallel distributive computers to learn from experience just as humans do, and particularly to communicate with us by using ordinary language and by 'thinking' according to humanlike mental models[21].

The Primacy of Direct Verbal Communication
33   The most basic function of language is to express concepts during direct

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[21] Bailey et al (1997); Feldman et al (1996); Grannes et al (1997); Narayanan (1997).

verbal communication. Three elements are required for direct verbal communication, namely two human participants and a theme. The two participants are the speaker (the first person) and the hearer (the second person). During the conversation, they focus their attention on the theme (the so called third 'person') and exchange new information about it.

34   Language is used most regularly during direct verbal communication when the two human participants take turns as speaker and hearer. When one participant monopolises the conversation, it becomes a monologue—an irregular form of communication during which the hearer easily loses interest and stops concentrating on the theme.

35   Written language is a secondary form of communication. It approximates conversation in narratives when it portrays a speaker and hearer exchanging ideas during direct conversation. In such instances, the reader becomes a silent observer of the reported proceedings. Forms of writing (such as this essay) that directly disseminate information, approximate monologues (or diatribes if they are badly written and blatantly seek to influence their readers' values) and are therefore the least regular forms of communication.

Fractals and Recursive Patterns in Language Structure

While I discussed aspects of fractal patterns in nature with the editor of ALTERNATION I was asked to comment on the possibility that language structure shows patterns of fractal organisation—the phenomenon where an entity reveals self-same patterns of replication on all levels of organisation. Several aspects of language structure are organised on the principle of recursiveness which could be a clue to fractal organisation:

1   Word categorisation entails that superordinate lexical categories contain subcategories, which in turn contain sub-subcategories: within the superordinate category *artefacts* we get a subcategory *furniture*, which in turns contains a sub-subcategory *chair*, which in turn contains a sub-sub-subcategory *lounge chair*, which in turn ....

2   Directional prepositional phrases (PP) can contain other prepositional phrases like [^{PP} *out* [^{PP} *of the house*]].

3   The use of epistemic verbs[22] enables one to string together multiple senten-

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[22] Epistemic verbs like *see, hear, feel, think, know* etc. all relate to forms of knowing.

ces (S) as in [$^{S\,1}$ *Jack thought* [$^{S\,2}$ *Peter knew* [$^{S\,3}$ *Jane heard* [$^{S\,4}$ *Sam felt* [$^{S\,5}$ *Andy claimed* [$^{S\,6}$ *Sue lied*]]]]]]

While at first blush such language patterns may look like fractal replication they are not. Lexical superordinate categories, basic level categories and superordinate categories differ in significant ways. Lexical organisation from superordinate categories like *artefact* and *furniture* through the basic level category like *chair* and the subordinate category *lounge chair* show a change of meaning from the generic to the highly specific. Furthermore, while ordinary people have picture gestalts[23] of basic level lexemes such as *chair,* they do not have gestalts for superordinate level lexemes such as *furniture,* or for subordinate level ones *lounge chair.*

Recursive language patterns such as the stringing together of directional prepositional phrases and multiple sentences that contain epistemic verbs are the exceptions, and are in any case self-same in a very limited way. One reason for this limitation is the fact that humanity can hold between only five and seven thoughts in his short term memory at a time[24]. This in itself would in my view make self-same patterning at various levels or organisation impossible in language.

Conclusion

In this essay I have tried to give a concise, easily understandable overview of the essential aspects of Cognitive Rhetoric as frame of reference for the four specialist contributions in this field that appear in this issue of *ALTERNATION.*

Because of current misconceptions about the need and role of theorising in the so called soft sciences I began this essay by discussing a number of surprising conclusions that emanate from twentieth century science. I showed how hard science theories reveal the universe to be a truly alien place, a place that is in many respects different from the inner images that humans form of the natural order of things. I have shown that hard science theories attempt to objectively reveal the universe as it fundamentally is—a place that is alien to humanity.

Cognitive Rhetoric by contrast attempts to reveal how humans subjectively perceive the universe from our relatively safe vantage point, mother earth. It does this by showing how humans associate perceptions to form concepts, and how we express those concepts as language while we communicate with one another.

Finally, at the dawn of the twenty first century humans are taking the first steps to devise forms of artificial intelligence that are learning to think independently,

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[23] Single mental pictures that can be easily drawn with just a few lines.
[24] Miller (1956).

and that will be able to communicate with us by using *Great-Chain-Of-Being* human mental models to conceptualise the nature of things.

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