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SEMANTIC CHANGE AND CHAOS THEORY

Jemand sagt mir: "Zeige den Kindern ein Spiel" Ich lehre sie, um Geld würfeln, und der Andere sagt mir "Ich habe nicht so ein Spiel gemeint". Mußte ihm da, als er mir den Befehl gab, der Ausschluß des Würfelspiels vorschweben? [...] Wie ist denn der Begriff des Spiels abgeschlossen? Was ist noch ein Spiel und was ist keines mehr? Kannst du die Grenzen angeben? Nein. Du kannst welche ziehen: denn es sind noch keine gezogen.

"Aber dann ist ja die Anwendung des Wortes nicht geregelt; das 'Spiel', welches wir mit ihm spielen, ist nicht geregelt." – Es ist nicht überall von Regeln begrenzt; aber es gibt ja auch keine Regel dafür z.B., wie hoch man im Tennis den Ball werfen darf, oder wie stark, aber Tennis ist doch ein Spiel und es hat auch Regeln (Wittgenstein, 1953:28).¹

Introduction

In this paper, the linguistic phenomenon of semantic change is examined from a broader, cross-disciplinary perspective. We intend to argue that the same laws that govern nature as a whole, can be successfully applied to the study of human language in general and semantic change in particular.

Chaos theory provides us with a new tool to view the world. For centuries scientists have used the line as a basic building block to understand the objects around us. On the contrary, chaos science uses a different geometry called **fractal geometry**. So far it has been successfully used to describe, model and analyse complex forms and phenomena found in nature such as, for example,

¹ *Someone says to me: "Show the children a game." I teach them gaming with dice, and the other says "That sort of game isn't what I meant." Must the exclusion of the game with dice have come before his mind when he gave me the order? [...] How is the concept of a game bounded? What still counts as a game and what no longer does? Can you give the boundary? No. You can draw one; for none has so far been drawn. "But then the use of the word is unregulated, the 'game' we play with it is unregulated." – It is not everywhere circumscribed by rules; but no more are there any rules for how high one throws the ball in tennis, or how hard; yet tennis is a game for all that and has rules too (Wittgenstein 1953:28e).*

plants, weather, clouds, fluid flow, geologic activity, coastlines, planetary orbits, galaxy clusters, the human body, medical diseases, animal group behaviour, socio-economic patterns and music. At this point one could advance the following question: *Why should not we apply it to the study of language?*

We claim that the way nature creates a magnificent tree from a seed in many respects resembles the **cumulative** process of how a semantic change develops and spreads in time, space and social strata. Moreover, its dissemination is rigorously governed by laws, which can be presented by means of a mathematical calculus.

How regular is language change?

Another question that may be formulated in this context is: *Is language a system or chaos?* In other words, should it be perceived as a perfect mechanism governed by universal rules and laws or rather do its paths remain beyond any empirical verification and its configurations by no means determinable scientifically. The belief that the study of language can be carried out in an equally scientific manner as that of mathematics or physics constituted the origin of modern linguistics. So, various attempts at formulating linguistic laws modelled on natural laws of science started to appear in the 19th century. The *Neogrammarians*, whose study of classical languages led to revelatory discoveries about the interrelationship of many modern and classical languages, had begun the search for general principles of language change. One of the foundations of their research was the explanatory power of what is known as *Verner's Law*, a statement of the phonological conditions which determine the class of Germanic words which can be exceptions to *Grimm's Law*, an earlier discovery stating the major phonological change from Proto-Indo European to the Germanic dialects. The theoretical significance of *Verner's Law* was that it eliminated the largest set of apparent exceptions to *Grimm's Law* by showing that the so-called exceptions exhibited lawful or rule-governed properties. This discovery led to the hypothesis that all sound changes are rule-governed. The Neogrammarians introduced the formula: *Ausnahmslosigkeit der Lautgesetze*, the principle stated that sound changes are exceptionless.²

This general enthusiasm and optimistic attitude, however, did not last long. It soon became obvious that many phonological changes can hardly be explained by rigidly operating sound laws. An attempt at explaining a number of newly discovered irregularities was made by the introduction of the so-called *six laws of analogy* proposed by Kuryłowicz (1945). Nonetheless, other obstacles started

² The idea was strongly advocated by, among others, Karl Brugmann (1849–1919) and Hermann Osthoff (1847–1909).

to appear and different, every time more abstract, phonological models had to be constructed, proving the idea of finding natural laws devoid of any irregularities in language to be futile and illusionary.

Naturally, the desire to formulate universal rules much in the same way that the *Junggrammatiker* developed their *Lautgesetze* has also been present in the studies on semantic change. Ullmann (1957:249) states that:

The search for semantic laws is as old as semantics itself. Students of meaning and others have frequently hazarded diametrically opposite forecasts as to the chances of its success: some have described it as the ideal target of our science, others as a pernicious mirage.

The list of semanticists who felt optimistic as to the possibility of discerning some kind of regularity behind semantic processes includes Reisig (1881), Haase (1874), Bréal (1897), Hecht (1888), Wundt (1900), Sperber (1923), Jespersen (1925), Leumann (1927), Carnoy (1927), Stern (1931), Kleparski (1990), Traugott and Dasher (2002). Their general belief was explicitly stated by Jespersen (1925:23) when he declared that *there are universal laws of thought which are reflected in the laws of change of meaning [...] even if the science of meaning has not yet made much advance towards discovering them.*

It should be noted that the postulated laws were believed to be either universal, as in the case of Reisig (1881), or historical and changeable as exemplified by Haase (1874).³ Others, for example, Ullmann (1951:80) and Antilla (1972:147), instead of discovering universal laws chose to talk about general tendencies. Likewise, Sperber (1923) did not believe that one could find semantic laws analogous to those operating at the sound level and thought that it is only possible to discover certain regularities.

Chaos theory in perspective

Chaos theory encompasses the principles and mathematical operations applying to chaotic systems. It is in fact the product of many scientific contributions from different disciplines, especially various branches of mathematics and physics, whose history goes back at least as far as the late 19th century. However, the present-day chaos theory as a unified discipline has been evolving since the late 1960s and the number of publications on the subject began increasing sharply in the early 1990s.

In a nutshell, for four centuries the Newtonian laws of physics have reflected the complete connection between cause and effect in nature. Thus, until recently, it was assumed that it was possible to make accurate long-term

³ Haase (1874:128) wanted to transform the figures of speech to *meaningful laws [...] that have a true life in a language.*

predictions of any physical system as long as one is familiar with the starting conditions. It goes without saying that the discovery of chaotic systems almost everywhere in nature has all but destroyed that notion. Likewise, the world of mathematics has been confined to logical linearity, that is to say, linear systems following predictable patterns and arrangements. Linear equations, linear functions, linear algebra, linear programming and linear accelerators are all areas that have been understood and mastered by the human race. However, the problem arises that we humans do not live in an even remotely linear world.

The very term *chaos theory* seems to contradict reason and common sense as it suggests that mathematicians have discovered some new and definitive knowledge about utterly random and incomprehensible phenomena, but this is not the case. Chaos is rather understood in the approach as *unstable aperiodic behaviour in deterministic non-linear dynamic systems* and its study can be carried out in qualitative manner.⁴ A dynamic system may be defined as a simplified model for the time-varying behaviour of an actual system, and **aperiodic** is simply the behaviour that occurs when no variable describing the state of the system undergoes a regular repetition of values. The term – deterministic – stresses, on the other hand, that its evolution can be determined or governed by precise laws. Waldrop (1992) claims that looking for a relevant example of aperiodic behaviour which would display chaotic characteristics, one may take the human history as a good representative of it. According to the author, history is indeed aperiodic since broad patterns in the rise and fall of civilisations may be sketched, however, no events ever repeat in exactly the same manner or pattern.

Williams (1997:12) observes that virtually anything that happens over time may be termed as chaotic. His examples include epidemics, pollen production, populations, incidence of forest fires or droughts, economic changes, world ice volume and rainfall rates. Many instances of chaotic systems have also been found in physics, mathematics, communications, chemistry, biology, physiology, medicine, ecology, hydraulics, geology, engineering, atmospheric sciences, oceanography, astronomy, the solar system, sociology, literature, economics or international relations. All of which makes chaos theory a truly interdisciplinary study and helps us to perceive any of the particular branches of science in a much more holistic manner.

Let us now have a closer look at the characteristics of chaos as discussed in Williams (1997). The author in his discussion on where chaos occurs comes to the conclusion that it is characteristic of **dynamic systems** that evolve over time. Sometimes space or distance can take the place of time. The term *dynamics* implies force, energy, motion or change. Hence, a dynamic system is anything that moves changes or evolves in either time or space. Basically,

⁴ See Waldrop (1992:12).

different natural phenomena happen over time in two ways. One of them involves discrete intervals, e.g., earthquakes, rainstorm and volcanic eruptions. The other way in which they take place forms a continuum, e.g., air temperature, the flow of water in perennial rivers. **Iteration** is a mathematical way of simulating discrete-time evolution; to iterate means to repeat an operation over and over. In chaos, it usually means to solve or apply the same equation repeatedly, often with the outcome of one solution fed back in as input for the next. And so, iteration is the mathematical counterpart of feedback. In temporal processes that translates as **what goes out comes back in again** and feedback is that part of the past that influences the present, or that part of the present that influences the future.

Another feature of chaos discussed by Williams (1997) is its **nonlinearity**. In fact, chaotic behaviour can only occur in non-linear systems. Campbell (1989:45) mentions three ways in which linear and non-linear phenomena differ from one another.

- 1) Linear processes are smooth and regular, whereas non-linear ones may be regular at first but often change to erratic-looking.
- 2) A linear process changes smoothly and in proportion to the stimulus, in contrast, the response of a non-linear system is often much greater than the stimulus.
- 3) Pulses in linear systems decay and may die out over time. In non-linear systems, on the other hand, they can be highly coherent and can persist for long times, perhaps forever.

Yet another property of a chaotic system that must be touched upon here is its **fractal nature**. The scholar who laid out the foundations for fractal geometry is a French mathematician of Polish descent, Benoit Mandelbrot, currently working at IBM's Watson Research Center and Yale University. Mathematically, fractals are pictures that result from iterations of non-linear equations, usually in a feedback loop. The term was coined by Mandelbrot who defines it along the following lines:

I coined fractal from the Latin adjective fractus. The corresponding Latin verb frangere means 'to break': to create irregular fragments. It is therefore sensible-and how appropriate for our needs!-that, in addition to 'fragmented', fractus should also mean 'irregular', both meanings being preserved in fragment (Mandelbrot, 1983:25).

The key feature of a fractal system is its self-similarity, which means that at every level the fractal image repeats itself. Notice that many shapes in nature display this fractal quality of self-similarity, e.g., clouds, ferns, coastlines, snowflakes, mountains as well as arteries and veins, just to give a few examples. As opposed to Euclidean geometry, which allowed the study of only abstract regular shapes, fractal geometry describes the real nature of physical phenomena

since as Mandelbrot (1983:26) puts it *clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in a straight line.*

The next prerequisite for any system to be chaotic is its extreme sensitivity to initial conditions which are understood as the values of measurements or other data at a given starting time. What this means is that when slight changes have been introduced to a system at one time, the resultant behaviour it displays will be significantly varied. Consequently, two nearly indistinguishable sets of initial conditions for the same system will result in two final situations that differ greatly from each other. This hypersensitivity to changes in initial conditions is sometimes referred to as **the butterfly effect**.⁵ The principle was vaguely understood centuries ago but is still satisfactorily portrayed in folklore:

*For want of a nail, the shoe was lost;
For want of a shoe, the horse was lost;
For want of a horse, the rider was lost;
For want of a rider, a message was lost;
For want of a message the battle was lost;
For want of a battle, the kingdom was lost!*

As can be observed, small variations in initial conditions result in huge, dynamic transformations in concluding events. That is to say that there was no nail, and, therefore, the kingdom was lost. The graphs of what seem to be identical, dynamic systems appear to diverge as time goes on until all resemblance disappears.

Finally, Williams (1997) points out the fact that chaotic systems are mathematically deterministic but nearly impossible to predict. More specifically, short-term predictions can be relatively accurate while forecasts of long-term behaviour are meaningless. The reasons are sensitive dependence on initial conditions and the impossibility of measuring a variable to infinite accuracy. Williams (1997:210) claims that *as the control parameter increases systematically, an initially nonchaotic system follows one of a select few typical scenarios called routes to chaos*. This seems to explain why randomness lurks at the core of any deterministic model.

Language as a chaotic system

If chaos is so widespread a phenomenon, occurring both in natural as well as man-made systems, why not try to analyse linguistic data in terms of chaos

⁵ The name stems from the theoretical possibility of a butterfly flapping its wings in a certain part of the world which can cause a storm one year later on the other side of the globe.

theory? In fact, language itself fulfils the criteria of a chaotic system and is no less complex or dynamic than weather changes, traffic flow, shifts in public opinion, epidemics or urban development. Note that, for example, Wittgenstein (1953) compares language to a city:

Unsere Sprache kann man ansehen als eine alte Stadt: Ein Gewinkel von Gäßchen und Plätzen, alten und neuen Häusern, und Häusern mit Zubauten aus verschiedenen Zeiten; und dies umgeben von einer Menge neuer Vororte mit geraden und regelmäßigen Straßen und mit einförmigen Häusern (Wittgenstein, 1953:7).⁶

One of the most important properties of a human language, which constitutes a basic parameter in its description, is the ability to change in time, space, and in various social dimensions. As a result, it makes more sense to perceive language as a temporal, geographical or social continuum. This dynamism is vital to a chaotic system where hierarchical progression in the evolution takes place and the systemic elements are in a persistent movement and readjustment.

The speech of a given generation of native speakers is never quite identical to that of their parents or to that of children. Of course, the differences between adjoining generations are slight and for the most part go unnoticed. However, given a time span of centuries or millennia, minute differences will have a **cumulative** effect and often a given language will acquire a very new form and its resemblance to the earlier stage will appear only after detailed scrutiny and investigation. The evolution of language is a cumulative process consisting of small changes as it is described by Keller (1994). Thus, we are normally dealing with a process that is brought about by populations, not by single individuals.⁷ Hence, the dynamic instability of a language and the fact that from one form at a given historical stage, a number of languages, dialects and other linguistic varieties develop, clearly shows that language is a chaotic system.

The most popular diagram for expressing genetic relationships of languages is the family tree, a device created by August Schleicher in the 19th century. A tree, on the other hand, is a well-known example of a fractal, which is a pattern that repeats the same design and detail over a broad range of scale. Each piece of a fractal appears the same as we repeatedly magnify it. For instance, a twig and its appendages from the edge of a tree form a pattern that repeats the design of the trunk and main branches of the tree. Similarly, although languages are all the time evolving and splitting, each stage of this continuous process exhibits the same degree of complexity and can be described as a coherent system of

⁶ *Our language may be seen as an ancient city: a maze of little streets and squares, of old and new houses, and of houses with additions from various periods; and this surrounded by a multitude of new boroughs with straight regular streets and uniform houses* (Wittgenstein, 1953:7e).

⁷ See Keller (1994:144).

elements genetically related to other languages. Notice that also dialects can be regarded as subdivisions of a particular language that, from a linguistic point of view, cannot be considered less complex, developed and possessing a less ordered structure than the standard variety. This kind of linguistic recurrence can be conducted even further up to the level of idiolect.

In chaos theory, such subdivision of a form into smaller replicas of the original is called **scaling**. Also, Williams (1997) shows that order, within any chaotic system, develops spontaneously, that is, without external causes, due to the process of self-organisation:

Self-organization is the act whereby a self-propagating system, without outside influence, takes itself from seeming irregularity or uniformity into some sort of order. Examples of self-organization are the organizing of birds into an orderly flock, of fish into a clearly arranged school, of sand particles into ripple marks, of weather elements (wind, moisture, etc.) into hurricanes, of water molecules into laminar flow, of stars into the spiral arms of a galaxy, and of the demand for goods, services, labor, salaries, and so on, into economic markets (Williams, 1997:223).

Language is without doubt aperiodic as it is not possible for two languages to develop identical structures. The same language can also split geographically or politically, like Dutch and Afrikaans or Serbian and Croatian. In these cases, each language variety tends to differentiate itself from its counterpart more dynamically than in other circumstances as the split results in establishing new, independent from each other, centres, or – in terms of chaos theory – new **attractors**, around which they continue their development. Thus, yet another model for the description of language configurations apart from a family tree or an old city could be put forward here – a kaleidoscope, that is a fractal system *par excellence*.

Semantic change as an instance of chaotic behaviour in language

Some linguists believe that semantic shifts, more than any other aspect of linguistic change, are related to the life and culture of a speech community and that is why they are somewhat free of the mechanisms that may be peculiar to language systems.⁸ Contrary to this line of reasoning, chaos theory provides evidence that chaotic patterns are entirely self-generated. In other words, aside from any influence of the constant, chaos develops without any external influences whatsoever. In fact, all changes of meaning are cognitively motivated

⁸ See Arlotto (1972:165) where the author supports his opinion with the claim that *studies in semantic change so far have not resulted in the formulation of abstract models or even in the reasoned educated guesswork that pervades the study of phonological, morphological, and syntactic change*.

which makes it impossible to differentiate between extralinguistic and purely linguistic causes of semantic alterations.⁹ This is the reason it seems justified to claim that cognition is the basic constant in semantic change which explains why meanings change even if there is no external need for it.¹⁰

Another feature of chaos present in the case of semantic alterations is sensitivity to initial conditions. In effect, a tiny difference, compounded over many iterations, grows into an enormous change. As an interesting example of the butterfly effect in historical semantics we may quote Lavrinenko's (2002) study in which the development of the Proto-Indo European form **dh(e)ghom* – 'earth' is reconstructed. The author shows that seemingly insignificant differences of the base **dh(e)ghom* in its synchronic polysemisation led to enormous changes in the diachronic development yielding such semantically divergent lexical items as, for instance, *danger*, *comb*, *dame*, *dome*, *domain*, or Polish *dąb* – 'oak', *ząb* – 'tooth', *poziomka* – 'wild strawberry', *mogiła* – 'grave', *gąbka* – 'sponge'. The linguistic investigation led Lavrinenko (2002) to formulate the following observation:

*Этимологические гнезда, в свою очередь, не “плавают” изолированно в виртуальном языковом океане, а также определенными способами (формально и семантически) связаны между собой, связаны по типу и тождества, и общности. Возникает “система систем” как таковая. То есть, можно сказать, что, потянув за одну тоненькую ниточку, мы в состоянии приоткрыть дверь в огромный мир, в огромное пространство (Lavrinenko, 2002:17).*¹¹

Sensitive dependence on initial conditions also explains the fact why words in different languages, despite being conceptual counterparts, exhibit a set of often contradictory meanings. For example, Spanish and Portuguese *propina* both have been derived from Latin *propina* 'gift, contribution', but while Spanish *propina* means 'a tip', its Portuguese homonym refers to 'a tuition fee'. Similarly, Polish *jutro rano* can be translated into English as 'tomorrow in the morning', while Serbian *rano jutro* means 'early morning'.¹² This seems to indicate that semantic change is of truly aperiodic nature.

Geeraerts (1997) puts forward a hypothesis about the descriptive characteristics of semantic change that links it with a prototype-theoretical conception of semantic structure. In fact, for Geeraerts (1997), semantic

⁹ On this issue see, among others, Kleparski (1997).

¹⁰ Notice that Lorenz (1993:24) defines a chaotic system as one that is sensitively dependent on *interior* changes in initial conditions.

¹¹ *Etymological nests, in turn, do not “swim” isolated in the virtual language ocean, and also, in determined ways (formally and semantically), they are interconnected according to the type of particular and general qualities. “A system of systems” is emerging as such. That is, one can say that pulling one thin thread we are able to open the door to a huge world, to enormous space (Lavrinenko, 2002:17).*

¹² On the issue of false friends see, among others, Kleparski (2003).

structure takes the form of a radial set of clustered readings and, as such, it clearly displays fractal construction. Prototypical categories consist of a dominant core area surrounded by a less salient periphery. New meanings arise from semantic extension of the central sense and may themselves become new attractors around which novel meanings start to develop. Williams (1997:241) stresses that fractals are by no means smooth, much in the same way as prototypical categories are blurred at the edges. Fractal structures also look rough, broken, jagged, bumpy, or shaggy.

Conclusion

In the forgoing, an attempt was made to give partial evidence that language can be perceived as a chaotic system and semantic change as a consequence of its chaotic variation. In this context the term **chaotic** refers to sustained and random-like long term evolution that satisfies certain qualitative criteria and that happens in deterministic, non-linear, dynamic systems. Chaos theory deals with the mathematics of such systems which although highly random, always seem to indicate some trends and tendencies. Its prediction may be quite accurate in the short run, but seems to make no sense when applied to much longer periods of time.

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