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Complexity Applications in Language and Communication Sciences

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Chapter 1
Introduction

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Abstract Based on the acknowledgment that many phenomena in human life are complex, there have been attempts to re-examine the conception of reality. Interdisciplines such as complex thinking, sciences of complexity or complex perspectives try to provide the "old" concepts with a new meaning. The complexity researches imply the restudy of reality, and they have cybernetics as precedent and partly as foundation: a transdisciplinary focus to explore the structures, restrictions and possibilities of regulatory systems. It intends to provide concepts, schemata and possibilities of thought and representation capable of expressing the interweaving and the multidimensional and systematic interdependence of the many phenomena of reality. Linguistics is one of the fields of knowledge that is making great progress under the new paradigm of complexity. The amount of contributions from physics and other scientific disciplines to linguistics is large, under which natural language has been addressed with theoretical and practical methods, both quantitative and qualitative. However, the conceptual resources and tools that are available nowadays are not completely suitable to perform all the tasks. Due to this, it is necessary to keep developing new theoretical and methodological tools that help understanding the dynamic interrelations of linguistic and sociocultural events. Simultaneously, the

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lines of inter and transdisciplinary research that transcend the communicative and linguistic phenomenon, and that connect them and interrelate them with life and the world must be strengthened.

1.1 Complexity as a Transdisciplinary View

The recognition that many phenomena relating to life are 'complex' in nature—i.e., that they are interwoven, self-organising, emergent and processual—has prompted a reexamination of how we have conceived reality, both the way we have looked at it and the images we have used to represent it. This constitutes the point of departure for the articulation of different interdisciplines engaged in refreshing such concepts and finding new ways of thinking that better fit the complex organisation of facts and events.

New science perspectives have emerged under this recognition, giving rise to disciplines or paradigms that are referred to as 'complex thinking', 'sciences of complexity', 'complex perspectives', 'complex [adaptive] systems', network sciences, …

The chose of the terms 'complex' and 'complexity' is, far from randomly motivated, precisely to suggest what their Latin etymology implies—*complexus*, to weave, braid, entwine—that is, a common characteristic of phenomena at this level of being, made up of a series of elements that are deeply interwoven and interdependent in their functioning. Fundamentally, the terms point to a need to go beyond approaches that are reductionist, one-dimensional or basically analytical in procedure—approaches that have been, and continue to be, useful at other levels and for other events—and to move towards perspectives that we have come to call systemic, holistic, ecological or networked, because they can more closely suit the kind of occurrences that we observe at this intermediate level of the universe.

From this point onwards the terms 'complexity' or 'complex' and 'complexics' or 'complexical' (see Bastardas 2016) will be used to refer to a common research framework shared by different disciplines that suggest more all-embracing, contextual and dynamic perspectives.

As a transdisciplinary view, the complexity perspective or complexics carries on the perspective of cybernetics: "Cybernetics deals with all forms of behaviour insofar as they are regular, or determinate, or reproducible. The materiality is irrelevant… The truths of cybernetics are not conditional on their being derived from some other branch of science. Cybernetics has its own foundations" (Ashby 1956: 1). Thus, it has a distinct transdisciplinary mission to provide concepts, schema and possibilities of thinking and representation able to express the multidimensional and systemic interwovenness and interdependence of the many, highly significant phenomena of reality which match these characteristics.

Contemporary cybernetics began in the 1940s as an interdisciplinar study connecting the fields of control systems, electrical network theory, mechanical engineering, logic modeling, evolutionary biology and neuroscience (concepts related to the biological work of Ludwig von Bertalanffy in General Systems theory).

Why do we talk about cybernetics in a book about linguistics? Because cybernetics is the science of systems in which we find a closed signaling loop—originally referred to as a "circular causal" relationship—following the circular causal process of (1) the action carried out by the system generates a change in its environment, (2) that change is, at the same time, reflected in the System (in the form of feedback) and finally (3) triggers a change in the whole system.

Both the structural patterns of this process and the fields of study of cybernetics are to be found in human linguistic interactions, as well as in social systems: the study of feedback, black boxes and derived concepts such as communication and control in living organisms, machines and organisations including self-organisation. Moreover, central concepts such as learning, cognition, adaptation of learning, adaptation, social control, emergence, efficacy, convergence communication, efficiency, and connectivity, notions of realimentation, regulation, communication, autodirection and autocontrol, become crucial when society is understood as a sociocultural adaptative complex system (Buckley quoted by Parra Luna 1992: 387–390).

From this perspective, it is possible to elucidate the foundations of Complexity theory. In fact, the discipline that dealt more with complex systems came to be Cybernetics, which has been defined by some authors as "complexity science" (Ashby 1956; Simon 1990). Studies in cybernetics, thus, provides means for examining the design and function of any system, including social systems, seeking to make them more efficient and effective.

Cybernetics (in the sense we use it today) was lined up by Norbert Wiener in his book *Cybernetics Or Control and Communication in the Animal and the Machine*, where he points out that the behaviour of some systems "may be interpreted as directed to the attainment of a goal" (Wiener 1954: 89). Wiener popularized the social implications of cybernetics, drawing analogies between automatic systems (such as a regulated steam engine) and human institutions.

The multiple definitions with which cybernetics is aligned are due to the richness of its conceptual base, founded in the common denominator of all its meanings: circularity. In order to synthesize the diverse constellation in which cybernetics is inscribed, we have selected particularly interesting insights adopted by different authors: while M. Mead (1968) states that "a form of cross-disciplinary thought which made it possible for members of many disciplines to communicate with each other easily in a *language which all could understand*", Pask (1992) defends that "*Cybernetics is the science of defensible metaphors*".

Kolmogorov[1] conceived it as the "science concerned with the study of systems of any nature which are capable of receiving, storing and processing *information so as to use it for control*". Bateson (1972), epistemologist and anthropologist, considered cybernetics as a "branch of mathematics dealing with problems of control, recursiveness and *information*". Rodney E. Donaldson,[2] first president of the American Society for Cybernetics, described it as an "art of the understanding of understand-

[1] Quotation from *Stanford Encyclopedia of Philosophy* (online: https://plato.stanford.edu/).

[2] See Footnote 1.

ing". Finally, Louis Kauffman,[3] President of the American Society for Cybernetics from 2005 to 2008, defined the discipline as "the study of systems and processes that interact with themselves and produce themselves from themselves."

New cybernetics will be more suited to the organizations which mankind discovers in nature, as biologists Maturana and Varela (2004) explain in their well-known book: *The science and art of understanding*. One characteristic of the emerging new cybernetics considered in that time by Felix Geyer and Hans van der Zouwen, according to Bailey (1994), was "*that it views information as constructed and reconstructed by an individual interacting with the environment*". This provides an epistemological foundation of science, by viewing it as observer-dependent, that connects cybernetics directly with complexity theory. In this sense, we draw the lines whereby cybernetics can be conceived as the intellectual and scientific thought that gave rise to the actual complexity frame.

Indeed, what the complexical perspective first undertook was to absorb the progress already made in disciplines such as physics—e.g., relativity and quantum theory—and biological ecosystems, as well as the foundations of cybernetics (Wiener 1948; Ashby 1956), as it has been explained in the previous paragraphs, and systems theory (Bertalanffy 1969). In the field of human and social sciences, the movement has been equally prevalent, although it has perhaps had less impact, despite the contributions of Gregory Bateson (1972), Morin (1973) and Elias (1982, 2000), whose works are central to the perspective applied in the area of human beings (cf. Bastardas-Boada 1996, 2013a, 2014). Others have had a hand in its construction as well. In Catalonia, for example, Munné (1995, 2013) was a driving force behind the creation and application of the perspective of complexity in social psychology, Serrano (1983, 2001) extended cybernetics and information and systems theories to linguistics and communication, and Aracil (1982, 1983) expressly developed an interdisciplinary, historical and discursive perspective in sociolinguistics.

The complexity perspective brings together all contemporary efforts in any specific disciplines or by any researchers specifically devoted to constructing tools, procedures, models and concepts intended for transversal application that are aimed at understanding and explaining the most interwoven and dynamic phenomena of reality. This would encompass Edgar Morin's theories of complex thinking (1992, 1999, 2005, 2007, 2008); the epistemological and theoretical contributions of physicists such as Bohm (1987), Prigogine and Stengers (1979, 1992), Capra (1982, 2002), and Wagensberg (1985), or of cognitive biologists such as Maturana and Varela (1999, 2004), and the proposals of ecologists such as Margalef (1991) and Allen and Hoekstra (1992). It also includes the most recent contributions of Barabási and Albert (1999) and of Solé (2009) in network theory, and of San Miguel et al. (2012), among others, in statistical physics and the study and computer simulation of complex systems.

Without doubt, complexics currently lacks an integrated and unified body of theory to enable us to characterise a field in a general, widely agreed-upon manner. Nor can we dispel all doubts about its feasibility as a unifying paradigm, although we are

[3] See Footnote 1.

convinced that we shall see important progress in coming years to confirm the wisdom of this approach. At a minimum, we are already witnessing a series of transversal concepts and models that are not only pushing forward specific disciplines with new images and perspectives that pass between them, but that are also forging a shared scientific lexicon useful in interdisciplinary communication and integration, which are made more difficult by the diversity of terminology.

Complexics, as a scientific paradigm, needs to provide a set of principles, concepts and conceptual landscapes that can be applied transversally to distinct areas of knowledge and phenomena of reality, enabling us to gain a much firmer grasp of the complex aspects of their existence than we currently have. For this reason, our aim needs to be, as Morin says, not "to reduce complexity to simplicity, [but] to translate complexity into theory" (1994: 315).

The complex or complexical approach is fully aware—as Morin put it—that our theories have the nature of 'translations' and not of 'mirrors'. Bearing full responsibility for our 'giving rise to a world' (Maturana and Varela 1999), we must be hugely mindful of the often hidden assumptions that govern our paradigms, that is, the conceptual lenses through which we imagine the world. For example, some points of contrast between traditional scientific thinking and complex thinking can be summed up as in table 1.1.

Table 1.1 Comparison between the traditional and the complexity perspective. Taken from Bastardas-Boada (2014)

Traditional perspective	Complexity perspective
Conceptual reification	There is no science without an observer (centrality of brain/mind)
Territory	Maps (we see by means of concepts and words)
Scientific truth	Provisional theories
Elements	Elements-and-contexts, interweaving, interdependences, networks
Objects	Events and processes
Steady-state	dynamic flux, change, evolution
Classical logic	Fuzzy logic
Linear causality	Circular and retroactive causality
Either/Or dichotomies	And/both integration and complementarity
Planned creation	Self-organisation and emergence
Unidimensionality	Inter-influential multidimensionality
"Explicate order" (things are unfolded and each thing lies only in its own particular region of space)	"Implicate order" (everything is folded into everything; a hologram, where the parts contain information on the entire object)
Fragmentation of disciplines	Inter- and transdisciplinarity
Structure, code	Meaningful and emotional Interaction

1.2 Complexity in the Study of Natural Language

The appearance and/or consolidation of these new theoretical perspectives has an impact at the more practical level of methodology. New tools for the conception, apprehension and treatment of the data of experience will need to be devised to complement existing ones and to enable us to make headway towards practices that better fit complexical theories.

Linguistics is one of the domains of knowledge that is undergoing a breakthrough under the new complexity paradigm, while Physics has become one of the pilot disciplines. Natural language has been treated with methods coming from Physics, both from a more theoretical and applied approach. On the one hand, we have the contributions of the more theoretical physicists, such as David Bohm, Ilya Prigogine and Fritjof Capra, and on the other hand, the contributions of more quantitative-oriented physicists from the field of statistical physics modelling, such as Murray Gell-Mann (1996), Maxi San Miguel and Albert Díaz-Guilera, for example. It will certainly be useful for us to gain familiarity with both of these major approaches, see their fruitful application in our disciplines and attempt to exploit them in a coherent and integrated manner. However, we must also be cognizant of the peculiarities of human phenomena, which are characterised by the existence not only of purpose and regularity in the control of behaviour, but also by the significant degree of agents' cognitive and interpretive autonomy and by the powerful influence of the emotional dimension.

This differential fact seems to pose a contradiction for the two fundamental orientations of complexics developed to date. On the one hand, the more epistemological and philosophical contributions lead us to postulate the inevitability of taking into account the brain/mind and everything that arises bio-cognitively from it in order to understand complex human behaviours. On the other hand, the proposals put forward by physics and computer science move in the opposite direction, postulating the selection of a few 'practical' parameters that can computationally 'explain' the observed facts.

The human, sociocultural level has special features that make it even more complex, if we compare it to other existing organisations of phenomena. The elements or human 'agents', the units of the system that we want to understand, are not themselves simple, but rather the products of an enormous internal and external complexity. Not only do they contain the prior physical, chemical and biological levels, but also, in their interaction with environments and with one another, they develop extraordinary emotional, cognitive and symbolic capacities that enable them to produce social organisations of extremely high complexity. This explains why in developing knowledge about these societies, what has prevailed is a 'separating' view of the several domains present. However, such a view leads us to misunderstand the very phenomena that we want to grasp, because it does not enable us to readily capture their dynamic interactions and inter-influences. As Morin says, for instance, "the non-complex perspective of the human sciences, of the social sciences, is to think that there is an economic reality on one side, a psychological reality on another side,

a demographic reality on yet another side, and so on. One thinks that these categories created by universities are realities, but forgets that in the economic, for example, there are human needs and desires" (1992: 92).

This can similarly happen to us at the level of language, if in our study of the facts and events, we forget the intrinsic complexity of their existence and production in human beings. If we treat what we call 'languages' as if they were simple, decontextualised objects, we can make headway in our understanding of some of their more 'mechanical' aspects, but we can also entirely overlook the conditions of their existence, functionality, maintenance, variation, change or disappearance. At the same time, it will become more difficult for us to account for the major constitutive influence that a language has at the cognitive level and we will completely miss the social phenomenon of the continuous use (or the disuse) of languages at all levels of human life.

In sociolinguistics and cognitive interactional linguistics, we have had to move towards the use of perspectives and metaphors relating to ecological complexity and complex adaptive systems in order to try to grasp the interdependencies among the different levels of organisation that can affect the determination of language behaviours (Bastardas-Boada 1996, 2013b, c, 2017; Junyent 1992; Ellis and Larsen-Freeman 2009; The Five Graces Group 2009, Massip-Bonet 2013a, b). The brain/mind, habits at the interactional level, demo-social groupings, the socioeconomic structure, the media and political power enter into constant relation with language forms and codes and can determine their course—through the pressures that individuals interpret as being exerted on them (Terborg and García-Landa 2013)—in an interdependent fashion, with conflict and tension that can vary by situation.

We must not forget that, even though the public authorities often try to intervene through directed actions, languages are basically dynamic phenomena of social self-organisation and emergence that are interdependent with all of their contexts and not solely with political ones. Ways of speaking and languages are like organisms adapted to their setting and to their function within the whole (that is, to the purposes they must serve within that whole) (Bohm 1987: 37). Thus, if a specific language—or linguistic form—is being left without any communicative function in its society of origin because people are adopting an alternative, either some of its 'own' functions will be preserved, or 'identity-based', symbolic functions will be created to maintain its use, or ultimately it will be abandoned. Similarly, the speakers, if necessary, will autonomously create new forms and/or develop the existing forms according to their needs and the social meanings that they give to them (Bastardas-Boada 2004). Language and interaction are co-phenomena; the former is within the latter and the latter is within the former.

In all likelihood, the conceptual resources and tools that we currently have are not yet entirely suitable to the tasks that must be undertaken. This is why it is necessary to continue developing new theoretical and methodological instruments that are able to help us more adequately imagine and understand the dynamic interweavings of distinct aspects of sociocultural and linguistic events.

The challenge stands before us. From the *socio*-complexical perspective, we ought to strengthen the inter- and transdisciplinary lines of research that, from the biological

to the socio-political levels, cut across the communicative, linguistic phenomenon, which in turn is part—in its way—of each and every one of the interrelated domains of human life. A complexical, eco-co-dependent and processual view of sociocommunicative events—languages are in societies/cultures and in the brains/minds that are in the languages—can help us push towards a significant deepening in our understanding (Roggero 2013; Ruiz Ballesteros 2013; Vilarroya 2002; Steels 2000; Mufwene 2001, 2013).

While every type of language study related to society, and language emergence has captured the attention of the researchers on complex systems, other branches of linguistics have not developed theories with explicative capabilities into this framework. This book is one of the first attempts to extend the paradigm of complexity to some areas of study of natural language that have not followed this theoretical perspective yet.

1.3 Structure of the Book

As stated above, this volume adopts a new theoretical position for the study of natural language as a complex entity. Within this framework, where interdisciplinarity and interaction with other sciences are necessary as methodological options, we approach different disciplines of linguistics and introduce different applications.

The book is divided into four parts. The first one is a theoretical section explaining why the concept of complexity has an important impact in human sciences, cognition and linguistics. After that, three more blocks are introduced, corresponding to three fields of linguistics—language change, sociolinguistics and a broader area including some developments in syntax, semantics and cognition.

The first part, "Interdisciplinary approaches for Human Sciences", consists of four contributions, which are oriented to philosophy of science, interdisciplinary approaches to complexity and historical interpretations of scientific theory.

Robert Hristovsky, Natalia Balagué and Pablo Vázquez develop the idea that sciences are social self-organizing adaptive cognitive systems. They explain the rise of unifying themata in science overcoming the fragmentation of scientific language and illustrate the diversification and unification of scientific language with examples of different disciplines such as cosmology, chemistry, psychology and physics, among others.

Alvaro Malaina presents what he calls the "paradigm of complexity", from the Khun perspective, as a paradigm that incorporates both a worldview and models of scientific realizations. He proposes the integration between "general complexity" and "restricted complexity", studying the implications of this process in sociolinguistics.

Leonardo Rodríguez Zoya proposes a model to approach the principles organizing a thought system. To address the issue, he suggests a qualitative and quantitative study of scientific beliefs, understood as a form of social cognition produced through social practices and discourses.

After theoretical foundations, the book introduces more concrete linguistic applications, starting with a second block especially focused on three models approaching language change.

Àngels Massip-Bonet provides a general theoretical introduction to the topic of linguistic variation and change adopting the perspective of complex adaptive systems. The paper draws the main implications of taking the paradigm of complexity as a methodological framework and highlights the general lines of research that can be developed in the area.

Enrique Bernárdez explains the idea of 'macrochange' in natural language, built in parallel to the concept of 'macroevolution' in evolutionary theory. This perspective of language change implies the consideration of language as a complex natural phenomenon, including not only structures and usage, but the whole 'ecological niche' where it exists and is in use by human beings in specific cultural and historical situations.

Gemma Bel-Enguix studies language emergence and change using the applications and tools provided by agents theory, complex systems and simulations. She presents the results of some experiments that demonstrate how social structures influence language evolution.

The third part of the book brings together three papers introducing several developments in sociolinguistics from the paradigm of complexity.

Albert Bastardas-Boada proposes to take an ecological framework and bring sociocomplexity into the study of language contact. He provides a survey of the restricted and general perspectives of complexity that have been adopted to tackle natural language, and claims for the integration of both views for a more complete picture of the factors that affect language behaviour and evolution.

Léo Léonard and colleagues provide a more specific case study, based on Mazatec dialects, an endangered Otomanguean language spoken in south-east Mexico by about 220,000 speakers.

Closing the works on the area, Roland Terborg and Virna Velázquez tackle the problem of language and common knowledge from an ecological perspective. Individuals develop physical and history together. By doing it, they modify the state of the world. In the same way, language and human interaction modify knowledge of agents in a way that ideologies, values and beliefs can emerge.

After the contributions dealing with the social aspects of language, three more papers deal with the issues related to discourse analysis.

Esperanza Morales López explains how discourse analysis can take advantage of some postulates of complexity, among them the holistic perspective and transdisciplinarity. She highlights the fact that both features can boost the area with new methods and tools.

In a similar range of thinking, García Riverón and Marrero Montero make use of a holistic perspective of research that leads them to find a new phonological interpretation of the prosody, lexical, grammar and speech systems in virtue of intention through speech multidimensional analysis. In this way, they describe the bases of a group of semantically and pragmatically founded attractors defined for the study of

intonation and a new concept of underlying structure formed by emergent features from the morphogenetic processes of the language systems.

The last contribution in the area of discourse is conducted by Sami Alim. The author offers a study of the so-called raciolinguistics in the speech of Barack Obama, giving a number of examples of that kind of performances in ethnoracial contexts.

The final part of this publication consists of several contributions on syntax, semantics and cognition.

Michael Zock presents the problem of lexical access, the tip-of-the-tongue problem and cognition. Obviously, the human brain is a complex object and so is the process of accessing words in the mental lexicon. The goal of the paper is to describe a method that, once implemented, should help people to overcome the ToT problem.

Lluís Barceló-Coblijn, Maia Duguine and Aritz Irurtzun connect the emergence of functional words as hubs in L1 acquisition with the DP theory in transformational grammar, with the help of graph theory.

Dariusz Plewczynski and his coworkers offer a study of culturally-driven emergence of color categories, extending a model by Steels and Belpaeme (2005). They bring the discussion to the process of modeling the emergence of perceptual categories in human subjects.

Closing the volume, Maria Antònia Font develops a review of the concepts of imagination, image schema, neural image and mental image, and discusses their implications in conceptualization about emotions.

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