

Katarzyna ROKOSZEWSKA
Akademia im. Jana Długosza w Częstochowie

FIRST AND SECOND LANGUAGE ACQUISITION FROM THE POINT OF VIEW OF THE COMPLEXITY THEORY

Abstract

The complexity theory, developed in the physical sciences, has been recently implemented in the field of applied linguistics. According to this theory, complex systems are random, non-linear, unpredictable, self-organizing and tend to form regular but never identical patterns. According to Larsen-Freeman (1997, 2008), language may be also construed in terms of complex systems. Language acquisition is a dynamic process characterized by variability. It is complex in that it involves many interacting factors and non-linear as learners do not master one item at a time. Their interlanguage is self-organizing as it undergoes continuous restructuring while their first language functions as the so called strange attractor. This theory brings together dynamic systems theory, emergentism, connectionism and ecological approaches. It offers a new metaphor and new ways of thinking about SLA issues, challenging the established ideas and modifying research methods. The aim of this paper is to present the main principles of the complexity theory in relation to the process of first and second language acquisition.

1. The definition and origins of the Complexity Theory

The Complexity Theory deals with the study of the behaviour of complex systems. The theory has originated from natural sciences, like biology, mathematics and physics but in the last twenty years it has been applied to other disciplines, like business, psychology and applied linguistics. The Complexity Theory may be said to be eclectic in that it is related to other up-to-date theories not only from the field of linguistics and applied linguistics. Firstly, it is related to the Chaos Theory which was popular in the 1990s and is now considered to be a part of the Complexity Theory. The mathematical term *chaos* refers not to complete disorder but to the behaviour that is neither predictable nor random. In other words, it refers to unpredictable behaviour in a non-linear dynamic system. Whereas the Chaos Theory deals with the study of chaotic systems, the Complexity Theory deals with chaotic and non-chaotic systems. Secondly, the Complexity Theory is rooted in the dy-

namic systems theory of human development¹, which rejects the distinction between competence and performance and is based on the assumption that an organism's ongoing activity continuously changes its neural states. Thirdly, it is based on such theories in applied linguistics as emergentism², connectionism³, socio-cultural theory⁴, and the ecological approach which uses the metaphor of complex ecological system to explain language learning⁵. Finally, it is based on a number of state-of-the-art linguistic theories, the most important being the theories which assume that language forms emerge from language use, namely cognitive linguistics⁶, usage-based grammar⁷, emergent grammar⁸ and construction grammar⁹. It is also related to corpus linguistics, conversation analysis and computational linguistics, which provide an insight into average speakers' experience with language, and probabilistic linguistics, which focuses on the variability of linguistic behaviour. In addition, the Complexity Theory refers to systematic-functional linguistics¹⁰, according to which language is a social and functional process which depends on interlocutors, purposes and contexts, and integrationist linguistics, which purports that linguistic signs are not autonomous social or psychological objects but "contextualized products of the integration of various activities by individuals in particular communicative situations".¹¹

2. Key features of complex systems

Complex systems are characterized with a number of features such as heterogeneity, dynamism, non-linearity, openness, adaptation and context-dependency¹². Heterogeneity refers to the fact that the components of complex systems, i.e., elements,

¹ L. Smith, E. Thelen (eds.), *A Dynamic Systems Approach to Development: Applications*. The MIT Press, Cambridge, MA 1993.

² B. MacWhinney, Models of the emergence of language, "Annual Review of Psychology" 1998, vol. 49. Pp. 199–227.

³ M. Gasser, Connectionism and universals of second language acquisition, "Studies in Second Language Acquisition" 1990, vol. 12/2. Pp. 179–99.

⁴ J. Lantolf, Language emergence: Implications for applied linguistics – a sociocultural perspective, "Applied Linguistics" 2006, vol. 27/4. Pp. 717–28.

⁵ C. Kramsch (ed.), *Language Acquisition and Language Socialization*, London Continuum, London 2002.

⁶ R. Langacker, *Foundations of Cognitive Grammar: Vol. 1. Theoretical Prerequisites*, Stanford University Press, Stanford, CA 1987.

⁷ J. Bybee, From usage to grammar: The mind's response to repetition. "Language" 2006, vol. 82/4. Pp. 711–33.

⁸ P. Hopper, Emergent grammar and the a priori grammar postulate, [In] *Linguistics in Context: Connecting Observation and Understanding*, ed. D. Tannen, Ablex Publishing Company, Norwood, NJ 1988. Pp. 155–175.

⁹ A. Goldberg, The emergence of semantics of argument structure constructions, [In] *The Emergence of Language*, ed. B. MacWhinney, Lawrence Erlbaum Associates, Mahwah, NJ 1999. Pp. 219–23.

¹⁰ M. Halliday, *Explorations in the Functions of Language*, Edward Arnold, London 1973.

¹¹ R. Harris, *The Linguistic Wars*, Oxford University Press, New York 1993. P. 311.

¹² D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008. Z. Dörnyei, *The Psychology of Second Language Acquisition*, Oxford University Press, Oxford 2009.

agents and processes, are numerous, different and complex themselves in that they constitute sub-systems of a larger system. Dynamism refers to the fact that the components and the way they interact change all the time at different timescales and levels which are not hierarchical but nested in such a way that one level or scale influences another in any direction, not necessarily top to the bottom. Complex systems are said to be in flux all the time. They are not separate entities with clear boundaries. They exist only through fluxes in the sense that they exist when the fluxes are present and disappear when the fluxes are absent. What is more, complex systems are iterative in that the present state of the system influences the future state. Non-linearity accounts for the change which is unpredictable and not proportional to input because it results from the dynamic interaction between the components. In contrast to the logic of determinism, which presupposes a linear and determined relationship between cause and effect, emergent processes, in line with the logic of freedom, are not fully determined. They offer the possibility of freedom, which means that the system can develop along different trajectories. Studies show that different aspects of language development are non-linear. For instance, vocabulary learning may be visualised as an S-shaped curve which shows that initially the progress is slow then it speeds up and after reaching a certain level it slows down again¹³. Another feature of complex systems is openness, which means that energy and matter enter the system from the outside, the system adapts and maintains dynamic stability or equilibrium. This type of stability is not fixed or static but dynamic as it is constantly in motion. Openness is connected with autopoiesis. The system is autopoietic because it maintains its identity although it is open to the influences from the outside. In other words, it is not subjected to chaotic changes. The next feature of complex systems is adaptation. This accounts for the fact that a change in one area of the system leads to the change in the system as a whole. Agents or elements in a complex system change and adapt in response to feedback. They interact in structured ways and interactions sometimes lead to self-organisation and the emergence of new behaviour. The last characteristic of complex systems is context-dependency. This feature refers to the interconnectedness of the cultural, social, cognitive and physical. Context is not separate from but part of the system and its complexity. Indeed, it is impossible for an open system to be independent of its context because there is a flow of energy or matter between the system and the environment. Complex systems adapt to the context and as a result of this adaptation they may change internally. In contrast to behaviourism, complex systems do not only depend on but also influence the context. In other words, they do not only adapt to their contexts but also initiate change in them.

¹³ P. Meara, Towards a new approach to modelling vocabulary acquisition, [In] *Vocabulary: Description, Acquisition and Pedagogy*, ed. N. Schmitt, M. McCarthy, Cambridge University Press, Cambridge 1997. Pp. 109–121.

3. Key notions in the Complexity Theory

The Complexity Theory introduces numerous new concepts and terms¹⁴. To begin with, change in complex systems may be discrete or continuous, smooth or sudden. Dramatic and sudden changes are called phase shifts or bifurcations. The state of the system before and after the phase shift is different. All possible states of a system may be visualized as a state space. Each point in the landscape represents a possible state of the system, whether it is used or not. The state space is constructed according to such dimensions as height above the sea level, longitude, latitude and time. The movement of the system through the actual states is called a trajectory, whereas the states or behaviours preferred by the system are called attractors. The attractors have the so called basins, i.e., regions in which they exert some force on the system so that it moves around the basin or settles inside it. The attractors may be visualised in different ways. In two-dimensional visualisation, they take the form of dark areas or arrows. The longer the arrow, the stronger the attraction and the faster the movement of the system. Spiralling arrows indicate that the system moves to the attractor basin. In three-dimensional visualization, attractors may be shown as balls rolling over the landscape full of hills and wells with basins. Shallow wells denote weak attractors. The ball goes from one basin to the other, which means that the system leaves the basin of attraction and moves on a trajectory across the landscape to the next attractor. Deep wells denote strong attractors. The ball stays at the bottom, which means the system is in a fixed state and cannot escape. The ball on the top of the hill indicates a very unstable state which is sensitive to small changes. Generally, three types of attractors have been identified. Fixed point attractors denote the system which moves into a preferred state and stays there. Cyclic or closed loop attractors indicate the system which moves periodically between different attractors. Chaotic or strange attractors render the system unpredictable and sensitive to small changes. Such attractors have large basins full of hills and valleys of different shapes and sizes around which the system moves fast in an unpredictable way. The system trajectory is influenced by the so called control parameters. They are said to be the key to understanding change in complex systems. Identifying control parameters informs researchers about the factors that drive the system and make intervention possible.

Other important notions in the Complexity Theory are stability and variation. It is assumed that variability around dynamic stability has the potential for change and development. Stability occurs when the system moves into a strong attractor. It shows how resistant the system is to being pushed out of the attractor by changes from the outside. A stable system is not static. It is like a ball rolling around in

¹⁴ D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008. Z. Dörnyei, *The Psychology of Second Language Acquisition*, Oxford University Press, Oxford 2009.

a bowl which cannot leave it because it does not move fast enough. The strength of the push needed to send the system out of the attractor is one way of measuring the strength of the attractor and the stability of the system. What is more, the system changes with optimum balance of stability and flexibility at the edge of chaos where it is most adaptive and responsive. At the edge of chaos, after sudden phase shifts, the system reaches the so called self-organized criticality or over-determination, i.e., a critical state before collapsing.

Finally, the key notions in the Complexity Theory are self-organization and emergence. These terms are two ways of talking about the source of phase shifts. A system self-organizes into a new pattern of behaviour after a phase shift into a new attractor. This shift is self-organized rather than other-organized because it depends on the dynamic properties of the system as opposed to some external organizing force. Self-organization can occur because the system can adapt in response to changes. Emergence is the appearance of a new state at a level of organization higher than the previous one. The emergent behaviour constitutes a whole that is more than the sum of its parts. Self-organization and emergence are also non-directed processes in that their effects may be negative, neutral or positive. Emergent phenomena are new stabilities of behaviour which are open to further changes because variability of different degrees exists around them. Emergence produces simplicity from complexity¹⁵. Thanks to self-organization and emergence, systems which have simple agents and rules for interactions can produce complicated behaviours. Complex systems often demonstrate this movement from complexity to simplicity and then to further complexity. An even more complex type of emergence occurs when an activity at a higher level constrains an activity at a lower level and vice versa, which is called reciprocal causality.

4. The view of language and its phylogeny

Firstly, according to the Complexity Theory, language is defined as a complex, dynamic, open and adaptive system¹⁶. Two important features of this system are stability and change. It is assumed that every use of language changes it in some way. For example, studies show that any word is pronounced differently on various occasions, and that using words strengthens neural connections and adds new meanings to already known words. Change is continuous but not always noticeable. It takes place in language users, who change over life and generations, as well as in their language resources. The interplay between stability and change is explained in terms of the adiabatic principle, which states that complex systems maintain stability

¹⁵ J. Cohen, I. Stewart, *The Collapse of Chaos*, Viking, London 1994.

¹⁶ D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008.

even though they are dynamic¹⁷. Language is dynamic as it changes all the time but it is also stable as without some stability rapid speech processing would be impossible¹⁸.

Secondly, language is said to consist of “form-meaning-use dynamic patterns of language using” or simply language-using patterns¹⁹. In other words, it is ‘a dynamic set of graded patterns emerging from use’²⁰. These are not discrete abstract symbolic representations on which some logical operations are performed. They do not always correspond to traditional linguistic categories but are accepted as conventional by the community. They include words, idioms, patterns partially or fully filled with lexis, and grammatical constructions. For Goldberg²¹, constructions are defined as any form-meaning patterns whose form or function is not predictable from its component parts. Language-using patterns have a number of characteristics. To begin with, these patterns are dynamic in that they change all the time. Yet, some patterns change faster, some more slowly depending on their frequency, practicality or prestige. The patterns are also probabilistic in use. As Thelen and Bates²² explain, linguistic knowledge is probabilistic because it reflects the statistics of language use in the input and language learning. Next, language-using patterns are conventionalized if they are used frequently but they may change if there exists some variability²³. Furthermore, they are unpredictable, which means that their form or function is not predictable from its component parts²⁴. They are also compositional in that they arise from components predicted with some probability. In addition, they are emergent in that they are adapted by language users in communication²⁵. The emergence of patterns is not random as the causes of change are known but the results cannot be fully predicted. Finally, language-using patterns are

¹⁷ J. Weiner, *The Beak of the Finch: the Story of Evolution in our Time*, Vintage Books, New York 1995.

¹⁸ T. Givon, *Generativity and variation: The notion “rule of grammar” revisited*, [In] *The Emergence of Language*, ed. B. MacWhinney, Lawrence Erlbaum, Mahwah, NJ 1999.

¹⁹ D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008. P. 82.

²⁰ D. Larsen-Freeman, *A Complexity Theory Approach to Second Language Development/ Acquisition*, [In] *Alternative Approaches to Second Language Acquisition*, ed. D. Atkinson, Routledge, Abington 2011. P. 52.

²¹ A. Goldberg, *The emergence of semantics of argument structure constructions*, [In] *The Emergence of Language*, ed. B. MacWhinney, Lawrence Erlbaum Associates, Mahwah, NJ 1999. Pp. 219–23.

²² E. Thelen, E. Bates, *Connectionism and dynamic systems: Are they really different?*, “*Developmental Science*” 2003, vol. 6. Pp. 378–391.

²³ P. Hopper, *Emergent grammar and the a priori grammar postulate*, [In] *Linguistics in Context: Connecting Observation and Understanding*, ed. D. Tannen, Ablex Publishing Company, Norwood, NJ 1988. Pp. 155–175.

²⁴ A. Goldberg, *The emergence of semantics of argument structure constructions*, [In] *The Emergence of Language*, ed. B. MacWhinney, Lawrence Erlbaum Associates, Mahwah, NJ 1999. Pp. 219–23.

²⁵ P. Hopper, *Emergent grammar and the a priori grammar postulate*, [In] *Linguistics in Context: Connecting Observation and Understanding*, ed. D. Tannen, Ablex Publishing Company, Norwood, NJ 1988. Pp. 155–175.

heterochronous, which means that using them on a local timescale may be a part of language change on longer timescales.²⁶

Thirdly, the Complexity Theory offers a relational as opposed to material view of language, replacing the so called container metaphor with a new metaphor, namely the participation metaphor advocated by researchers like van Lier²⁷ or Kramsch²⁸. In line with this metaphor, it is believed that the mind does not contain language but is shaped by language and that knowing the language does not mean possessing it but participating in it.

Finally, the Complexity Theory offers an interesting perspective on the origins of language which contributes to the debate between nativists and emergentists. According to the former, innate language faculty is a kind of language organ developed by many small genetic mutations or one serious mutation²⁹. According to the latter and to the proponents of the Complexity Theory, language is a cultural artifact, i.e., a kind of technology passed from one generation to the next. It is said that language emerged in two ways, namely it formed itself spontaneously when appropriate physiological, psychological and social conditions were created, and it became more complex thanks to self-organization³⁰. What is more, when language emerged, human brain had to adapt. This means that humans did not evolve for language but languages evolved so that they became learnable to humans. As nativists noticed, similarities across languages are not accidental but, contrary to what they said, these similarities are not innate but shaped by human learning mechanisms.³¹ Thus, according to the Complexity Theory, social and cognitive capacities were developed together with language capacity or before language and created the conditions for language to emerge.³² Finally, it is said that language resulted from interaction. According to Kirby³³, grammar emerged from the use of lexical items in interaction which in turn modified grammatical structures to fit brain capacities.

²⁶ J. Lemke, Language development and identity: Multiple timescales in the social ecology of learning, [In] *Language Acquisition and Language Socialization*, ed. C. Kramsch, Continuum, London 2002. Pp. 68–87.

²⁷ L. van Lier, From input to affordances, [In] *Sociocultural Theory and Second Language Learning*, ed. J. Lantolf, Oxford University Press, Oxford 2000. Pp. 245–259.

²⁸ C. Kramsch (ed.), *Language Acquisition and Language Socialization*, London Continuum, London 2002.

²⁹ L. Steels, Emergent adaptive lexicons, [In] *From Animals to Animals 4: Proceedings of the Fourth International Conference on Simulation of Adaptive Behaviour*, ed. P. Maes, M. Mataric, J. Meyer, J. Pollack, S. Willson, The MIT Press, Cambridge, MA 1996. Pp. 562–567.

³⁰ L. Steels, Emergent adaptive lexicons, [In] *From Animals to Animals 4: Proceedings of the Fourth International Conference on Simulation of Adaptive Behaviour*, ed. P. Maes, M. Mataric, J. Meyer, J. Pollack, S. Willson, The MIT Press, Cambridge, MA 1996. Pp. 562–567.

³¹ J.R. Saffran, Statistical language learning: Mechanisms and constraints, “*Current Directions in Psychological Science*” 2003, vol. 12. Pp. 110–114.

³² D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008.

³³ S. Kirby, *Language Evolution Without Natural Selection: From Vocabulary to Syntax in a Population of Learners*, Language Evolution and Computation Research Unit, University of Edinburgh, Edinburgh 1998.

6. First and second language acquisition

6.1. Genetic inheritance

The Complexity Theory offers new ways of thinking about first and second language acquisition. Following emergentism, this theory states that first and second language acquisition depend on general inborn cognitive capacities as opposed to inborn linguistic capacities in the form of Universal Grammar. More precisely, Larsen Freeman and Cameron³⁴ claim that “human genetic inheritance consists of cognitive mechanisms and social drives which interact with the environment to organize the development of complex behaviour.” In terms of L2 acquisition, such a view is congruent with general nativists³⁵ who claim that SLA takes place through general cognitive mechanism without Universal Grammar. At the same time, this view contrasts sharply with what Long³⁶ calls special nativist view according to which SLA takes place with Universal Grammar, and hybrid nativist view³⁷ according to which Universal Grammar operates in the acquisition of the first but not second language.

First and second language acquisition are different processes because language, like any complex system, is characterized with sensitive dependence on initial conditions. More specifically, language is sensitive to its initial conditions but these conditions are updated in that new word classes may appear or grammar may change. As already mentioned, complex systems are iterative in that previous experience shapes the present in significant ways. In applied linguistics, it is assumed that timely L1 acquisition is necessary but not enough for success at learning the second language. What is more, L2 acquisition is different from L1 acquisition because L2 is affected by the initial conditions of L1 which functions as a strong attractor. In mainstream SLA, this phenomenon is referred to as language transfer. From the point of view of connectionism and the Complexity Theory, transfer takes place because learners are neurologically tuned to L1, which influences L2 learning.

In first language acquisition, nativists and emergentists disagree also with reference to language complexity and the poverty of stimulus. According to innatism, language must be inborn because language complexity cannot be induced from the impoverished input. According to emergentism and the Complexity Theory, complexity comes from self-organization and emergence, which means that cognitive

³⁴ D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008. P. 133.

³⁵ W. O’Grady, The radical middle: Nativism without universal grammar, [In] *Handbook of Second Language*, ed. C. Dougherty, M. Long, Blackwell, Malden, MA: 2003. Pp. 52–79

³⁶ M. Long, Stabilization and fossilization in interlanguage development, [In] *Handbook of Second Language Acquisition*, ed. C. Doughty, M. Long, Academic, San Diego, CA 2003. Pp. 487–535.

³⁷ R. Bley-Wroman, What is the logical problem of foreign language learning?, “*Linguistic Analysis*” 1990, vol. 20. Pp. 3–49.

structure and language organize themselves³⁸. Ambient use of language is not so impoverished since positive evidence that children receive is sufficient for patterns to appear in the child's language resources. Language is learnt from input in statistical and probabilistic way. The brain is good at detecting patterns but does not register everything. Instead, it becomes tuned to frequently occurring language-using patterns. In other words, humans register qualities and quantities about language, e.g., the frequency of constructions, and maintain them in language production and comprehension. For instance, the ratio of positive and negative clauses is 9:1. Sensitive to this frequency, humans check if their choices correspond to the norm in speech comprehension and production. To sum up this point, it is said that probabilistic grammars, in contrast to categorical grammars, are learnable only from positive evidence so that there is no need for the innate faculty to operate in the face of impoverished input.

As far as structure formation is concerned, structures are said to arise from frequent language-using patterns in a bottom-up way and not top down from some innate programme. It is hypothesised that structure formation is motivated by two types of discrepancy among detected patterns, namely discrepancy between patterns that children hear and produce and discrepancy between what children want to say and what they are able to say. It is also said that first children learn concrete patterns, then they categorize them and generalize from them on the basis of input statistics. They learn complex constructions on the basis of simpler concrete constructions which are frequent and semantically prototypical. In contrast to children in L1 acquisition, learners have less contact with L2 but they can make generalizations in the same way. Frequency, prototypicality and low variance are said to optimize acquisition.³⁹

6.2. Cognition and linguistic knowledge

The Complexity Theory presents a different view on cognition and linguistic knowledge. Cognition is no longer understood in terms of problem solving on the basis of mental representations. It is said not to represent but enact the world. It is not separated from the body and environment but embodied in action and linked to the history of interactions. As far as linguistic knowledge is concerned, competence is not understood as the mastery of formal grammatical rules without semantics but the mastery of meaningful patterns or constructions which come from interaction and which form a structured inventory.⁴⁰ This is explained in terms of the network metaphor according to which constructions form a network in which their elements are connected by inheritance hierarchies. In other words, constructions

³⁸ R. Port, T. van Gelder, *Mind as Motion: Explorations in the Dynamics of Cognition*, The MIT Press, Cambridge, MA 1995.

³⁹ R. Elio, J.R. Anderson, 'The effects of information order and learning mode on schema abstraction. "Journal of Experimental Psychology: Human Learning and Memory" 1981, vol. 7/6. Pp. 397–417.

⁴⁰ M. Tomasello, *Constructing a Language*, Harvard University Press, Cambridge, MA 2003.

form families in which similar but different constructions are linked to each other to obtain the highest level of organization and separated to grasp their specific properties.⁴¹ Furthermore, it is claimed that language resources only reflect latent potential. Language-using patterns are process representations, i.e., memories of acts of using language patterns which form a dynamic network and become latent language resources for future use. The term *latent* means that the patterns do not exist apart from the context. Language users, based on their experience, require the brain to use its resources in a given way but it may not happen on a given occasion. Hence, competence is defined as memory of using language patterns which changes the probability of what patterns will be used at a given point. In this sense, linguistic knowledge is not given but adaptively achieved by the individual in the environment. As far as representation in mind is concerned, the complexity theory rejects the existence of mental internal representational states in favour of non-representational internal states. In line with the claim that dynamic systems do not represent but enact the world⁴², the Complexity Theory downplays the importance of mental internal representational states such as symbols and rules proposed by innatism and focuses on “distributed dynamic processes that operate on non-representational internal states”.⁴³ As far as language creativity is concerned, the proponents of the Complexity Theory claim that people do possess language creativity but in practice their language use is non-creative and formulaic as they tend to put together earlier registered constructions. Such use of language provides communicative events with certain stability. As Hopper⁴⁴ pointed out, language is not composed of totally new combinations of words but of sequences sedimented from interaction.

Furthermore, the Complexity Theory rejects the distinction between competence and performance focusing on the phenomenon called soft assembly. Larsen Freeman and Cameron⁴⁵ explain that behaviour is always assembled in time. This means that it is impossible to make the difference between competence and performance because mental activity develops from perception and action, takes place in real time, and is connected to an internal and external context. They also point out that development emerges from use. More specifically, development emerges from repeated activity in slightly different conditions. Learning takes place through

⁴¹ A. Goldberg, The emergence of semantics of argument structure constructions, [In] *The Emergence of Language*, ed. B. MacWhinney, Lawrence Erlbaum Associates, Mahwah, NJ 1999. Pp. 219–23.

⁴² F. Varela, E. Thompson, E. Rosch, *The Embodied Mind: Cognitive Science and Human Experience*. The MIT Press, Cambridge, MA 1991.

⁴³ J. Elman, Connectionist models of cognitive development: Where next?, “*Trends in Cognitive Sciences*” 2005, vol. 9. P. 112.

⁴⁴ P. Hopper, Emergent grammar and the a priori grammar postulate, [In] *Linguistics in Context: Connecting Observation and Understanding*, ed. D. Tannen, Ablex Publishing Company, Norwood, NJ 1988. Pp. 155–175.

⁴⁵ D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008.

many attempts that create a repertoire of solutions to the task. Language use is the soft assembly of language resources for particular instances. In first and second language acquisition, people soft-assemble their language resources, i.e., they interact and adapt their resources to each other in a given context. Adapting means appropriating patterns and innovating so that resources are variegated and variable. When people interact, they in fact co-adapt. Co-adaptation or co-evolution, or in other words alignment, is defined as the interaction of two or more complex systems. It is the coupling of one complex system to another so that each system changes in response to the other. Co-adaptation is an iterative process in that one person adjusts to the other over and over again. For example, infants and their caretakers, language users, teachers and learners co-adapt their language in communication. The main role of context is affording for co-adaptation. Tomasello⁴⁶ points out that in first language acquisition context does not trigger an innate language faculty but affords for co-adaptation between an infant and the caretaker and restricts the number of possible interpretations to the child. The result of co-adaptation is that language and language resources change. In other words, people change language by using it. This means that language system and language use are mutually constitutive and that language is constructed by the construction process itself. Language resources constitute a dynamic ensemble, i.e., they are not separate from the physical, cognitive, affective and socio-cultural elements of the system which interact in language users. Larsen Freeman and Cameron⁴⁷ point out that learning does not involve taking in linguistic forms by learners and conforming to some uniformity in terms of native-like version of the target language. According to them, learning is “the constant adaptation and enactment of language-using patterns in the service of meaning-making in response to the affordances that emerge in a dynamic communicative situation”.⁴⁸

6.3. Language development

The proponents of the Complexity Theory prefer the term language development to language acquisition. In line with the participation metaphor, they claim that language develops and changes all the time and as such it is never acquired. This claim is in line with Hopper’s⁴⁹ view according to which grammar is constantly emerging during ongoing discourse. This in turn contrasts sharply with Goldberg’s⁵⁰ view ac-

⁴⁶ M. Tomasello, *Constructing a Language*, Harvard University Press, Cambridge, MA 2003.

⁴⁷ D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008.

⁴⁸ D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008. P. 158.

⁴⁹ P. Hopper, Emergent grammar and the a priori grammar postulate, [In] *Linguistics in Context: Connecting Observation and Understanding*, ed. D. Tannen, Ablex Publishing Company, Norwood, NJ 1988. Pp. 155–175.

⁵⁰ A. Goldberg, The emergence of semantics of argument structure constructions, [In] *The Emergence of Language*, ed. B. MacWhinney, Lawrence Erlbaum Associates, Mahwah, NJ 1999. Pp. 219–23.

according to which grammar emerges till it is acquired and then it becomes conventional and stable. In mainstream SLA, learners' progress is assessed on the basis of the proximity of their interlanguage system to the target language. According to the Complexity Theory, the two systems will never be the same because there is no final fixed state of the target language.

Language development is construed not in terms of system internalization but morphogenesis. It is claimed that children in first language and learners in second language acquisition do not internalize a ready-made system but form patterns triggered by the data. Their capacity to create their own patterns with their own meanings and uses which expand language is called morphogenesis. It is also claimed that learners use heterogeneous language patterns, i.e., patterns different from the ones described by linguists, and that they may develop different language resources even when the ambient language is similar.⁵¹

It is also claimed that language development is not general, discrete and incremental. Larsen-Freeman and Cameron⁵² point out that general developmental stages may be less similar than it is assumed. The stages provide average timing and sequence but there is massive variation. Such variation is even stronger in SLA which is influenced by the first language, cognitive maturity and learners' different orientations. In fact, it is assumed that individual developmental paths, each with all its variation, may be quite different. It is important to emphasize that variability is a key issue in the Complexity Theory. The theory may be said to constitute a different approach to variability than the ones represented by Labov⁵³ or Tarone⁵⁴ because it does not focus on the systematicity of variability but on how it leads to language development. Variability is treated as an inherent feature of language. It stems from the continuous self-organization of the system. But most importantly it is treated as the mechanism of change. The goal is to identify variability around stable behaviour to find out the possibilities for future change. In other words, local variability around stabilized ways of using language contains the potential for future change.

Furthermore, language development is not understood as a progress toward increasing stability but as a series of changes of stability and instability. Instead of discrete stages in which learners performance does not vary, there are periods when certain patterns dominate. The dominance of patterns comes from the fluctuation between competing patterns, followed by a phase shift or bifurcation in the system when a certain threshold is reached and some wider reorganization is started⁵⁵. Bi-

⁵¹ K.P. Mohanan, Emergence of complexity in phonological development, [In] *Phonological Development*, ed. C. Ferguson, L. Menn, C. Stoel-Gammon, York Press, Timonium, MD 1992. Pp. 635–662.

⁵² D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008.

⁵³ W. Labov, *Sociolinguistic Patterns*, Basil Blackwell, Oxford 1972.

⁵⁴ E. Tarone, On the variability of interlanguage systems, "Applied Linguistics" 1983, vol. 4/2. Pp. 143–63.

⁵⁵ B. McLaughlin, Restructuring, "Applied Linguistics" 1990, vol. 11/2. Pp. 113–28.

furcations in language development show that the system may behave in different ways when resources change. It may shift between two different states at the same time, which is called bimodality. Language resources typical for earlier and later stages co-exist, interact and are produced differently in various contexts which explains progression and regression in language development⁵⁶. Thus, language development is not only uneven, non-linear and organic but it also takes place at multiple rates at the same time. In addition, language development is iterative in that each step in the process creates the conditions for the next step. Bidirectionality between the internal and external enables new patterns to emerge⁵⁷. The emergence and variability of new forms in interlanguage depend on learners' processing skills at different stages, which is in line with Pienemann's⁵⁸ Processability Theory.

Finally, language development is influenced by the fact that dynamic systems are interconnected. The systems interact in supportive, competitive and conditional ways, which means that development in one area may depend on or compete with the development in another area. For instance, the U-shaped curve in the acquisition of verbs is explained in mainstream SLA in terms of two different mechanisms, namely rule-learning for regular verbs and rote learning for irregular verbs. In the Complexity Theory, it is explained in terms of one mechanism, namely dynamic competition between regular and irregular verbs⁵⁹. The same dynamic competition is observed between vocabulary burst which takes place between the age of 14–24 months and grammatical burst which takes place at the age of 20–36 months. It is claimed that vocabulary growth decreases because grammatical growth increases and children switch their attention from vocabulary to grammar.

6.4. Language use as a fractal

The last important issue to mention is that the proponents of the Complexity Theory treat language use as a fractal. Fractal is a geometric pattern that is repeated at every scale. Zipf's⁶⁰ law indicates that there are fractals in using words. The law states that the wavelength of the *n*th word is $10n$ where *n* stands for the average number of words occurring between its average occurrences. This means that the first most frequent word has a wave length of 10, the second of 20, the third of 30. In other words, the first most frequent word will appear every ten words no matter how long the text is and so on. The law was observed in English, Latin and other

⁵⁶ J. Lemke, Across the scales of time: Artifacts, activities, and meanings in ecosocial systems, "Mind, Culture and Activity" 2000, vol. 7. Pp. 273–90.

⁵⁷ P. van Geert, Dynamic systems approaches and modelling of developmental processes, [In] Handbook of Developmental Psychology, ed. J. Valsiner, K. Connolly, Sage, London: 2003. Pp. 562–567.

⁵⁸ M. Pienemann, Is language teachable? Psycholinguistic experiments and hypotheses, "Applied Linguistics" 1989, vol. 10(1). Pp. 52–79.

⁵⁹ J. Elman, Connectionist models of cognitive development: Where next?, "Trends in Cognitive Sciences" 2005, vol. 9. Pp. 111–17.

⁶⁰ G.K. Zipf, The Psycho-biology of Language, Houghton Mifflin, Boston, MA 1935.

languages as well as in the historical development of English. Larsen- Freeman and Cameron⁶¹ point out that language use is a fractal if it has properties that apply to all levels. They suggest that if there are fractals in using words, there may be fractals in other language-using patterns because each use of a given pattern influences the probability with which this pattern will be used in the future. What is more, fractal shape of language or organizing smaller units into larger units is said to facilitate learning. Technically speaking, fractals occur at the boundaries of attractor basins when the system is in a critical state at the edge of chaos. Simple processes produce complicated fractals for the system trajectory. Fractals may be expressed through inverse power laws. Such laws express the relation between variables in which each successive state is inversely related to the logarithm of the previous state, e.g., the rate of vocabulary growth is inversely related to proficiency.⁶²

7. Evaluation

The Complexity Theory provides SLA with a new metaphor and new ways of thinking about the issues important to this field. However, a single metaphor is not sufficient for SLA theory. Thus, no matter how novel and important this metaphor is, it should be complemented with other theories and metaphors. The opponents of the Complexity Theory criticize the idea of implementing this theory in the field of SLA and point out the risk of comparison fallacy which accounts for the argument that comparisons between humans and chaotic systems are inappropriate and similarities between social and physical processes are misleading⁶³. The theory is also criticized for the emphasis on determinism as opposed to human agency. Dynamic systems are deterministic as future states depend on the present state of the system. However, the proponents of the theory point out that human agency or deliberate decision making is more limited than we think. Humans, who are systems themselves, are parts of larger systems in which they interact with other agents and elements which in turn influence individual decisions and choices. They also refer to ethics pointing out that self-organization and emergence are neutral processes but people have to take responsibility for their decisions as a decision in one part of the system influences other parts. They also explain that modelling human life in an abstract system is not dehumanizing but distancing. Generally speaking, assessing the Complexity Theory is difficult at this point because it is not known what insight will be provided into SLA by the studies conducted in line with this theory.

⁶¹ D. Larsen-Freeman, L. Cameron, *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008.

⁶² P. Meara, Towards a new approach to modelling vocabulary acquisition, [In] *Vocabulary: Description, Acquisition and Pedagogy*, ed. N. Schmitt, M. McCarthy, Cambridge University Press, Cambridge 1997. Pp. 109–121.

⁶³ Brugge P., *Mythos aus dem Computer*. "Der Spiegel" 1993, vol. 39. Pp. 156–64.

Bibliography:

- Bley-Wroman R., *What is the logical problem of foreign language learning?*, "Linguistic Analysis" 1990, vol. 20. Pp. 3–49.
- Brugge P., *Mythos aus dem Computer*. "Der Spiegel" 1993, vol. 39. Pp. 156–64.
- Bybee J., *From usage to grammar: The mind's response to repetition*. "Language" 2006, vol. 82/4. Pp. 711–33.
- Cohen J., Stewart I., *The Collapse of Chaos*, Viking, London 1994.
- Dörnyei, Z., *The Psychology of Second Language Acquisition*, Oxford University Press, Oxford 2009.
- Elio R., Anderson J.R., *The effects of information order and learning mode on schema abstraction*. "Journal of Experimental Psychology: Human Learning and Memory" 1981, vol. 7/6. Pp. 397–417.
- Elman J., *Connectionist models of cognitive development: Where next?*, "Trends in Cognitive Sciences" 2005, vol. 9. Pp. 111–117.
- Gasser M., *Connectionism and universals of second language acquisition*, "Studies in Second Language Acquisition" 1990, vol. 12/2. Pp. 179–99.
- Givon T., *Generativity and variation: The notion "rule of grammar" revisited*, [In] *The Emergence of Language*, ed. B. MacWhinney, Lawrence Erlbaum, Mahwah, NJ 1999. Pp. 81–114.
- Goldberg A., *The emergence of semantics of argument structure constructions*, [In] *The Emergence of Language*, ed. B. MacWhinney, Lawrence Erlbaum Associates, Mahwah, NJ 1999. Pp. 219–23.
- Halliday M., *Explorations in the Functions of Language*, Edward Arnold, London 1973.
- Harris R., *The Linguistic Wars*, Oxford University Press, New York 1993.
- Hopper P., *Emergent grammar and the a priori grammar postulate*, [In] *Linguistics in Context: Connecting Observation and Understanding*, ed. D. Tannen, Ablex Publishing Company, Norwood, NJ 1988. Pp. 155–175.
- Hopper P., *Emergent grammar*, [In] *The New Psychology of Language*, ed. M. Tomasello, Lawrence Erlbaum Associates, Mahwah, NJ 1998. Pp. 215–243.
- Kirby S., *Language Evolution Without Natural Selection: From Vocabulary to Syntax in a Population of Learners*, Language Evolution and Computation Research Unit, University of Edinburgh, Edinburgh 1998.
- Kramsch, C. (ed.), *Language Acquisition and Language Socialization*, London Continuum, London 2002.
- Labov W., *Sociolinguistic Patterns*, Basil Blackwell, Oxford 1972.
- Langacker R., *Foundations of Cognitive Grammar: Vol. 1. Theoretical Prerequisites*, Stanford University Press, Stanford, CA 1987.
- Lantolf J., *Language emergence: Implications for applied linguistics – a sociocultural perspective*, "Applied Linguistics" 2006, vol. 27/4. Pp. 717–28.
- Larsen-Freeman D., Cameron L., *Complex Systems and Applied Linguistics*, Oxford University Press, Oxford 2008.

- Larsen-Freeman, D. 1997. 'Chaos / complexity science and second language acquisition'. *Applied Linguistics* 18/2: 141–65.
- Larsen-Freeman, D., *A Complexity Theory Approach to Second Language Development/Acquisition*, [In] *Alternative Approaches to Second Language Acquisition*, ed. D. Atkinson, Routledge, Abington 2011. Pp. 48–72.
- Lemke J., *Across the scales of time: Artifacts, activities, and meanings in ecosocial systems*, "Mind, Culture and Activity" 2000, vol. 7. Pp. 273–90.
- Lemke J., *Language development and identity: Multiple timescales in the social ecology of learning*, [In] *Language Acquisition and Language Socialization*, ed. C. Kramsch, Continuum, London 2002. Pp. 68–87.
- Long M., *Stabilization and fossilization in interlanguage development*, [In] *Handbook of Second Language Acquisition*, ed. C. Doughty, M. Long, Academic, San Diego, CA 2003. Pp. 487–535.
- MacWhinney B., *Models of the emergence of language*, "Annual Review of Psychology" 1998, vol. 49. Pp. 199–227.
- McLaughlin B., *Restructuring*, "Applied Linguistics" 1990, vol. 11/2. Pp. 113–28.
- Meara P., *Towards a new approach to modelling vocabulary acquisition*, [In] *Vocabulary: Description, Acquisition and Pedagogy*, ed. N. Schmitt, M. McCarthy, Cambridge University Press, Cambridge 1997. Pp. 109–121.
- Mohanan K.P., *Emergence of complexity in phonological development*, [In] *Phonological Development*, ed. C. Ferguson, L. Menn, C. Stoel-Gammon, York Press, Timonium, MD 1992. Pp. 635–662.
- O'Grady W., *The radical middle: Nativism without universal grammar*, [In] *Handbook of Second Language*, ed. C. Doughty, M. Long, Blackwell, Malden, MA: 2003. Pp. 52–79.
- Pienemann M., *Is language teachable? Psycholinguistic experiments and hypotheses*, "Applied Linguistics" 1989, vol. 10(1). Pp. 52–79.
- Port R., van Gelder T., *Mind as Motion: Explorations in the Dynamics of Cognition*, The MIT Press, Cambridge, MA 1995.
- Saffran J.R., *Statistical language learning: Mechanisms and constraints*, "Current Directions in Psychological Science" 2003, vol. 12. Pp. 110–114.
- Smith L., Thelen E. (eds.), *A Dynamic Systems Approach to Development: Applications*. The MIT Press, Cambridge, MA 1993.
- Steels L., *Emergent adaptive lexicons*, [In] *From Animals to Animals 4: Proceedings of the Fourth International Conference on Simulation of Adaptive Behaviour*, ed. P. Maes, M. Mataric, J. Meyer, J. Pollack, S. Willson, The MIT Press, Cambridge, MA 1996. Pp. 562–567.
- Tarone E., *On the variability of interlanguage systems*, "Applied Linguistics" 1983, vol. 4/2. Pp. 143–63.
- Thelen E., Bates, E., *Connectionism and dynamic systems: Are they really different?*, "Developmental Science" 2003, vol. 6. Pp. 378–391.

-
- Tomasello M., *Constructing a Language*, Harvard University Press, Cambridge, MA 2003.
- van Geert P., *Dynamic systems approaches and modelling of developmental processes*, [In] *Handbook of Developmental Psychology*, ed. J. Valsiner, K. Connolly, Sage, London: 2003. Pp. 562–567.
- van Lier L., *From input to affordances*, [In] *Sociocultural Theory and Second Language Learning*, ed. J. Lantolf, Oxford University Press, Oxford 2000. Pp. 245–259.
- Varela F., Thmopson E, Rosch E., *The Embodied Mind: Cognitive Science and Human Experience*. The MIT Press, Cambridge, MA 1991.
- Weiner J. *The Beak of the Finch: the Story of Evolution in our Time*, Vintage Books, New York 1995.
- Zipf G.K., *The Psycho-biology of Language*, Houghton Mifflin, Boston, MA 1935.