



## **Complexity Theory and SLA**

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### **Abstract**

The second language acquisition (SLA) field has always been closely linked to cognitivism (Atkinson, 2011). From the cognitivist perspective, the process of acquiring an additional language is similar to data being fed into a computer. While this traditional approach to SLA has been widely accepted, recently, two comprehensive collections of essays by theorists promoting newer conceptualizations of SLA have been published (Atkinson, 2011; Kramersch, 2002). Both collections include a chapter written by Larsen-Freeman, a respected author on language issues, in which she proposes complexity theory (CT) as a better way to analyze SLA. Reviewing and expanding on Larsen-Freeman's ideas, the authors explore the relationship between CT and SLA and encourage further research in this area. They suggest that viewing SLA through the lens of complexity theory may prove helpful to researchers and teacher trainers in TESOL because of the new insights it provides into how students learn additional languages.

### **Introduction**

Since the beginnings of the field of second language acquisition (SLA), the discipline has been closely linked to cognitivism (Atkinson, 2011). From this perspective, language acquisition is viewed as similar to data being fed into a computer processor. Although more recently English as a Second Language (ESL) researchers and teacher trainers have certainly included a sociolinguistic slant to their endeavors, more than thirty years into the field's development Kramersch (2002) still found SLA to be "dominated by the LEARNER-AS-COMPUTER metaphor" (p. 2). Over the years, some linguists have raised objections to this traditional understanding of SLA (e. g., Larsen-Freeman, 1997). Recently, theorists suggesting new conceptualizations of SLA, including complexity theory (CT), have published two comprehensive collections of essays (Atkinson, 2011; Kramersch, 2002), breathing new life into this essential aspect of ESL practice. In addition to the chapters on CT that Larsen-Freeman contributed to these collections, in 2014, she also spoke on this issue to attendees at the TESOL International convention in Portland, Oregon, in a keynote entitled, "Complexity Theory: Renewing Our Understanding of Language, Learning and Teaching" (Larsen-Freeman, 2014). Following Larsen-Freeman's lead, the authors of this paper call for more research in the ESL/TESOL field to examine complexity theory and its relationship with SLA. The authors begin by taking a brief look at the reasons for reevaluating the traditional theories of SLA. They then explore complexity theory as a possible reformulation of SLA (Larsen-Freeman, 1997;

2002; 2011). Such a reformulation focuses on the multitude of internal and external factors that affect the process of acquisition of a second or additional language, bringing to the fore the characteristics of language seen as a complex system, with accompanying benefits for teachers and learners.

### **Second Language Acquisition**

A concise definition of SLA is difficult to determine. Krashen (1982) and others have described language *acquisition* by contrasting it with language *learning*. In their view, language learning is the conscious learning of language that takes place in the classroom while language *acquisition* is what takes place subconsciously as language develops in the learner due to being in a context where the language is spoken. Gass, Behney, and Plonsky (2013) similarly make a contrast between *foreign language learning* and *SLA*. Foreign language learning takes place where an additional language is taught in the environment where the native language is the main means of communication. On the other hand, “SLA refers to the process of learning another language after the native language has been learned” (Gass, Behney, & Plonsky, 2013, p. 4). They see SLA as learning a second (or third, or fourth) language in or outside the classroom. However, the difference between acquisition and learning in any context is just one piece of the picture. A definitive definition of SLA needs to be just as complex as the process it is attempting to describe. In Long’s 2007 overview, he notes “as many as 60 theories, models, hypotheses and theoretical frameworks” related to SLA (p. 4). No matter what variety of approaches are suggested, some believe the dominant cognitive model is too structured to be truly able to describe the complexity and unpredictability of language and everything learning one (whether second, third, or fourth) includes. Complexity theory seems to answer the concerns connected with dominant views of SLA.

### **Complexity Theory: Its Roots and Pivotal Concepts**

The purpose of this section is to introduce the pivotal concepts of complexity theory that are used as the basis for discussions in the remainder of the paper. The selection of sources reviewed throughout this article reflects the fact that few researchers apply complexity theory to language, thus the necessity to rely heavily on the work of Larsen-Freeman. Complexity theory is a theoretical attempt to explain the phenomenon of *organized complexity*, that is a complexity of a self-organizing system that results from the interrelatedness of several factors, e.g. an embryonic development, which is affected by genetic and environmental factors producing a self-organized whole. *Organized complexity* can be juxtaposed with *simplicity* as well as *disorganized complexity*. The concept of *simplicity* refers to phenomena affected by few variables and possessing predictable outcomes, e.g. a trajectory of a bullet. *Organized complexity* consists of erratic behavior of an individual system affected by many factors, e.g. weather conditions. *Disorganized complexity* can be tackled by statistical tools (Weaver, 1948, as cited in Larsen-Freeman, 2011). As the above examples illustrate, the concept of complexity emerges from and is most often utilized in natural sciences. However, complex physical phenomena possess characteristics that are also intrinsic to complex social phenomena, thus we argue after Larsen-

Freeman throughout this paper that it can be beneficial to extend the use of complexity theory beyond natural sciences.

Larsen-Freeman points to general systems theory by von Bertalanffy (1950, as cited in Larsen-Freeman, 2011), as a paradigm that facilitated subsequent formulating of complexity theory, as it explained the emergence of complex systems as a result of *inter-relatedness of variables*. New systems appear as a system's parts interact with one another. Another operating principle, postulated by Maturana and Varela (1972, as cited in Larsen-Freeman, 2011), called *dynamism*, refers to the observation that systems become stable while their parts constantly change. Finally, the principle of self-organization, i.e. spontaneous creation of complexity without outside influence or internal plan (Mitchell, 2003, as cited in Larsen-Freeman, 2011), completes the picture of the processes responsible for creation of complex systems.

It is no surprise that the features of systems that emerge as a result of a dynamic interplay among their parts that reaches the level of complex self-organization clearly reflect that process.

Thus, complex systems are described as *dynamic, open, self-organizing, adaptive, autopoietic, and non-linear* (Larsen-Freeman, 2011). It is important to explain them here, as they will be applied to language in the next section of the paper. We use a tree as our example to illustrate the discussed features. Complex systems are *dynamic*, i.e. they constantly change (e.g. a tree constantly grows; even dormant periods are characterized by chemical changes). They are *open*, meaning external factors prompt change (e.g. light and temperature trigger blooming or dormancy). Complex systems are *self-organizing*, i.e. a whole emerges from parts and their sum is not the whole (e.g., a tree is more than just its roots, trunk, and branches). They are *adaptive*, i.e. they constantly adapt to environmental changes (e.g., tree dormancy in winter, root shape based on water availability). Complex systems are *autopoietic*, which means that in spite of the constant change of their parts, the systems maintain their identity (sapling or mature, with or without leaves, it is still the same tree). Finally, complex systems are *non-linear*, that is small changes in initial conditions result in huge changes in outcomes ("the butterfly effect", Lorenz, 1972, as cited in Larsen-Freeman, 2011) (e.g., a small break in the bark may make a tree vulnerable to diseases and ultimately cause its gradual death).

The next section provides examples in support of conceptualizing language as a complex system, thus advancing an argument for applying complexity theory to language learning and teaching.

### **Languages as Complex Systems**

All the characteristics symptomatic of complex systems can also be found in languages.

Through the examples below, we show how it can be easily seen that languages are *dynamic*, as change permeates all language building blocks: phonetics, phonology, morphology, syntax, semantics, and pragmatics. Phonetic changes, that is changes in sound features, occur constantly in every language. Probably one of the most dramatic examples in the history of the English language is the Great Vowel Shift, which occurred during the 1500s, which caused numerous changes in the way vowels were pronounced. Also, a velar fricative /x/, reflected in spelling by *gh*, as in the word *night*, disappeared before Modern English. Change is intrinsic not

only to phonetic features of particular sounds, but also to phonological rules that govern how clusters of sounds are pronounced. The initial /k/ in the word *know*, silent in Modern English was pronounced in Old and Middle English, before the rule that two stops cannot occur in the initial position in a word became part of the English phonological inventory. Change also affected the morphological structure of English words, which is most visible in the loss of case endings in English nouns. While Modern English possesses three grammatical cases reflected in the form of personal pronouns, e.g.: subject: *I*, object: *me*, and possessive: *mine*, Old English boasted four cases, for which nouns would change endings, e.g. *stan* (*stone* as subject), *stones* (*of a stone*, possessive/genitive), *stane* (*to/for the stone*, dative), *stan* (*stone* as a direct object, accusative) (Baugh & Cable, 2002). The loss of endings made the English sentence more rigid as the role of nouns in a sentence became marked by their placement in the sentence (e.g. subject first) rather than their endings. Another dramatic change in syntax was the loss of double negatives, which used to be a standard, required structure before Modern English. Just as the form of a language changes, so do its meaning and use. There is a plethora of examples illustrating the changes in word meanings. One example would be the word *mouse* which gained an additional computer-related meaning a few decades ago. A more recent example would be the use of the word *friend* as a verb in the context of online networking, meaning to add someone to one's list of contacts. Along with semantic changes mentioned above, pragmatic changes, i.e. referring to use, are ubiquitous as well. One example would be the spread of first name terms in social contexts, in which a few decades ago such uses would be deemed inappropriate.

All the examples of the dynamic nature of English, keeping in mind that similar examples can be given for any other language, also illustrate language *openness*, as their emergence was caused by external factors. All the listed phonetic, phonological, and morphological changes were likely the result of inter-dialectal and inter-lingual contacts. The discontinuation of double negatives in standard writing may have resulted from a desire to model grammar on formal logic, which would explain why double negatives are easily understood by native English speakers and used across non-standard dialects. The remaining examples stem from the arrival of new technologies (*mouse*, *to friend*) and cultural changes (use of first names).

Languages are also *self-organizing* as stages of language development, including second language acquisition, clearly illustrate. Research on *interlanguage*, a concept introduced by Selinker (1972), which refers to any stage in the process of second language acquisition, suggests that at any given time during that process the learner's grammar is a system with its own rules, albeit transitional and different from the grammars of native speakers of the target language. At the societal level, language *self-organizing* is evident in the emergence of pidgins, which form as a result of interactions between two groups of people who do not speak the same language. While pidgins are characterized by simplified grammars, they are complete linguistic systems and once they gain their own native speakers by virtue of children being born to pidgin-speaking parents, they become more complex and re-organize as creoles.

Semantic and pragmatic examples illustrating the dynamic nature of language listed earlier can also be used to demonstrate its *adaptivity*, as language changes to meet the needs for new

vocabulary (*mouse*) or to reflect social developments (first-name terms). In spite of often radical changes in structure and vocabulary that languages undergo over time, *they retain their identity*. As different as they may be, Old and Modern English are considered different stages of the same language, which attests to the *autopoietic* nature of languages. Finally, languages are *non-linear*, as their developmental trajectories hardly follow straight lines, simplifying some parts of the system (e.g. loss of nominal case endings in English), while complicating others (the development of numerous English tense structures).

### **Viewing SLA through the Complexity Theory Lens**

Just as languages themselves can be viewed as complex systems, so second language development can be seen as a creation of a complex system (Larsen-Freeman, 2011). To this end, it can be viewed as a bottom-up process, in which patterns emerge rather than get acquired. As interlanguages become stable, their parts continue interacting among themselves through soft assembly that is by being changed by the very interaction. They also co-adapt to other parts and external factors. Pivotal among those factors is “frequency of perceptually salient and semantically transparent linguistic features... Thus, language development is a probabilistic process, with learners extracting probabilities of particular forms occurring in particular contexts with particular frequencies” (Larsen-Freeman, 2011, p. 55). It is worth emphasizing that while frequency of occurrence of a given structure plays an important role in acquiring that structure, noticing its meaning and function is required.

Additional points strengthening the argument of applying complexity theory to second language development come from the variability among learners and non-linear learning patterns within each learner as well as from cross-linguistic influence with its own complexities. While the above arguments are accepted by some researchers, others raise objections to applying complexity theory to second language development. Some of those objections are discussed in the next section.

### **Objections to Complexity Theory and SLA**

Larsen-Freeman (2011) notes several objections raised to connecting complexity theory to SLA. There are those who object to using a theory that stems from the natural sciences to describe language learning. In reality, the use of a theory from one discipline or field is not new. One only has to think of the how Darwin’s theory of evolution has been applied to the way languages develop in families to know this to be true. Larsen-Freeman (2011) points out that this multidisciplinary borrowing is not something new to other areas of linguistics either, explaining that previously linguistics had followed structuralism, a concept shared with economics, sociology, anthropology and other fields.

That complexity theory disregards the intentionality and agency of learners is another objection (Larsen-Freeman, 2011). Larsen-Freeman (2011) counters this argument, saying, “at the same time as individuals are operating in intentional ways in the moment, their personal language resources and those of their speech communities are being transformed beyond their

conscious intentions” (p. 58). In other words, as a complex system, language develops both through the learner’s intentionality and beyond it.

### **Implications for Research**

The application of complexity theory to research in SLA has the potential to stand the research in the field on its head. With it, our conceptualization of the purpose of research has changed. Larsen-Freeman, Schmid, and Lowie (2011) note that the previous emphasis on using computer input and output as the metaphor for language acquisition channeled “researchers’ efforts ... into searching for a universal stage-like progression towards full rule-governed competence” (p. 4). Complexity theory makes this focus obsolete. Instead, it suggests a wide spectrum of new concepts to be studied. As one avenue of research, Cameron (as cited in Harshbarger, 2007) calls for study of the classroom as a whole as a dynamic system, “not as a static background to performance” (p. 23). Similarly, Burns (2011) calls for researchers to “study classrooms in a way that recognizes and accounts for their complexity, rather than one that reduces it” (p. 20). Furthermore, *openness* of language calls for a renewed focus on external factors determining its acquisition. *Self-organization* suggests researching interlanguage as a dynamic play between change and acquiring equilibrium. Finally, *non-linearity* posits a challenge of teasing out the factors that cause seemingly unpredictable steep curves and plateaus in language learning.

### **Implications for ESL Teacher Preparation and Professional Development**

While complexity theory may undoubtedly seem esoteric and removed from classroom reality, we believe that it has concrete implications for language teaching and as such it should be included in ESL teacher preparation and professional development along with other approaches, considered staple knowledge in the field. Here are some instructional implications, which may not seem novel to a seasoned teacher, yet which provide further validation for some time-honored teaching strategies. Meaningful repetitions of target structures, when both their meaning and form are noticed by learners is of paramount importance to language teaching, as they strengthen the connections among particular language items and help create a robust system. *Co-adaptation and soft assembly* discussed earlier suggest that language teaching should occur in rich context allowing for negotiations of meaning, function, and form. If nothing, language is a flexible tool and this flexibility is best taught by showing how the same word or phrase can bear different meanings depending on context or intonation and, conversely, how the same message can be expressed by various language structures. *Agency* calls for making students responsible for their own learning, which can be emphasized by language tasks that need to be performed outside the classroom, e.g. participating in a conversation club, reading books in the target language and the like. Intentionality of learning can be enhanced by using language as a tool for accomplishing non-linguistic tasks. *Openness* of language can help teachers remain aware of the importance of external factors in its acquisition. Teachers may want to encourage students to engage in meaningful target language activities outside the classroom. They may also take notice of the effect the students’ environment has on their language learning. *Self-organization* at any

given level helps assess students' progress and perceive errors as a mark of learning. At the same time, knowing that language learning is non-linear prepares teachers to accept the unpredictability of the outcomes of their labor.

### **Conclusion**

As it is argued throughout this paper, complexity theory, although developed in areas conceptually distant from second language acquisition, provides us with a useful, albeit unusual, lens to view ESL teaching and learning, enriching our understanding of this complex and multi-faceted process. While complexity theory, in spite of its universal characteristics, may not provide ultimate answers about the nature of second language acquisition, it is not so due to this particular theory's inadequacy, but because second language acquisition is best understood when viewed from multiple perspectives.

### **Author note**

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