**Language Development in Personal and Social Systems:**
**Second Language Development from an Autopoietic Systemic Perspective**

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**Abstract**

Over the past two decades, holistic and systemic approaches to second language development have begun to draw the attention of scholars in the field of SLA. These studies are primarily informed by complexity theory, which emerged from the general systems theory. General systems theory, however, has another important theoretical offshoot in social sciences, namely autopoietic systems theory. An investigation of conceptual tools drawn from the latter theory has been absent in the field of second language education.

This paper seeks to explore how systemic thinking has improved the field's understanding of the complexity of the L2 development. It then explores the possibilities for incorporating autopoietic systems theory into complexity thinking to better understand the dynamics of L2 development at personal and social levels. Finally, it will highlight two insights from a systemic analysis of language development in L2 classroom groupings. These insights build on each other to describe L2 development from a systemic perspective. By exploring and bringing together these theoretical perspectives, this paper hopes to shed light on how complexity theory can provide a systemic description of L2 development.

**Keywords:** Complexity theory, Autopoietic systems theory, Communication, Classroom groupings, Interaction systems

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## Introduction

Over the past two decades, scholars in the field of applied linguistics and second language (L2) education have begun using holistic approaches to describe the different aspects of language acquisition (Herdina & Jessner, 2002; Larsen-Freeman, 2007; Larsen-Freeman & Cameron, 2008; de Bot, 2008; Verspoor et al., 2011; Dörnyei & Ushioda, 2013). These approaches are systemic in nature and are mainly informed by complexity theory. Complexity-informed research has been used to investigate diverse dimensions of L2 acquisition in individuals such as the interaction of first and second language (Herdina & Jessner, 2002; van Geert, 2008), motivation (Dörnyei & Ushioda 2013; Dörnyei, et al. 2015), learners' agency (Al-Hoori, 2015), teachers' cognition (Feyrok, 2010), vocabulary development (Meara, 1997), and grammar acquisition (Verspoor & Behrens, 2011).

What these studies have in common is their focus on how individuals develop their knowledge of the L2 in a dynamic interaction with a multitude of factors or subsystems. Only a marginal number of studies in the second language acquisition (SLA) research have used the conceptual framework of complexity thinking to conceive of larger social formations like classroom groupings as complex learning systems (e.g. Larsen-Freeman & Cameron, 2008). Beyond the field of SLA, however, the number of such macro-level studies in the broader field of education is larger (e.g. Vanderstraeten, 2001; Davis and Simmt, 2003, 2006; Davis and Sumara, 2006; Senge et al., 2012). My article will build on these and similar studies that focus on the distinct nature of learning across groups and individuals and explore how systems thinking can shed light on the development of L2 knowledge in classroom groupings on the one hand and in individuals on the other.

## Title

The title of this study begs for a few explanations. As its theoretical lens, this paper uses two systems theories: complexity theory (Holland, 2015; Johnson, 2011; Mitchell, 2009) and autopoietic systems theory (Luhmann, 1995, 2012, 2013). Both allow for conceiving of different phenomena as complex systems that maintain their evolution and their identities in spite of their

constant adaptation to a changing context. Thus far, complexity theory has been the only approach that has been adopted by SLA researchers to view the various aspects of L2 development from a systems perspective. This paper seeks to investigate the potential contribution that the other approach might make in bettering our understanding of L2 development from a systems perspective.

In spite of their common roots and similarities, complexity theory and autopoietic systems theory explain the behavior of a system and its interaction with its context or environment differently. While the first approach has been used in education research to explain, among others, the nature of collective learning compared to that of individual learning, the second approach could be used to view the communicative interactions in the context of classroom as a social system that gives rise to a different level of understanding and learning than that of students and/or teachers. Analyses of these communicative interactions provide an understanding of L2 development from a systems perspective without falling into reductionist traps. These frameworks further allow for viewing larger social formations such as classroom groupings as learning systems, whose emerging learning structure is different from the learning structures of learners or teachers, separately or collectively.

Against the backdrop of the systemic approach this study adopts, the term development is used instead of the term acquisition. This use is informed by an increasing awareness in the field that learning is a dynamic process, and hence the tendency to conceive of it as a dynamic adaptive system (Beckner et al., 2009; de Bot, 2008; de Bot, Lowie, & Verspoor, 2007; Ellis & Larsen-Freeman, 2009). There is no endpoint in L2 learning, hence the preferred use of L2 development over acquisition in the title to reflect the systemic nature of language learning at the macro-perspective. The macro-systemic dimension of language development highlights the holistic approach of this paper: L2 development in the context of classroom interactions that results from the communicative actions among the participants of a classroom is considered a social system and as such is treated distinctly from L2 development at the level of individuals. This paper investigates how a systemic analysis of L2 development might enhance our understanding of language development at the level of individuals and classroom groupings.

**Positioning of the researcher**

Similar to any other researcher, I am not a neutral observer. My philosophical assumptions construct the bias I bring to this analysis.

As for my take on reality, I align myself with an idealist epistemology: relying on Kant's distinction between *noumenon* and *phenomenon*, I believe that reality is accessible not in its pure form, but in its constructed form. Similarly, aligning with a general assertion among postmodernists, I believe that the same phenomenon has multiple realities and each of these realities is contingent upon the observer and the vantage point he uses to observe the phenomenon. So, while there are different realities of the same phenomenon, depending on which perspective is adopted to observe the phenomenon, these realities do not necessarily correspond to one another. Projecting this epistemological view of reality to my own research, I believe that the reality of a social system, like that of a classroom, is different from the reality of an individual who participates in the social system of classroom. Therefore, understanding and explaining the reality of language development at the level of classroom requires a different sort of knowledge.

Before studying in the field of education, I had developed an interest in social systems theory during my doctoral studies at the University of Ottawa's School of Translation. For my dissertation, I used Niklas Luhmann's theory of social systems to investigate the interaction between the social systems of politics and religion in the case of Iran's post-revolutionary modern theocracy. After receiving a German Academic Exchange Services grant (i.e., a DAAD) to conduct research on systemically informed theories of society, I took two introductory courses at the University of Heidelberg (Germany) where I realized how systemic theories can provide a rich conceptual framework for the analysis of a wide range of social phenomena.

After being exposed to complexity theory during my subsequent studies in education, I quickly noticed possible similarities and differences between complexity theory and social systems theory that I felt compelled to examine in further detail. In adopting such systemic thinking to describe how social order is maintained, social systems theorists like Luhmann elaborate certain concepts from general systems theory in greater detail so that the theoretical construct can better address the diverse dimensions of social phenomena (Luhmann, 1995, pp. 4-5). Similarly, adopting systemic thinking to describe language development from a complexity perspective can at least add "another way of understanding phenomena in our applied linguistic problem space" (Larsen-Freeman and Cameron, 2008, p. 13).

## Major shifts in SLA research

In his introduction to "Alternative Approaches to Second Language Acquisition", Atkinson (2011a) writes that "if language is many things, then so is its acquisition" (p. 1). This is now a truism in applied linguistics. Language and language acquisition are highly complex phenomena. The learning of a language, for example, has multiple dimensions such as cognitive and psychological, syntax-semantics-pragmatics, discursive, social, political, and ideological (de Bot, 2008) and scholars have attempted to investigate each of these dimensions to varying degrees. Furthermore, language has constituted not only the subject matter of linguistics over the past few decades, but also that of philosophy, cognitive sciences, psychology, sociology, cultural studies, political sciences, postcolonial studies, and feminism, to name a few. Research in SLA has been aware of these developments (de Bot, 2015, p. 31) and has used some of the new insights to better its understanding of L2 development.

Larsen-Freeman (2007) suggests that three major turns mark the changing paradigms in L2 acquisition: cognitive, social, and complexity. Each of these shifts puts its respective emphasis on certain aspects of L2 development that it deems more fundamental. These shifts might best be understood in a Hegelian dialectic that could account for "a history of applied linguistics", as the title of de Bot's (2015) monograph reads.

The first shift, the 'cognitive turn', coincided with the rise of scientific investigation of SLA. In this turn, language is traditionally conceived of as a cognitive product and hence the development of language has been investigated as a cognitive process (Atkinson, 2011b). Early research orientations were inspired by Chomsky's universal grammar (Selinker, 1972; Dulay & Burt, 1973) and took the view that language learners are computational systems and language learning is a form of information processing that builds upon learners' "built-in" syllabus (Corder, 1967). Concentration of efforts around this research agenda contributed to the differentiation of SLA as an autonomous field of study from the mid 1960s onward.

The scientific vigor of Chomsky's linguistics had a lasting influence on SLA research. The cognitivist approach and its disciplinary offshoots dominated the field up until the mid 1990s. In the latter half of this decade, an antithesis to the cognitive turn emerged in the field that emphasized the social dimensions of language acquisition (Firth & Wagner, 1997). This new 'social turn' is primarily characterized by "its focus on if and how learners develop the ability to use the new language to mediate (i.e. regulate or control) their mental and communicative activity" (Lantolf,

2011, p. 24). In this turn, the L2 is understood as a social medium and it is argued that its acquisition should be considered from a social point of view (ibid; Lantolf, Thorne & Poehner, 2015, p. 207). While social approaches to SLA do not negate the learning of language as a cognitive process, they shift their focus away from the micro-context of mental processes to "macro- and meso-contexts in which language is learned and used" (Duff and Talmy, 2011, p. 95). In the case of sociocultural theory, it is a theory of "human mental activity" (Lantolf, 2011, p. 24) and the process of individuals' "learning and mental development" (Lantolf, Thorne & Poehner, 2015, p. 207) in interaction with their environment.

While the social turn is still dominating the field, the last decade of the 20th century was a time of even more intense interdisciplinary research than ever before (Block 2003). Since then, the field has been drawing on other disciplinary fields to develop theories to describe and explain the multifaceted dimensions of SLA (Block 2003; Atkinson, 2011b; VanPatten & Williams, 2015). Similar to other scholarly fields, theories in SLA account for and explain L2 development, make predictions about the potential modes and conditions of L2 development under certain conditions, and ideally attempt to bring all of the observed phenomena under one umbrella (VanPatten & Williams, 2015, p. 4). In a mutually reinforcing way, these theories have not only enriched the "conceptually limited" foundations of the field (Atkinson 2011b), but they have also broadened the complexity of the field's subject matter. Accordingly, L2 development is investigated not exclusively as a linguistic, psychological or sociocognitive phenomenon, but also as a complex phenomenon with crucial social, cultural, sociocultural, political, economic, and identity components (see Atkinson, 2011a).

The synthesis of the cognitive and social turns –and their theoretical offshoots– is culminated in the third turn, i.e. the 'complexity turn'[i]. SLA is observed in this shift as a dynamic system that constantly changes and moves from one status to another. Complexity theory is a holistic theory – an offshoot of general systems theory that emerged from the 1970s onward to study the behavior of complex systems (Cilliers, 1998). To study complexity is to study a phenomenon as a complex system whose behavior cannot be predicted from that of its constituting

[i] Complexity theory might be seen as an umbrella term suggesting a systemic view of a phenomenon. Scholars in the field of L2 development have used chaos theory (Larsen-Freeman, 1997), emergentism (Ellis and Larsen-Freeman, 2006), dynamic systems theory (de Bot et al., 2007), and complexity theory (Larsen-Freeman and Cameron, 2008) to refer, more or less, to the same theoretical construct. For the sake of coherence, I shall use complexity theory from now on unless in quotes where authors adopt a different name for their use of the theory.

components. The behavior of a system is contingent upon its constituting elements as well as the system of which it is a component. "The combination of 'top-down' and bottom-up' affects is a pervasive feature of a complex system" (Holland, 2014, p. 5) and hence the analysis of such systems escapes linear causations and reductionist approaches. To date, some scholars in SLA have used the conceptual tools of complexity theory to understand the emergence of a wide range of learning patterns in students and to explain change and growth during the learning process (Herdina & Jessner, 2002; Larsen-Freeman & Cameron, 2008; de Bot, 2008; van Geert, 2008; Feryok, 2010; Larsen-Freeman, 2015). Observing SLA, or language development, as a complex system entails a profound shift of perspective from language use as an innate, rule-based, static, and linear system to an emergent, patterns-based, dynamic, and non-linear system (Larsen-Freeman, 2015; Verspoor & Behrens, 2011).

Against the backdrop of the three paradigms mentioned above and drawing on the complexity turn in L2 development research, this paper investigates how systemic theories can help to better our understanding of the L2 development in classroom groupings in systemic terms and the potential gain this understanding has for SLA research. I explore how the learning experience in interactions give rise to the emergence of a new learning that is distinct from that of the individuals or even the sum of them. This observation will be made from a systemic or sociological perspective (Vanderstraeten, 2001). The emphasis on the sociological aspect should differentiate the focus of this study from the much better known sociocultural theory that has been extensively used in L2 development research (van Lier, 2004; Thorne, 2005; Lantolf & Beckett, 2009) and that emphasizes "the influence of sociocultural environment over the adaptive activity of *human mental systems*" (Larsen-Freeman & Cameron, 2008, p. 35, emphasis mine). This paper seeks to study social groupings such as L2 classrooms as social systems that have their own means of developing knowledge. This approach is embedded in a complexity-informed literature that regards groupings as learners. As Davis and Sumara (2006) highlight is several instances, learning systems in complexity terms are not reduced to individuals, but encompass other entities such as species, ecological systems, social and classroom groupings, schools, communities, languages, and cultures. Accordingly, while this paper also looks at how the personal systems of students develop L2 knowledge, its primary focus is to study language development at a rather macro-level without having recourse to the psychological processes of L2 development in individuals at the micro-level.

Given the emphasis of both cognitive and socio-cultural turns on the individual learner, it seems that such a macro-perspective is fairly absent in systemic approaches to L2 development research. What comes closest to such macro-perspective in the field of applied linguistics is the debate around structure and agency, as Block (2015) argues. Even in these studies, the focus has been on agency and less on structure to the extent that "there is often a total absence of anything […] with reference to structure" (Block, 2015, p. 18). With its systems perspective, this paper will seek to avoid the dichotomy of structure and agency and attempt to contribute to the scant literature that takes classroom groupings as learnings systems and attempt to describe the dynamics of learning from a systems perspective.

**What is so unique about complexity theory?**

Perhaps the epistemological openness of complexity theory to a plurality of perspectives is key to its uniqueness. It has encouraged some scholars in the field of SLA to see in complexity theory "a comprehensive theory of second language development" (de Bot et al., 2013, p. 199), one that synthesizes, among others, the cognitive and social turns in SLA research (Larsen-Freeman, 2007, de Bot et al., 2007a). That is why some scholars argue that complexity theory can "nicely describe several puzzling language learning phenomena" (Dörnyei et al, 2015, p. 1) beyond the functional and structural research orientations (Larsen-Freeman, 2007; see also the collection of articles in Atkinson, 2011a). This promising aspect of complexity theory has been called a "paradigm by some, by others a meta-theory, and by still others a theoretical framework" (Larsen-Freeman, 2015, p. 11). While many aspects of language development such as agency, motivation, L1 and L2 interference, grammar acquisition, and student/teacher cognition have been addressed from the viewpoint of complexity theory, many others remain to be discussed in future studies.

Complexity theory in SLA research promotes a non-reductionist approach to the study of language learning. It does not reject these detailed studies of individual dimensions of language learning; but rather, its focus on analyzing the interaction of different elements in the emergence of language acquisition relies on the findings of these detailed studies and gives them a different meaning. Hence, as Larsen-Freeman (2007) asserts, a complexity informed research orientation rejects neither the cognitive nor the social view of language acquisition. Rather, it simply holds that they do not show the whole reality of L2 development. Therefore, linear thinking should exist inside complex or circular thinking and not the other way around.

**Description of the problem**

As it is mentioned above, this paper seeks to describe the dynamics of L2 learning in individuals and that of L2 classroom interaction as complex and/or autopoietic systems. In so doing, it looks at how complexity theory and autopoietic systems theory can improve the way SLA research can provide a more comprehensive picture of L2 development as a system.

Conceptualizing a phenomenon as a (complex) system shows an enormous potential for opening up new avenues of (re)thinking classical questions of different fields (Berghaus, 2011, p. 24). One could consider a system as simple, but considering it as complex aims to get at questions that would otherwise remain inaccessible (Sagner & Gidings, 2012; Holland, 2015). With this in mind, this paper is well located in the spirit of complexity theory in asking "how might complexity thinking contribute to educational research?" from a top-down perspective, or "how might educational research contribute to complexity thinking?" from a bottom-up point of view (Davis & Sumara, 2006, p. 8).

In a sociologically-informed study of L2 development, neither cognitive nor social approaches provide the sufficient conceptual apparatus to move beyond the individual to conceive of communicative interactions in L2 classrooms as learning systems. Systemic views of language development have moved reflections beyond the structural (i.e. Chomskyan) and functional (i.e. Hallidayan) dualism of the SLA research. Here, language development is understood as an emergent phenomenon that is neither a cognitive nor a social process, but both at the same time, and more. Being non-reductionist in nature, scholars informed by complexity thinking argue that cognitive and social turns each tap into certain aspects of a highly complex phenomenon and reduce the complexity of SLA to these aspects (Larsen-Freeman, 2007). L2 development as a complex system emerges out of the interaction of many subfields. As such, it is a constantly emergent phenomenon that is more than and different from the sum of its constituting elements or systems. Larsen-Freeman (2015) contends that because complexity thinking "features systems which are complex, dynamic, emergent, open, self-organizing, and adaptive, it holds great promise for inspiring innovative thinking concerning both first and second language development" (p. 74).

In this paper, I look to think innovatively about one social system in particular: communicative interactions in the context of L2 classroom. These interaction systems are complex systems, and as such, the communicative interaction among participants gives rise to the

emergence of a reality that is neither reducible to the sum of the individuals' realities nor is it reminiscent of the realities of the participants. Classroom interaction systems construct their own reality, which is different from that of the teachers and that of the students, or even both of them altogether. Therefore, in order to account for the social dimension of L2 development in classrooms, it is necessary to go beyond the individuality as well as the agency of learners and/or teachers.

**Research objectives**

With this in mind, this paper adopts the conceptual apparatus of complexity theory and autopoietic systems theory to explain the dynamics of L2 development in classroom groupings as a system. The emphasis on classroom dynamics as a system should clarify my intention to move beyond traditional dichotomies like structure vs. agency (Block, 2015; Mick, 2015) and cause vs. effect (as an implicit assumption in many cognitively and socio-culturally informed studies in L2 development), which have dominated recent debates in L2 education (Larsen-Freeman & Cameron, 2008). It is in this spirit that this paper pursues three objectives:

i. explore the conceptual tools offered by complexity in the context of language development,
ii. articulate several ways in which autopoietic systems theory might be extended to complement complexity theory in this context, and
iii. highlight two insights offered by autopoietic theory's holistic analysis of L2 development in individuals as well as in classroom groupings.

**Method**

To better describe L2 development from a systems perspective, I began by locating manuscripts and articles in complexity and autopoietic systems theory. I first reviewed five conceptual areas – system, organization of systemic structure, vertical or horizontal emergence, system-context (or environment) interaction, and causality – that are either often used or might be used to describe L2 development from a systems perspective. For my review of these concepts in the literature on complexity theory, in addition to general introductory books in general, I relied

on de Bot's (2015, p. 89) list of seminal publications between the year 2005 and 2015 that have played an important role in introducing L2 development as a complex system in the fields of applied linguistics.

To further contextualize the research objectives within the literature, I reviewed some influential literature published over the last 20 years (so 1997 onward) that used a complexity framework to describe language and L2 development in (classroom) groupings as a dynamic system. In order to build on the small number of studies in applied linguistics that analyze this, I extended my review of the literature to include works that were published since 2000 in the field of education that examine collective learning from a complexity perspective (e.g. Davis & Simmt, 2003, 2006, Davis & Sumara, 2006).

For a comparable review of these concepts from the viewpoint of autopoietic systems theory, I used three of Luhmann's publications (1995, 2012, 2013) that clearly spell out the key ideas of his systemic thinking.

Following this review of the literature, I reflected on two areas where I felt an autopoietic perspective could add to complexity-driven research when describing L2 learning at the level of personal and classroom interaction systems. To bring these theoretical reflections closer to concrete learning and teaching experience, I re-analyzed a corpus from a conversation analysis performed by Larsen-Freeman and Cameron (2008, pp. 206-7). In my systems-informed analysis of the corpus, I inserted fictional additions to the corpus data to demonstrate how the trajectory of communication in classroom (and hence the learning experience of students) is contingent upon the programs and expectations of the classroom interaction system. Further to this, I complemented the authors' analysis of this example with further reflections from autopoietic systems theory so as to highlight two potential insights into our understanding of L2 development. Considered collectively, the insights drawn from this reanalysis of the corpus show why and how learning at the collective level is distinct from that of the personal level.

This research paper does not suggest that concepts from complexity theory do not or cannot go far enough in describing holistic aspects of L2 development at personal or classroom levels. Nor does it maintain that autopoietic systems theory can better describe L2 development from a systems perspective. The truth is that the use of complexity theory in applied linguistics and L2 education is still in its infancy, despite its two-decade tradition. Accordingly, many aspects of the complex nature of L2 development remain to be investigated. With this in mind, this paper argues

that there is a space for exchange between the two system theories, resulting in a more comprehensive description of L2 development that aligns with its complexity. It aims to paint a self-referential and self-organizational picture of learning at personal and classroom levels that is closely attuned to the complex realities of L2 development. Ideas on how to improve L2 teaching and learning can benefit from a more detailed picture of L2 development, which complexity- and autopoietic systems theory-informed studies together can provide.

**Preview of insights**

The conceptual tools of autopoietic systems theory might help to describe L2 development at two distinct levels: at the level of personal systems, and at the level of classroom interaction systems. In so doing, it provides a horizontal level of analysis of L2 development that can complement complexity informed description of L2 development that enables a horizontal level of analysis of language development (i.e., one that explains learning or understanding in the classroom interaction system without having to have recourse to the learning system of individuals, and vice versa). This paper discusses three insights that are elaborated against the backdrop of these questions: How does a horizontal description of learning contribute to a systemic understanding of L2 development at personal and social systems? How can classrooms or groupings be conceived of as autonomous social systems? How are (second) language and the structure of L2 classroom described from the autopoietic system perspective compared to that from complexity theory? Each of the three insights are discussed in brief in what follows and in greater detail in the article.

I first attempt to use the theoretical framework of autopoietic systems theory to distinguish between personal and social systems. Two concrete instances of these system types that I investigate in this study are the personal systems of students and the interaction system of L2 classroom. Both of these systems types are closed in their operations; it is only in the personal system of students that events of thought are connected to further events of thought in a self-referential way, and it is only in the interaction system of L2 classroom that cycles of communication are replaced by cycles of communication.

While systems are closed at the operational level, they are open at an energetic or cognitive level. This allows systems to gain access to their environment and to translate the available data or resources in their environment into information and knowledge that can be used within the system to foster the self-production of the system. In my first insight, I use the autopoietic systems

theory to argue that the psychic systems of students will each observe the dynamics of communication in the environment as the source of data. In so doing, they will have recourse to their structures to self-referentially transform this data into learning experience. Since each psychic system has its own structure, the learning experience that is formed in each psychic system against the same L2 classroom environment is not necessarily the same. Therefore, learning is not about the transfer of knowledge or the re-construction of the same content in students' personal systems. In a similar vein, I argue that the L2 interaction system will observe the learning experience of the personal systems of students in the classroom and self-referentially translate these into different themes or trajectories of communication.

To further distinguish between personal systems and the interaction system of L2 classroom, I use autopoietic systems theory to underscore the different nature of understanding across the two system types. As for personal systems, I suggest that the experience of learning or understanding is the ultimate element, of which a personal system consists. As for the L2 interaction system, I suggest that the experience of learning or understanding is only one of the three components of a communication cycle, and it is this cycle of communication that constitutes the ultimate element of the L2 system. I call this experience as communicative understanding that differs from understanding with a personal reference in three ways. As a component of communication, what counts as communicative understanding in a communication cycle is exclusively determined by the upcoming communication cycle. This means that understanding is detached from a personal reference, and gains a social relevance. Therefore, to explain such communicative understanding, one no longer needs to have recourse to individuals' understandings or the sum of these understandings. This is to say that communicative understanding in the context of classroom groupings is not necessarily explained vertically by looking at how different understandings among individuals give rise to a communicative understanding, as complexity theory suggests, but rather horizontally by looking at how one understanding calls for another understanding within the context of classrooms.

As a bridge to the second insight, communicative understanding can help to describe the interaction system of L2 classroom as an operatively closed communicating system. Unlike complexity theory, which explains the emergence of phenomena by looking at a hierarchical structure, i.e. how subsystems interact to give rise to systems at a higher level, autopoietic systems theory explains the emergence of phenomena based on a horizontal structure, how operations of

the same system self-referentially reproduce the same system. Classroom interaction system is, accordingly, argued to be a social system that emerges from the continual connection of communication cycles. This emergence is not explained by the participants (e.g., learners, teachers, etc.), but rather by the conditions that allow for 'connectibility' of communication cycles within the constraints of the classroom interaction system. Due to the limitation in space in the article, the extended conclusion that accompanies this article will focus on a sociological description of classroom groupings as an independent social system.

The second insight relates to a systemic description of language and the dynamics of communication in L2 classroom interaction system. Unlike in complexity theory, language is not considered a system, because it neither generates nor organizes itself. Yet it is required for the operations of personal and communication systems to the extent neither psychic system can produce thoughts nor L2 interaction system can generate further communications without communication. Moreover, unlike in complexity-informed research that attributes language evolution to the bottom-up language use during intentional action of agents (Larsen-Freeman and Cameron, 2008, p. 99), autopoietic systems theory attributes such evolution to the continuous use of language in various communication systems.

I then use this non-systemic view of language to distinguish the dynamics of communication in an L2 classroom from that in a content classroom. to highlight this distinction, the concept of communication and the synthesis of its components is investigated in greater detail: while a communicative understanding in an L2 classroom interaction system generally results from the indication of the form or utterance rather than the information side, communicative understanding in a content classroom interaction system generally results from the indication of the information rather than the form or utterance side. In other words, an L2 classroom differentiates itself from classrooms by its primary tendency towards the self-referentiality of communication. Unlike in the majority of classroom interactions where the informational value of what is said is oftentimes used as the premise of the upcoming communication cycle, it is the formal or linguistic aspect of what is said that is oftentimes used as the premise of the upcoming communication cycle. Accordingly, since different communicative understandings are used as the premise of the following communication cycles, the trajectories of communication in an L2 and content classroom interaction system are different.

**Structure of the paper**

The focus of this paper as well as the primary objectives of the article are introduced in section 1. Section 2 outlines the method and lays out the paper's aim within and without the purview of the current literature. A conceptual comparison between two streams of systemic thinking, i.e. complexity theory and autopoietic systems theory, are sketched out in section 3. While both of these streams evolved from the same roots, mainly general systems theory as outline in the works of Bertalanffy, and hence bear significant similarities, autopoietic systems theory has been primarily developed to describe social phenomena and has been mainly developed and applied in sociology. Section 4 reviews the literature in applied linguistics and education that attempt to describe groupings, teams and classrooms as complex systems with their unique structures for learning and experience. Section 5 looks more closely at how concepts from autopoietic systems theory can be used to describe classroom interaction system as autonomous social systems. The two insights discussed in greater detail in this section should contribute to a systemic description of language, classroom interactions, and learning at the level of personal and classroom interaction systems. The paper concludes with final remarks and a brief discussion on the scope of its contribution for research in applied linguistics and education.

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## 1. Introduction

It is commonly known in the field of applied linguistics that the knowledge or proficiency of a (second or foreign) language has both a cognitive and a social dimension. Linguistic proficiency is the competence that allows an individual to adapt and select from his/her cognitive and linguistic repertoire the understanding or language forms that are pragmatically and socially appropriate for a given context (Cameron, 2001, p. 51). A holistic analysis of this knowledge and its development has found its way into applied linguistics and language education research over the past two decades. Primarily informed by complexity theory (Larsen-Freeman & Cameron, 2008; Ellis & Larsen-Freeman, 2009; Verspoor, de Bot & Lowie, 2011), such a view contrasts with the current research agendas that take language acquisition from cognitive, social, or cultural perspectives. Instead, it foregrounds the highly complex nature of language acquisition; one that emerges from an intricate interaction of not only cognitive, social, and cultural components, but also many other aspects that are oftentimes studied in the literature in isolation and in a reductionist way (Larsen-Freeman, 2007).

The aim of this paper is to explore the potentials of systemic thinking in describing the language learning experience from a holistic viewpoint. In so doing, it draws from complexity-informed research in education to re-think understanding of language, learning experience, and second language development (L2 development) in both individuals and collectives as complex adaptive systems (Larsen-Freeman & Cameron, 2008; Davis & Sumara 2006; McMurtry, 2010). What distinguishes this analysis from the current literature, however, is its exploration of another stream of systemic thinking, namely a general theory of self-producing systems, or as it also commonly known, a "theory of autopoietic systems" (Seidl & Mormann, 2014, p. 127). This brand of systemic thinking was primarily developed in sociology by the German sociologist Niklas Luhmann (1995, 2012, 2013), who himself applied the principles of systemic thinking to various social spheres such as politics, religion, law, and education in different monographs. Similar to other fields of study, scholars in the field of the sociology of education have shown an interest in describing the social dimensions of education by using this theoretical framework (Vanderstraeten, 2001, 2004, Herzog, 2009; Baraldi & Corsi, 2016). This paper continues this application to the

field of L2 development research in order to provide a holistic description of learning and understanding of the second language at personal and classroom levels from an autopoietic and a self-referential systems perspective.

Admittedly, complexity theory and autopoietic systems theory have a great deal in common: they have both been inspired by general systems theory and use a holistic or systemic lens to explore various objects of study (Mitchel, 2009, pp. 297-298). Therefore, the key concepts bear strong similarities. However, as I will show in this article, some conceptual tools are highlighted more in one frame of reference than the other; furthermore, combining these conceptual tools provides a greater explanatory potential for understanding the complexity of language, the learning experience and L2 development.

With this in mind, this article attempts to meet the following objectives:

i. explore the conceptual tools offered by complexity theory in the context of second language development,
ii. highlight five conceptual areas in which autopoietic systems theory might be extended to complement complexity theory to better describe L2 development in the context of L2 development research, and
iii. elaborate two insights offered by autopoietic theory's holistic analysis of L2 development in individuals as well as in classroom groupings.

## 2. Method

To better describe L2 development from a systems perspective, I began by locating manuscripts and articles in complexity and autopoietic systems theory. I first reviewed five conceptual areas – system, organization of systemic structure, vertical or horizontal emergence, system-context (or environment) interaction, and causality – that are either often used or might be used to describe L2 development from a systems perspective. For my review of these concepts in the literature on complexity theory, in addition to general introductory books in general, I relied on de Bot's (2015, p. 89) list of seminal works published between 2005 and 2015 that have played an important role in introducing L2 development as a complex system in the fields of applied linguistics.

To further contextualize the research objectives within the literature, I reviewed the rather recent literature published over the last 20 years (since 1997) that uses a complexity framework to

describe language and L2 development in (classroom) groupings as a dynamic system. In order to build on the small number of studies in applied linguistics that analyze this, I extended my review of the literature to include works published since 2000 in the field of education that examine collective learning from a complexity perspective (e.g. Davis & Simmt, 2003, 2006, Davis & Sumara, 2006).

For a comparable review of these concepts from the viewpoint of autopoietic systems theory, I used three of Luhmann's books (1995, 2012, 2013) that clearly spell out the key ideas of his systemic thinking.

Finally, I reflected on two areas that complexity-driven research can benefit from an autopoietic perspective when describing L2 learning at the level of personal and classroom interaction systems. To bring these theoretical reflections closer to concrete learning and teaching experience, I borrowed a corpus from a conversation analysis in Larsen-Freeman and Cameron (2008, pp. 206-7). In my systems-informed analysis of the corpus, I inserted fictional additions to the corpus data to demonstrate how the trajectory of communication in classroom (and hence the learning experience of students) is contingent upon the programs and expectations of the classroom interaction system. Further to this, I complemented the authors' analysis of this example with further reflections from autopoietic systems theory so as to highlight two potential insights into our understanding of L2 development. Considered collectively, the insights drawn from this reanalysis of the corpus show why and how learning at the collective level is distinct from that of the personal level.

This research paper does not suggest that concepts from complexity theory do not or cannot go far enough in describing holistic aspects of L2 development at personal or classroom levels. Nor does it maintain that autopoietic systems theory can better describe L2 development from a systems perspective. The truth is that the use of complexity theory in applied linguistics and L2 education is still in its infancy, despite its two-decade tradition. Accordingly, many aspects of the complex nature of L2 development remain to be investigated. With this in mind, this paper argues that there is a space of exchange between the two system theories, resulting in a more comprehensive description of L2 development that aligns with its complexity. It aims to paint a self-referential and self-organizational picture of learning at personal and classroom levels that is closely attuned to the complex realities of L2 development. Ideas on how to improve L2 teaching

and learning can benefit from a more detailed picture of L2 development, which complexity- and autopoietic systems theory-informed studies together can provide.

To begin, the next section outlines the points of convergence and divergence across relevant concepts from complexity theory and autopoietic systems theory.

## 3. Conceptual comparisons: points of convergence and divergence

A turning point in the dissemination of systemic thinking, as the systems theorist Ervin Laszlo (1972) notes, was the publication of *General Systems Theory* (1968). In it, the well-known Austrian biologist, Ludwig von Bertalanffy, suggests complementing – if not replacing – the reductionist Newtonian worldview with a holistic and an interdisciplinary perspective (Kneer & Nassehi, 2000, p. 19). The key question in such a holistic perspective is how complex entities as diverse as machines, organisms, firms, or societies maintain their complexity, identity and structure against a constantly changing and hyper-complex context. Insights from different fields of study such as cybernetics, mathematics, biology, theories of chaos, game, complexity, communication, computer sciences or theories of evolution have contributed to this debate (Grizelj, 2012, p. 29).

Two theoretical frameworks that are inspired by general systems theory and adopt a systems perspective to address the complexity of entities are complexity theory (Juarrero, 1999, Mitchel, 2009, Holland, 2015) and autopoietic systems theory (Luhmann, 1995, 2012, 2013). While complexity thinking has captured the attention of scholars over the past couple of decades (e.g., Diane Larsen-Freeman, Kees de Bot, Marjolyn Verspoor, Rod Ellis, Wander Lewis), autopoietic systems theory has still remained a *terra incognita* in the field of applied linguistics and language education.

The common roots of the two theories hint at a fundamental resemblance between them. Entries on systems theory (Vornberg, 2013) and complexity theory (Jones, 2013) in the *Handbook of Educational Theories* (2013) provide a clear portrayal of this similarity. Both the entries on systemic thinking seek to describe the relationship between a system's stability through self-organization and its change through context influence. Accordingly, many concepts show considerable similarities across complexity and autopoietic systems theories. This being said, there are at times differences in nuances and focal points that give the concepts and hence the two theories different explanatory powers. For example, autopoietic systems theory, as Luhmann

(1995, 2012, 2013) elaborates it, is heavily influenced by cybernetics. As a result, concepts such as autopoiesis, operational closure, structural coupling, and observation become key and more omnipresent and fundamental in this theory when compared with complexity theory. The centrality of these concepts turns Luhmann's conception of autopoietic systems into a radical constructivist theory (Luhmann, 2012, p. 12; Moeller, 2012, Ch. 7). As seen in Table 1 and as I describe in the sections that follow, these nuances add a complementary dimension of explanatory power to L2 development at both personal and classroom levels.

### 3.1. System definition

In complexity thinking, a system is defined in terms of elements, internal relationships, and/or inter-relational processes. Elements in a complex system are correlated and coordinated, integrate into an orderly whole, and function as an organic unity (Juarrero, 1999, p. 109). They "learn or adapt in response to interaction with other [elements]" (Holland, 2015, p. 45). Yet, in spite of the changing relationship among elements, the system remains stable and identifiable over time. Therefore, "the components of a system", as Larsen-Freeman and Cameron suggest (2008), "may be processes, rather than elements" (p. 28). In the field of applied linguistics, complexity-informed researchers conceive of language as a complex system *par excellence* (Beckner et al, 2009; Ellis, 2008; Ellis & Larsen-Freeman, 2009; Kretzschmar, 2015). Accordingly, the systemic nature of language "is given by the coordinated organization of the processes that make it up, not the primary material of its components" (Juarrero 1999, p. 125).

In autopoietic systems theory, a system is defined self-referentially. Similar to the Swiss linguist Ferdinand de Saussure who defines language *qua* language, Luhmann (2013) defines a system as "the difference between system and environment" (p. 44). This difference is created through the operations that connect one element in a system type with another element in the same system type. These operations lead to what the Chilean biologists Maturana and Varela label as autopoiesis, i.e. "self-construction" (Mitchell, 2009, p. 298). Depending on what elements systems reproduce, Luhmann divides systems into biological, psychic (psychological or personal), and social systems (see Figure 1). Of these, psychic and social systems rely on language to reproduce thoughts and communications, respectively. Viewing this function of language in relation to the system's operations led Luhmann (2013) to conclude that "*language is not a system*" (p. 204,

| Complexity theory | Autopoietic systems theory |
|---|---|
| system definition | |
| • A system is defined by means of its constituting its elements and their changing relationships: a system is the coordinated organization of the processes that make it up, not the primary material of its components. | • A system is defined self-referentially: a system is the difference between system and environment. |
| key question | |
| • How does a system manage complexity in such a way that systems change without losing their identity? | • How does a system produce the operations that constitute the self-reproduction of the system? |
| system organization | |
| • Hierarchical structure | • Horizontal structure |
| • A system is embedded in its lower level systems (the interaction of elements culminates in emergent behavior in a system), and emergent behavior of a system constraints the (re-)action of its constituting elements | • A system is distinct from its environment (e.g. humans do not communicate, only communications can communicate) |
| primary emphasis: openness or closure? | |
| • Systems at the edge of chaos: systems are open to, interconnected and embedded in their context and self-referentially maintain their identity at the edge of chaos | • Systems are operationally closed and yet cognitively open to their environment |
| causality in system–system relations | |
| • Interlevel or recursive causality | • Structural coupling |
| • Language as a system *par excellence* | • Language as a medium *par excellence* |

Table 1: Complexity theory vs. autopoietic systems theory

emphasis in the original), because it has no mode of operation of its own: "There is no linguistic operations that is not communication or thinking in language" (p. 205)[i].

### 3.2. System organization

The way in which systemic structures are organized is also viewed slightly differently across complexity and autopoietic theories. Complexity theory underscores the "hierarchical structure" (Holland, 2015, pp. 32-34, 37-39) and autopoietic systems theory the horizontal structure of systems.

Complexity theory adopts a *hierarchical* perspective when describing complex phenomena. In an influential paper, *The Architecture of Complexity*, the polymath Herbert A. Simon (in Mitchel, 2009) reiterates the simultaneous bottom-up and top-down organization as key to the understanding of complex systems. He suggests even "what the study of complex systems

[i] For more on this, see insight 3.

needs is 'a theory of hierarchy'" (p. 110). This hierarchical structure, as Holland (2015) suggests, is closely tied to how systemic order emerges from elements' "interactions where the aggregate exhibits properties not attained by summation" (p. 25). The resulting order displays a behavior that is different from the sum of the behavior of their parts (Mitchel, 2009, p. 27). Accordingly, emergence as a property of complex systems allows "thinking about systems without reducing them to any of their constituent parts" (Marais, 2013, p. 47) and hence conceiving of systems in a circular way. In this vein, L2 development researchers such as van Geert (2008) have proposed a dynamic model for language growth and development and Ellis (2008) has called for a comparable model with regard to L2 adult users, proposing a circular model of language development.

In contrast, autopoietic systems theory underscores the *horizontal* aspect of emergence. Luhmann (2012, p. 77) considers the hierarchical emphasis on emergence "more as a component of a narrative than an explanatory concept" (p. 77). Therefore, he shifts his focus to the temporal and horizontal aspect of emergence and looks at how emergence of order in a system coincides with its dissolution. This horizontal view allows for describing a system in its own terms. As Figure 1 shows, biological, psychic and social systems maintain their autopoiesis by ensuring the perpetual replacement of their system-specific elements with other system-specific elements: "systems produce their ultimate elements as events that arise at a point in time only immediately to disintegrate, can have no duration, and occur for a first and last time" (Luhmann, 2012, p. 23). For example, the elements of a psychic system (i.e., thoughts) should be continuously replaced by other thoughts to ensure the autopoiesis of the system. Otherwise, the psychic system dies. Similarly, the elements of a social system (i.e., communications) should follow one another to maintain the autopoiesis of the system. Otherwise, the social system will cease to function. In a similar vein, the interaction system of classroom (see Figure 1), will continue its autopoiesis only when cycles of communication continue. As I will elaborate later in this article, this continuation provides the nourishing ground for personal systems of students to develop their respective learning experience, while its discontinuation or periods of silence is detrimental to their learning experience.

### 3.3 Primary emphasis – openness or closure?

The emphasis on either the hierarchical or the horizontal aspects of emergence has consequences for how a system's interaction with its environment is described. While both

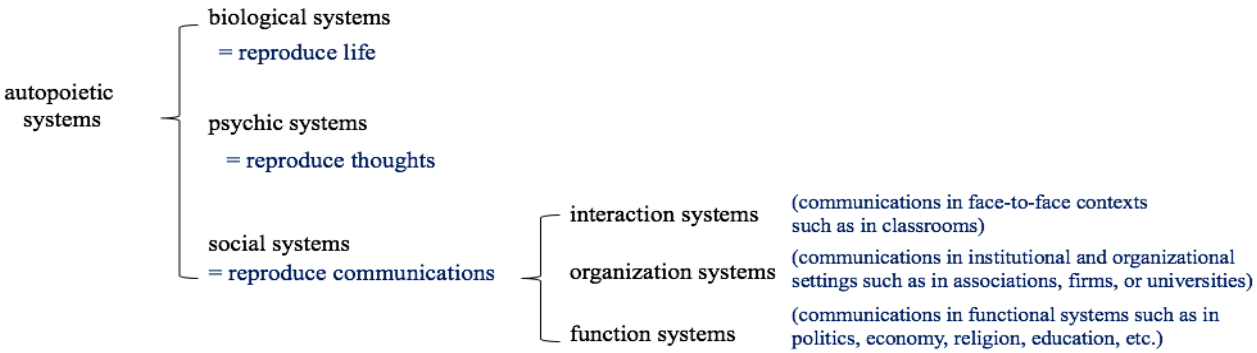


Figure 1: Differentiation of autopoietic systems

theoretical frameworks recognize the simultaneous openness and closure of systems, they put this in a different priority.

In complexity thinking, systemic order is maintained "at the edge of chaos" (Larsen-Freeman & Cameron, 2008, p. 58). In it, the primary emphasis is on a complex system's openness to its context as a source of matter, energy, data or influence (Mercer, 2016). One considers even the "context not separate from the system but part of it and its complexity" (Larsen-Freeman & Cameron, 2008, p. 34). Mercer (2016) goes even farther. While taking the learning self as a complex system, she suggests that context is not an external, objective, independent variable affecting the self or even interacting with the self, but it represents an inherent and an integral part of our sense of self (p. 24). Complex systems are, therefore, "interconnected" (ibid.) with their context or other systems and embedded in them. This openness pushes the system toward variation, change, evolution, development, and even radically formulated, toward chaos. However, complex systems are amazingly robust and maintain their identities even against the backdrop of the most turbulent contexts. This is due to the system's closure, which brings it back toward a self-organizational robustness, stability or equilibrium. A complex system maintains this "in-between" (Miller & Page 2007, p. 6) status due to its competence to change "with optimum balance of stability and flexibility" (Larsen-Freeman & Cameron, 2008, p. 58).

Autopoietic systems theory does not advocate the interconnectedness of a system with its environment. Instead, it suggests a neat separation between the two. Its emphasis on the horizontal view of emergence puts the primary emphasis on a system's closure at the level of its operations (Luhmann, 2013, p. 28): elements of a system as well as the operations that connect these elements are only found within the system and not outside. This is to say that there is no input of information or element from the outside into the system. Such closure leads the system to "draw its own

boundaries by means of its own operations" (Luhmann, 2013, p. 63). This operational closure, moreover, undermines the emphasis on the hierarchical and "interconnected" structure of systems as emphasized by complexity theorists: a social system draws a border with its environment by self-referentially connecting one communication cycle or event to another, and a psychic system does so by self-referentially connecting one thought to another, without each system type interfering in the autopoiesis of one another. Hence, autopoietic systems theory separates the two system types and explains psychic systems *qua* thoughts and social systems *qua* communications. One consequence of this theoretical construct is that communications do not result from human action, but are rather the products of social systems. This brings Luhmann (1994) to a radical conclusion: "Humans cannot communicate; not even their brains can communicate: not even their conscious minds can communicate. Only communication can communicate" (p. 371)[ii]. This particular point of divergence is key to the insights that follow, as it enables a discussion of learning at the level of classroom interaction system without having recourse to learning at the level of personal systems, and vice versa.

Such closure, however, does not negate a system's openness to its environment. On the contrary, operational closure conditions a system's openness to its environment at a cognitive level. Said differently - a system is cognitively open to its environment and learns from it. In Luhmann's words, in a system's "self-referential mode of operation, closure is a form of broadening possible environmental contacts" (Luhmann, 1995, p. 37). With regard to psychic and social systems that process meaning, a system's openness allows it to self-referentially analyze data from its environment and process it by using its own structures. This allows for a level of analysis of classroom learning that is independent of individuals' learning experience.

Cognitive openness and operational closure provide a restrictive framework for the extent of complexity one can observe in a system. Unlike the emphasis complexity-informed thinkers put on the multifaceted complexity of different subjects of study (Larsen-Freeman & Cameron, 2008), Luhmann's theory of autopoietic systems underscores the necessity of complexity reduction when describing an autopoietic system's interaction with its environment (Luhmann 1995). Key for explaining the mechanism of complexity reduction is the concept of observation, which Luhmann

[ii] Often misunderstood, this uncommon formulation "does not deny the existence of human beings, but says that humans are as little in control of social functions as they are of brain functions" (Moeller, 2012, p. 23). Operationally closed systems, however, exchange with their environment. In the case of psychic and social systems, there is an exchange of information between the system and its environment.

(2013), inspired by the English polymath George Spencer Brown, defines as the "handling of a distinction in order to indicate one side and not the other" (2013, p. 102). Observation is an operation that an autopoietic system carries out to reduce the complexity of its environment, learn about it, and construct information about it. "Depending on how [autopoietic] systems observe, they will see different things" (Baraldi et al., 1997, p. 125, my translation). For example, the self-referential nature of autopoietic systems will guide the (participants of a) system to adopt the system-specific distinction criteria when observing. A teacher, a researcher, and a psychotherapist will each adopt a different distinction criterion of the system they belong to (i.e. the systems of education, science, and health, respectively) when observing the dynamics of communication in a classroom. These individuals will, therefore, observe quite different things when observing the very same classroom dynamics.

### 3.4. Causality in system-system relations

The horizontal and vertical structure of emergence has also consequences for how causality is understood in complexity and autopoietic systems theory. Obviously, a system's openness is closely linked to its competence to be influenced by and to influence its context. This mutual influence, however, is non-linear. Juarrero (1999) calls it interlevel causality and Larsen-Freeman and Cameron (2008) call it reciprocal or recursive causality. Here, there are effects across the system from the lower to the higher and from the higher to the lower. While the interaction of elements accounts for the emergence and behavior of a system, the behavior of this system in turn constrains the activities of the lower level elements. Further to this, time adds another level of complexity to such reciprocal causality. A system's starting state at every time accounts for how it will react to the external influence. This is known as "sensitive dependence on initial condition" (Mitchel, 2009, p. 20) and explains how the initial state of a system can translate minor changes into big transformations in the long run. More precisely, there is no proportionate relationship between the size of an initial perturbation and the effects it might have in the short or long run. Hence, while a small cause might produce large results, major perturbations might be absorbed by the system without any major change. Scholars such as Verspoor (2015) and Larsen-Freeman and Cameron (2008) use the concept to explain why the same instruction of second language often leads to various trajectories and learning experiences among the different students in the same class.

In contrast, Luhmann ties causality closely to self-organization, autopoiesis, operational closure and cognitive openness and understands it in terms of "structural coupling" (2013, p. 83-100). Borrowing from Maturana, Luhmann describes with structural coupling the relationship of a system with conditions in its environment that should be given in order for a system to maintain its autopoiesis (Baraldi et al. 1997, p. 186). Structural coupling is a mechanism of complexity management. Through this mechanism, a system manages to reduce the complexity of its environment, which in turn allows the system to increase its internal possibilities. The "reduction of complexity is", as Luhmann (2013) succinctly points out, "the condition of the increase in complexity" (p. 86). For instance, the brain is structurally coupled with the external environment via the media of ear, nose, skinn, and eye. These two organs channel a manageable influx of data to the brain system. Social and psychic systems are likewise structurally coupled in the medium of language. Language allows a psychic system to construct thoughts about its (mainly social) environment and a social system to derive communicable themes from its (mainly psychic) environment. These distinct system types incessantly provide one another with resources, or for that matter, supplies of matter, energy, or data. This mutual influence, however, does not go through the channel of transfer. Resources cannot move from one system into another without change. Hence, a systemic explanation as for why the same instruction is translated into different learning experiences in the psychic system of students centers on the fact that each system has its own structure to transform data into a learning experience. More specifically, Luhmann uses the term *irritation*[iii] to describe the nature of inter-systemtic relations beyond simplistic cause-and-effect or input-output explanations. The psychic system of students is constantly irritated by the communication in the classroom. Yet each of these systems are operationally closed and have their own means of connecting to what is communicated in the classroom[iv].

[iii] This use is particularly pertinent for the purpose of this article, for it wishes to object the metaphor of knowledge transfer in classroom interactions systems. What is communicated in the classroom interaction system in the form of knowledge is nothing but noise to students. The organizational settings of classroom make students attentive to such noises. Whether or not and how each and every individual psychic system in classroom will observe these noises and transform them into thoughts remains the sole discretion of the observing system. Neither the teachers nor the teaching material can interfere with the operations of the students' psychic systems.

[iv] At the level of society, the system of education is structurally coupled with the systems of science and economy and is hence often irritated by communications in either of these systems. When, for example, the economy system registers an increased demand for skilled labor with good foreign language skills, or when the science system publishes research-based evidence on more efficient teaching methods, they do not cause one and only one reaction in the system of education. These economic and scientific communications rather

This comparative analysis shows that the two system theories (i.e., complexity and autopoietic) emphasize concepts differently. This has consequences for how complex phenomena such as L2 development at personal and classroom levels are described from a systems perspective. In what follows, I discuss some of these consequences by arguing that autopoietic systems theory can contribute to a systemic description of learning at the level of psychic and social systems. Before doing so, however, I will use the next section to highlight some contributions in the field of education that use a complexity framework to provide a systemic analysis of classroom or group learning, and contrast this with individual learning.

## 4. Complexity and classroom groupings

Complexity theory has been mainly used in SLA research to shed light on the minds of students, on their learning competence/development, or on their linguistic performance (de Bot, Lowie, & Verspoor, 2007a, p. 18). This is to say that learning has been predominantly studied with reference to the psychic or psychological systems of students. SLA research has not yet sufficiently exploited complexity theory to investigate learning with reference to larger social formations (see Larsen-Freeman & Cameron, 2008, for an exception). Classroom groupings might be seen as an example of such social formations, in which learning emerges, among others, from the interaction of the agents involved in it.

Scholars using complexity theory consider L2 classroom a complex system that consists of various interacting subsystems and agents. Dynamics of communication and interaction in the system is the source of L2 development. In their macro-study of classroom interactions, Larsen-Freeman and Cameron (2008, pp. 197-227) explored how a complexity perspective can offer new ways of thinking about classroom actions (such as communicative and speech action, teacher action, language using, thinking, task action, physical action) and the role of the teacher. They analyzed the classroom as a complex system consisting of several interconnected subsystems across levels of humans (teacher to student or student to student) and social organizations (curriculum, school policies, socio-political contexts of language learning, etc.). The authors

irritate the education system to the extent that education can no longer go as if nothing has happened. Yet it cannot be predicted by certainty whether the system will create new academic fields of study, change the dominant teaching methods (and if yes, how), add a new focus to the existing fields of study, or adopt other measures. This is decided only in the education system.

argued that interactions of multiple systems influence, constrain, and shape the overall action of the classroom, and this in turn affects the actions of classroom elements (i.e. students and teachers). More particularly, they allude to the communicative interactions between the teacher and students to suggest that learning is a complex system whose emergence is contingent upon the way teachers and students adapt their linguistic action to one another. They conclude that such systemic understanding of the language classroom can advance the field's understanding of emerging problems and issues and hence suggest better ways of intervention to improve learning.

In education research, systemic references to (classroom) groupings has a longer tradition. They shed light on how learning at group level is distinct from that at individual levels and how the two affect one another (e.g. Davis & Simmt, 2003, 2006; Davis & Sumara, 2006; Senge et al., 2012). A case in point is a complexity-informed collaborative action research project by McMurtry (2010), in which he explored the emergence of knowledge in inter-professional health teams: he found that the concepts such as learning, consensus and trust do not mean the same thing in individuals and groups. Moreover, he suggested complexity-informed conceptions of collective learning, consensus, and trust can explain well how the group can learn from the issue at hand and propose better solutions to deal with the problem.

Davis and Sumara (2006) echoed McMurtry's finding. When conceived as a system, both individuals and groupings can be argued to learn about their context. This learning, however, is neither the same nor is it developed or processed similarly at the two systemic levels. By quoting from Surowiecki that "paradoxically, the best way for a group to be smart is for each person to act as independently as possible" (Surowiecki, in Davis & Sumara, 2006, p. 85), the authors qualify group learning: collectives take "smart" and "intelligent action" in the sense that they explore a wider range of possible actions and select those that are better-suited to the immediate situation.

Complexity thinkers conceive of learning as a system's self-modification in relation to a constantly evolving environment. Davis and Sumara (2006) subscribe themselves to this concept of learning, and extend this competence to groupings or collectives, and introduce them as complex learning systems. The dynamics of interaction among the members of a reading group the authors investigate exemplifies one such complex system. The system constantly adapts in response to the contributions of readers. In the to and fro of ideas exchange, it further shows emerging possibilities that exceed those of its members. The group is both open to change and structurally determined. They observe that while the system is open, which ensures the influx of required energy or data

from the system's context, it is at the same time structurally determined, which ensures the system's self-organization. This determines the autonomy of the system in adapting to its context, making it unpredictable for two reasons; "First, a complex system learns, that is it is constantly altering its own structure in response to emergent experiences. (…) Second, systems that are virtually identical will respond differently to the same perturbation" (p. 100).

**5. Classroom dynamics as an (autopoietic) interaction system**

Section 3 highlighted some points of convergence and divergence between the two system theories. Section 4 showed the tradition in the field of education that considers classroom groupings or teams as complex adaptive systems. This section attempts to extend the findings of the earlier two sections to better understand L2 learning from a systems perspective and ask: How can autopoietic systems theory add further details to the complexity-theory informed description of L2 development at the level of individuals and/or classroom groupings?

In what follows, I use the conceptual tools of autopoietic systems theory to give an account learning dynamics of L2 in two subsections. In Insight #1 I begin by demonstrating how autopoietic systems theory can be used to describe understanding from a systemic perspective at two distinct levels, namely at the levels of personal (or psychic) and classroom communication (or interaction) systems. In Insight # 2, I discuss how the classroom interaction system constitutes a different level of meaning construction than a psychic system in general, and how L2 interaction classroom differs from other content classroom interaction systems, in particular.

To connect this description to the scarce literature available in the field, I borrow from two extracts (see Figure 2 – taken from Larsen-Freeman and Cameron, 2008, p. 205-207) to discuss the potential for autopoietic systems theory to further develop the systems description of L2 development. These extracts are snapshots from an English lesson with 11-year old students in a village in northern Norway whose teacher sets out a two-step oral task. In extract 7.1, he begins by asking the class to think of two arctic animals they know ('think of any animals you know'), and then asks two students to write their animal on the board. The two students write their animal with the help of the teacher on the blackboard. Then, in extract 7.2, the teacher invites student A to produce an extended description of the 'arctic fox, what kind of animal is it?'. The interaction continues with the teacher adapting his questioning from open ('describe it') to closed ('is it big'

or ‘is it small’) questions when he realizes the student’s difficulties in answering the open questions.

### 5.1. Insight 1 – Understanding in personal and interaction systems

In applying complex systems thinking to the unfolding of the lesson, Larsen-Freeman and Cameron (2008) consider the L2 classroom as a complex dynamic system. This system consists of three subsystems, “teacher + learner + task” (p. 207). These subsystems each evolve as the interaction progresses. They adapt to one another in a non-linear way; not only is “the teacher-learner interaction co-adaptive, with each response constructing a feedback loop between participants” (p. 207), but this interaction also changes the dynamics of the task as the lesson unfolds. “The group talk changes the task as they begin to do it, and the task is constructed through the doing of it” (p. 203). Viewing a task as a dynamic system is more like “an evolving, open dynamic structure offering various affordances to learners” than a static frame that attempts at transferring the same linguistic knowledge from interaction to students.

In applying autopoietic systems theory, the unfolding of the English lesson can also be considered a complex adaptive system, or an interaction system. As Figure 1 shows, this system differs from other social systems in that it strictly relies on the physical presence of teachers and students. While a teacher constantly observes his students, he is also observed by all the students. This mutual observation makes mutual perception in such a context unavoidable; A’s silence followed by T’s invitation to talk (lines 6-7 - ‘could you tell us … describe it?’) is hence observed as an attempt to impart a message (e.g., that A has not understood or that one does not want to participate in the class). Whatever the message, it can be used as an impetus to continue the trajectory of classroom interaction in one way or another. Accordingly, the classroom interaction system consists exclusively of cycles of communication. This means that the system consists neither of teacher nor of learner nor of task; although they are indispensable for cycles of communication to come about, they are neither elements nor subsystems of the system and cannot be used as the criterion to describe the autopoiesis of communication in the classroom dynamics. In fact, teacher, learner, and task are part of the environment of and not the subsystems of the L2 classroom interaction system.

The separation of system from its environment is of relevance for the field of L2 education in explaining distinct processes of understating and learning across psychic and social systems.

| | | Extract 7.1 |
|---|---|---|
| 1 | T | (4.0) there were some |
| | | (1.0) polar |
| | | (3.0) some some animals |
| | | there mentioned |
| 5 | | (2.0) er |
| | | (2.0) could you please |
| | | (2.0) think of |
| | | (3.0) any animals (.) you know |
| | | (2.0) um |
| 10 | | (3.0) A |
| | | and then B |
| | | could you please |
| | | (2.0) go to the blackboard |
| | | and write (.) down |
| 15 | | (2.0) the name of an animal you know |
| 16 | T | while you are on the blackboard |
| | | could you please tell us a little about (.) |
| | | arctic fox |
| | | what kind of animal is it? |

| | | Extract 7.2 |
|---|---|---|
| 1 | T | what kind of animal is it? |
| | A | it's (.) fox |
| | T | it's a fox? |
| | | yes it is (laughs) |
| 5 | | um |
| | | (3.0) could you tell us |
| | | describe it? |
| | | is it big? |
| | | is it small? |
| 10 | | (1.0) how does it (.) look like? |
| | A | little |
| | | and white |
| | | er |
| | | (5.0) |
| 15 | T | is it a big or a small (.) animal? |
| | A | little one |
| | | (1.0) |
| | T | a small one |
| | | yes |
| 20 | | rather small |
| | | compared with |
| | | (1.0) for instance |
| | | polar bears |
| | | yes |
| 25 | T | have you seen an arctic fox? |
| | A | no |
| | | er |
| | | on TV yes |
| | T | not (.) the real one? |
| 30 | | no |
| | | (2.0) do we have |
| | | the arctic (.) foxes |
| | | in (.) Norway? |
| | A | I don't think so |
| 35 | T | no I don't think so too |
| | | I think |
| | | you have to go to |
| | | further |
| | | further north to get them |
| 40 | | (2.0) yes thank you |

Table 2. Classroom communication, derived from Larsen-Freeman and Cameron (2008, pp. 205-207)

At the personal level, understanding is the ultimate element of the psychic system and emerges as a result of the system's observation of its environment. For example, T's psychic system observes A's silence when asked to describe the artic animal fox and distinguishes it from a potential meaning. This distinction is informed self-referentially (i.e., it refers to earlier understandings within the system and at the same time prepares the structure for further understandings). To put it more concretely with the help of hermeneutics (Gadamer, 2004),

perhaps T comes with a pre-understanding of A's linguistic performance or personality and this pre-understanding affects the way he assigns a meaning to A's silence. T could understand the silence in a variety of ways (e.g., that A is shy, reluctant to participate in class, unwilling to share his ideas with the class, unclear about the question, not attentive to class, etc.) and processes this meaning internally. These possible instances of the autopoiesis of the teacher's psychic system remain invisible or non-transparent to either the interaction system or the participants in the classroom. Moreover, these instances constitute the ultimate elements of the psychic system; the perpetual replacement of one instance of understanding or thinking by another one constitutes the autopoiesis of the psychic system. At this level, understanding occurs at the psychic level and as such is not part of the interaction system of the L2 classroom.

As seen in Figure 2, at the level of the L2 interaction system, understanding (u.) is only one component of communication, the other two being utterance (ut.) and information (i.). A cycle of communication emerges from the synthesis of these three components, and the continual replacement of one cycle by another accounts for the autopoiesis of the L2 interaction system in the extract 7.2. To distinguish this instance of understanding from that of the psychic understanding mentioned above, one might call it a "communicative understanding". Although this understanding emerges from a psychic system, its selection is not informed by the psychic system, but by the interaction system, and is used as the premise of the forthcoming cycle of communication. To return to the extract, T communicatively realizes that his initial open-ended question was overwhelming for A and then proceeds with more closed-ended questions (e.g., "is it a fox?", "is it big?", "is it small?", etc.) in lines 3-10. The selection of this communicative understanding is informed by the dynamics of the classroom interaction system; the system is built upon the expectation that L2 classroom communications "provide frameworks for individual language-using activity, and that this will facilitate language learning through use" (Cameron & Larsen-Freeman, 2008, p. 212). This expectation creates a structure in the classroom interaction system that prompts T to connect A's silence to the complexity of the question and not to his lack of attention. That's why T decides to reduce the complexity of the question by breaking it down to closed questions.

As Figure 2 shows, the communicative understanding plays in part in the autopoiesis of the classroom interaction system in two ways. The first way concerns the completion of a communication cycle. For example, T distinguishes the short replies of A at a lexical level in lines

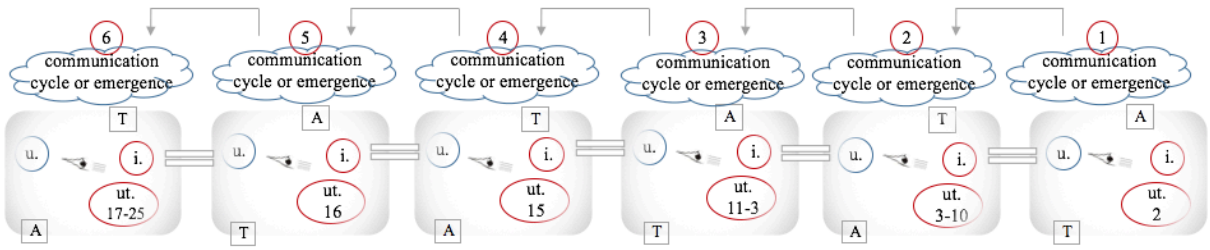


Figure 2: Autopoiesis of communication in the interaction system of the English classroom

11-13 (i.e. little … and white … er …), which is followed by a silence of five seconds in line 14, from the information value of the replies. With this understanding, a cycle of communication concludes. If this understanding remains at this level, the system reference of understanding is T's psychic system. But the interaction system also consists of cycles of communication. Hence, the second way relates to the connectibility of one communication cycle to another (seen in the communication cycle of 3 to 4. Accordingly, understanding at the L2 interaction system departs such a psychic reference and becomes communicative when it becomes the premise of a (linguistic) action. T contributes to the fourth communication cycle by using the communicative understanding into a piece of information that seeks communication by selecting an utterance. And the same process continues as the interaction system proceeds.

This analysis shows the potential for understanding to be seen as being formed at a communicative level. This understanding has three key characteristics. First, a communicative understanding is not necessarily guided by the sender's intended meaning. It is rather determined by the receiver's understanding, irrespective of whether the sender in fact had any intention to impart a piece of information. Baecker (in Seidl, 2006) calls this the "principle of hermeneutics", according to which it is "not the speaker, but the listener [who] decides on the meaning of a message, since it is the latter whose understanding of the set of possibilities constrains the possible meaning of the message, no matter what the speaker may have had in mind" (p. 29). Pushing this hermeneutic principle even further, Luhmann's theory of social systems holds that the observation of sender's behavior occurs irrespective of whether or not the sender intended to impart a piece of information and irrespective of whether the receiver's understanding coincides with the sender's intended information. To return to our example, A's short reply might be due to his unease to communicate in the presence of the researcher with her recording instruments in the class. This might not have anything to do with the difficulty of the task, as the same student might have performed well in comparable situations. Yet the teacher observes this and possibly (mis-)

understands it as A's being overwhelmed by task and uses this as the premise of a new communicative action and reduces the complexity of the task. From a social perspective, there is hardly any difference between an understanding and a misunderstanding of A's linguistic behavior. What matters is the communicative success; that a (mis-)understanding is used as the premise of a new cycle of communication.

Second, as each cycle of communication in Figure 2 shows, a social systems analysis of this excerpt shows how a communicative understanding concludes the emergence of a communication cycle. This may seem counter-intuitive, in the sense that a communication cycle is seen to not begin with the sender who (intentionally or non-intentionally) imparts a piece of information, but with the receiver who understands by attributing an information value to a phenomenon. In the excerpt, T observes A's short response and assigns a particular meaning to this linguistic behavior and hence brings a cycle of communication to conclusion. The nature of this understanding is not clear for the system unless it is turned into a new piece of information that is then further communicated in the system. As Schneider (2009a, p. 279) summarizes, a communicative understanding becomes clear in what follows next. Thinking back to the example, the fact that T simplifies the task by breaking down the open question to closed questions in lines 6-10 of the extract 7.2 indicates how he communicatively (mis)understood A's short response as a meaningful social action.

Third, the teacher's communicative understanding does not necessarily reveal his thoughts, reflections and understandings (i.e., his psychic understanding). As this analysis shows, communicative understanding is a selection the teacher makes from the repertoire of the existing understanding possibilities. This selection is mainly restrained by a more general, restrictive framework – like (for example) the functional system in which the teacher acts. As Herzog (2009) suggests, the sociological perspective suggests that the interaction system of the classroom serves to cultivate the knowledge that students will need to efficiently integrate into different spheres of society. Therefore, the teacher is more prone to adopt only those understandings that better reflect the social function of education, within which the interaction system of the classroom takes place. More specifically, however, the teacher's selection of communicative understanding is determined by the earlier cycles of communication as well as by the anticipated cycles of communication. This twofold bind obliges the teacher to select only certain thoughts or understandings for imparting and to exclude everything else - "each individual [communication] event gains meaning

(=understandability) only because it refers to others and restricts what they can mean" (Luhmann, 2012, p. 37). Therefore, the teacher cannot arbitrarily choose any understanding as the premise of his upcoming linguistic action. For example, he cannot cancel the class based on his understanding that students are unwilling to cooperate or expel the student due to his lack of concentration in the class. Only the communication process itself can determine through the connecting communication events which understanding the teacher adopts as an appropriate communicative understanding and how he uses this understanding as the premise of a new linguistic action in the context of classroom interaction system.

These three characteristics of communicative understanding, which distinguish it from personal understanding, have consequences for how dominant teaching methods have been conceptualized over the past decades. One such consequence is a non-anthropocentric view of managing classroom dynamics; one that puts the primary emphasis neither on the learner nor on the teacher but on the dynamics of communication and interaction in the class. Similar to Larsen-Freeman (2015, p. 83), who adopts a complexity perspective to call for a learning-centered approach to replace either a curriculum-centered or learner-centered approach in L2 education, an autopoietic systems theory approach to teaching would subscribe to a communication-centered approach.

If the concept of operational closure is adopted, then it is understood that neither teachers nor teaching cause learning in students. Each learner has his/her own path for learning, and this path is neither accessible to other psychic systems nor to the L2 classroom interaction system. This path is oftentimes influenced by the dynamics of classroom. From an autopoietic systems perspective, the learning experience of students is, among others, incessantly irritated or triggered by the cycles of communication in the L2 classroom interaction system. Luhmann (1995) calls the content value of these communication cycles "noise" and Mauthe and Web (2013) call this "data", because it lacks any information or knowledge value. As Figure 3 shows, each personal system will observe this noise or data in its environment and process it in a self-referential way, meaning that each personal system will exclusively have recourse to earlier learning experiences, to generate new knowledge or learning experience and at the same time to create a structure for future learning experiences. It is only inside the personal system of students that cycles of communication are transformed in learning or understanding experiences. This being said, different trajectories of L2 classroom communication will trigger different learning experiences in students; hence the

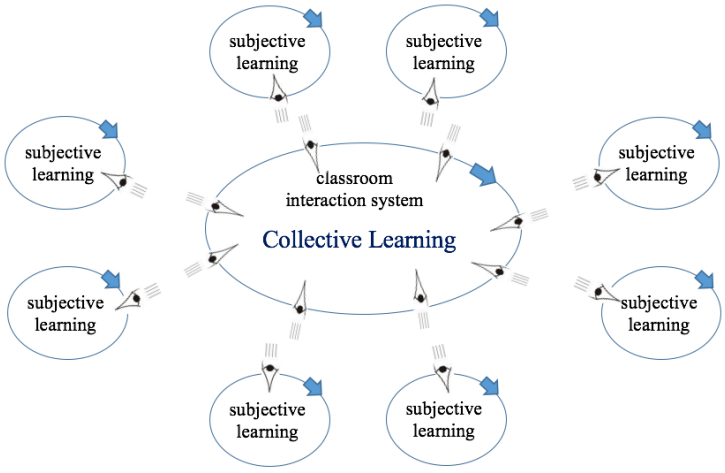


Figure 3: Operational closure in systemic learning

relevance of curriculum and the teacher. The curriculum might provide the framework that constrains the trajectory of communication in a way that maximizes the learning affordance of students, and the teacher might manage the learning experience of students that is constant with their learning processes.

### 5.2. Insight 2 – Dynamics of communication in L2 classroom interaction system

Complexity-inspired scholars tend to view language as a complex, adaptive, dynamic system (Beckner et al., 2011, p. 230). Larsen-Freeman and Cameron (2008, p. 80) subscribe to this view and explain the evolution and change in language in the in-between space of a bi-directional movement; upwards in the sense that language patterns emerge from a co-adaptive and an interactive use of language, and downward in the sense that language patterns themselves constrain emerging patterns. It is in this vein that both authors advocate a dynamic view of L2 learning, consisting of "the constant adaption and enactment of language-using patterns in the service of meaning-making in response to the affordances that emerge in a dynamic communicative situation" (2008, p. 158).

In describing the cognitive and social function of language, scholars with a complexity-perspective focus on "action: communicative and speech action, teaching action, language-using, thinking, task action, physical action" (Larsen-Freeman & Cameron, 2008, p. 197). As Dörnyei (2011, p. 230) suggests, this systemic view is conceived within an action- and agent-based framework that highlights variations in individual language use patterns against the backdrop of

characteristics and contextual circumstances of the learner. An action theory is a humanist approach for the emphasis it places on the telos of communicative actions: it is the intentional actions of individuals that serve as a premise for further intentional actions. In his theory of social systems, however, Luhmann (1995) replaces the emphasis on action with communication and suggests a radically "antihumanist" (Moeller, 2012, p. 5) definition of communication: to communicate means to understand a phenomenon as the difference between information and utterance with no telos or purpose but to ensure the connectibility of one cycle of communication to another. The sole telos of communication is to use the communicative understanding as the premise of another cycle of communication (as was shown in Figure 2). For example, A's five-seconds long silence in line 5 of extract 7.2. might refer to anything but his inability to provide a lengthy reply to T's open question. Communicative understanding, as discussed in the first insight, is formed self-referentially, i.e. with or without correspondence to A's intention, and is then used as the premise of another cycle of communication. This explains why neither participants nor intentional actions in the L2 classroom system but the cycles of communication that constitute the ultimate elements of the system. In the environment of the L2 interaction system, the teacher and the students can irritate the dynamics of communication with their contributions as communication themes and bring it to different trajectories.

The varying emphases complexity-informed research on L2 development and autopoietic systems theory put on action and communication account for their different views of language as a system or non-system. In his understanding of language, Luhmann subscribes to the linguistic turn in philosophy and linguistics that takes language as the very condition and frame for thinking and communicative action (e.g. Gadamer, 2004). With the evolution of society, language has become indispensable for psychic and social systems: for the former, it serves as the attractor of attention that guarantees the continuous accompaniment of consciousness and understanding, and for the latter, it allows the formation of communicative thinking as well as the extension of communication across different times and contexts. Moreover, because it is common in both psychic and social systems, it serves as "a mechanism of structural coupling between heterogeneous and completely different systems [i.e. between psychic and social systems]" (2013, p. 206). This leads Luhmann to conclude that "language is not a system" (ibid., p. 204) – it neither generates itself nor organizes itself. As such, "there is no linguistic operation that is not communication or thinking in language" (Luhmann, 2013, p. 205). Rather, language is a medium

that remains invisible and is used to give form or shape to the elements of psychic and social systems (i.e., thoughts and communications). Unlike in complexity-informed research that attributes language evolution to the bottom-up language use during intentional action of agents (Larsen-Freeman and Cameron, 2008, p. 99), autopoietic systems theory attributes such evolution to the continuous use of language in various communication systems.

This non-systemic view of language can complement the scant literature in applied linguistics that describes the dynamics of communication in L2 classrooms from a systems perspective. In a recent contribution, Larsen-Freeman (2015, p. 228) uses a complexity framework to allude to the self-referential nature of learning but leaves its elaboration to a future publication. Autopoietic systems theory could contribute to this debate with regard to both personal and communication systems. As I briefly outlined in the first insight, the concept of operational closure can be used to reiterate the self-referential aspect of autopoiesis in personal systems, according to which learning is argued to be the exclusive product of the system that is formed on the basis of a system's structure and not a reproduction of what is in the environment of the system. That's why students in the same class will understand or learn the same teaching content differently. In a similar vein, the emphasis on the self-referential aspect of communication can help to distinguish one L2 classroom interaction system from other content classroom interaction systems.

As each cycle of communication in Figure 2 shows, to understand means to distinguish an utterance (i.e., a form) from its information value (i.e., from its content) and to indicate one side. A system can either indicate the form or the content, and use it as the premise of another communication. The dynamics of communication in an L2 classroom interaction system is primarily informed by self-reference, or "the reference to the utterance", while those of a content classroom interaction system are primarily informed by hetero-reference, or "the reference to the information" (Luhmann, 203, p. 57). This self-referential aspect of communication is vividly visible in several spots in extract 7.2: In line 2, A introduces his animal by saying "it's (.) fox" and T uses the form as the premise of the upcoming communication, correcting A's sentence as "it's a fox?". The same self-referential aspect occurs in line 11, where A uses the adjective "little" to describe the fox, and T self-referentially indicates the form, (i.e. the adjective "little") by formulating a closed question with the grammatically correct adjective in line 15 (is it a big or a small (.) animal?). One can see an expectation in the interaction system that provides a nourishing environment for the learners to self-referentially learn the right form, here the adjective "small"

compared to "little" to describe the fox. A, however, keeps using the same adjective in line 16 (i.e. little one) followed by a silence. T, one more time, self-referentially indicates the form and explicitly corrects it in line 18 as "a small one".

A content classroom interaction system, in contrast, tends to base understanding on indicating the information side and use this side of the distinction as the premise of the upcoming communication cycle. In such systems, the system will have recourse to the form (i.e., the utterance), only when the system cannot attribute the expected meaning to the linguistic form that is in line with the expectations or the structures of the system. For example, Larsen-Freeman and Cameron (2008, pp. 210-212) reported on a different trajectory of communication compared to that in extract 7.2. when Student D chooses to talk about his pet, a tropical bird, instead of a polar animal. Knowledge of the content allows D to produce a lengthier contribution and to stretch his linguistic resources to describe his pet in a way that is compatible with the expectation that T's open question raises. Since the primary mode of autopoiesis in L2 classroom is self-referential, it does not put the expectation on T to interrupt D's contribution; the aim of an L2 class is to connect to the form and not to the content. Had this class been a content and not an L2 interaction system, the interaction system would take a different trajectory.

## 6. Conclusion

This paper began with a key assumption in complexity thinking, that conceiving of L2 learning as a complex system allows for explaining and understanding its development in interaction with a wide range of interacting variables. Although complexity has gained a solid ground in SLA research over the past two decades, the wealth of its conceptual tools calls for a wider range of L2 research to understand and describe the conditions of L2 development. As such, complexity-informed research in SLA is still in its infancy. It is against this backdrop that this paper used autopoietic systems theory not to suggest that complexity theory does not go far enough to describe systemic aspects of L2 development, but rather to suggest the value it can add to a complexity-informed understanding of L2 development from a systems perspective.

This paper argued that the two theories, in spite of their common roots and similarity in many notions, emphasize concepts differently when describing how systems interact with one another or with their environment. As Table 1 summarized, complexity theory has a hierarchical structure; it underscores a system's openness to its environment as a source of information and

closes itself from its context at the edge of chaos to maintain its identity. Accordingly, the behavior of a system emerges vertically as a result of the interaction of its constituting subsystems. In contrast, autopoietic systems theory was argued to have a horizontal organization; it underlines the strict separation of a system from its environment that results from the emphasis it puts on the closure of a system from its environment at the level of its operations. Accordingly, the system's behavior emerges horizontally as a result of the system's autopoiesis or self-production.

This comparative analysis was used as the premise to describe two insights; first, how autopoietic systems theory can complement complexity-informed research in describing systemic aspects of L2 development at the level of personal systems and at that of the L2 interaction system; and secondly, how autopoietic systems theory can contribute to the definition of language as a non-system and how such a definition of language allows for characterizing the dynamics of L2 communication as primarily self-referential.

Lastly, this paper is a first attempt to apply autopoietic systems theory to L2 development in the field of applied linguistics and L2 education. In spite of their fundamental similarities, I believe that autopoietic systems theory and complexity theory do differ in their description of L2 development (as shown above). This difference is beneficial to future SLA research, for each theory can provide valuable insight using a slightly different picture of the complex phenomenon of L2 development. Systemic descriptions of L2 development might be particularly relevant for the field of education, for suggestions as to how to improve the learning and teaching experience depends on how well we can describe the dynamics of communication in classrooms. As extract 7.2. showed, an interaction trajectory that begins with an open question and is then reduced to more closed questions does not necessarily involve the desired active participation of language learners. As Larsen-Freeman and Cameron (2008, pp. 210-211) suggested, the inclusion of one variable, like familiarity with the content, could positively impact the trajectory and increase the learners' verbal participation. It is against this backdrop that a systemic view of L2 classroom dynamics emphasizes neither the teacher- or curriculum-centered nor a learner-centered approach to learning but one that is rather learning-centered. In a similar vein, one could use autopoietic systems theory to better understand the dynamics of interaction between personal systems and the L2 classroom system and put forth suggestions on how structures of expectation can be built into the L2 classroom system to maximize the engagement of students in the process of communication.

To conclude, autopoietic system theory's description of L2 development as an operationally closed and cognitively open system might be beneficial for practitioners and researchers alike in the field of L2 education. The theory portrays a picture of L2 development as a dynamic process which includes both psychological and social dimensions: psychic, for L2 competency is ultimately developed in the psychic system of learners as the result of a self-referential autopoiesis; and social, for L2 development is continuously irritated and/or influenced by its (primarily communicative) environment. For L2 educators, this means that L2 teaching practice should focus less on steering or determining the learning experience of students. This experience is *determined* neither by the environment nor by the intervention of environmental factors. Rather, it is *irritated* by environmental factors, hence the need to shift the focus of teaching practice from controlling to managing the dynamics of communication so that students can develop their learning experience against the dynamics of L2 classroom communication. For L2 education researchers, the cognitive or self-referential dimension of L2 development provides conceptual tools to help explain variations in learning experiences as being less like noise (or undesirable) and more natural, like an indication of different modes of learning autopoiesis. For example, the social dimensions of learning can complement L2 discourse analysis. In this line of thought, the data derived from the analysis of L2 classroom discourse could be analyzed not exclusively from a micro-perspective (i.e., from the viewpoint of students and teachers), but from a meso-perspective, (i.e., from the viewpoint of system expectations). The structures of these expectations (e.g. open-ended questions vs. closed questions, short vs. long pauses for reflection, etc.) are developed in the interaction system of an L2 classroom and regulate the participation of students and how the system self-referentially modifies these structures, so that exclusion or inclusion of classroom participants is regulated differently.

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## Substantial Conclusion

### Autonomy of classroom interaction system

Of the two insights mentioned in the article, I believe that using social systems theory to classify communications in the context of classroom as an interaction system, which has an order of its own, is worth discussing in greater detail. This order is maintained against a constantly changing environment, to which the system is although structurally coupled, it has its own structures to adapt. Once the interaction system is sufficiently understood, I believe, researchers in the field of SLA can describe in a new light the learning experience at collective and individual levels, address difficulties in the 'to and fro' of interaction among participants, and come up with suggestions as to how the learning experience can be promoted. It is therefore my intention in this conclusion to use Luhmann's theory of social systems to describe classroom groupings as an autonomous social entity, in which learning and understanding occurs at a different level than that of learners and teachers.

If one agrees with Luhmann that communication builds upon processes of mutual perception, then communicative interactions in the classroom become a prime example of a social system. The communication type occurring in classrooms is an interaction system, which differs from functional systems and organizations in that it strictly relies on the physical presence of teachers and students (Herzog, 2009, pp. 178-182). There is a mutual perception at work in classroom groupings. For instance, to return to the classroom grouping example provided in the article, the teacher observes the students in the class. He also knows that he is being observed by these two students, and by others. This mutual perception gives the system an order of its own, "one that more than any other perhaps, is in fact orderly, and that this orderliness is predicated on a large base of shared cognitive presuppositions, if not normative one, and self-sustained restraints" (Goffman, 1983, p. 5). It further creates the generative framework that not only actions, but also behaviors potentially acquire a "surplus of meaning" (Ricoeur, 1973) and gain a social relevance beyond the intentions of its participants. In this order, a blink might be understood as a wink, and a wink might be understood as a blink. To give another example from the corpus, A's silence in extract 7.2 (line 14) gains a communicative relevance. In the interaction system and under the condition of mutual perception, "one *cannot not communicate*" (Luhmann, 1995, p. 477, emphasis in original). Similar examples occur constantly in the context of classrooms. Even silence or the communication of not wanting to communicate in a classroom setting could be understood

and treated as communication. For instance, teachers might understand the silence of students as non-understanding, disagreement, protest, confusion, lack of interest or attention, etc. Depending on which of these understandings are used as the premise of new communicative actions, the course of the interaction system in classroom will change accordingly.

This unique characteristic of interaction makes it indispensable for the education system (Luhmann, 2002). The primary function of education is to prepare individuals for socialization by transforming their psychological states, knowledge, values, norms, and worldviews (Herzog, 2009, p. 166; Qvortrup, 2005, pp. 12-13). Key to this function is to intervene in individuals: it reforms or improves their inner world so as to promote their ability to participate in future in wider spheres of society (Vanderstraeten, 2004). Intervention effects in education (as much as in other settings like psychotherapy, religious conversion, counseling, etc.) are best materialized and measured in face-to-face interaction. Socialization of individuals occurs both at households and educational institutions. Individuals learn to participate as non-professionals at home and school, and as professionals in society (e.g., as politicians in the political system, lawyers or judges in the legal system, financial analysts in the system of economy, or teachers in the system of education) at higher education institutions such as colleges, universities, and research centers.

As a communication system, interaction creates its own order and reality (Goffman, 1983; Vanderstraeten, 2001; 2004; Luhmann, 2002). Social systems theory *á la* Luhmann allows viewing this order horizontally – as one that emerges from the connection of communications to communications, without having to have recourse to individuals as agents or elements of the system. Through its autopoiesis, the interaction system of classroom creates an intellectually nourishing environment for psychic systems. Psychic systems tend to use their unique structures to observe this environment and use the result of their observation as the premise of further thoughts or reflections, culminating in learning experience. The organizational setting of classrooms reinforces this tendency by establishing expectations among students that encourage participation in communication and advances the learning experience among them. These expectations are laid out in an evolutionary way outside the classroom interactions (Vanderstraeten, 2001; Davis & Sumara, 2006, pp. 90-94) and render the otherwise improbability of willingness to learn into a probability (Luhmann 2012, p. 90). They help to distinguish between good behavior and bad behavior, provide criteria for success versus failure of students, suggest measures to praise conforming behavior and punish non-conforming behavior, etc. These norms

further promote the asymmetry between teachers and students, both in number and in authority. As the example from the article shows, the teacher, and not the students, has the authority to observe all the students, and to contradict, compliment, or reproach them. Likewise, he can communicatively self-impose by intervening in interaction, slowing down the pace of communication, changing its direction, introducing new themes, or even terminating the communication (Vanderstraeten, 2001, pp. 270-271; Luhmann 2002, pp. 102-111).

As a social system, a classroom interaction system interacts in its environment with a number of organizations and other social systems. However, the order of the system emerges more out of the communication within the system than out of organization settings. To be more precise, this order is framed, but is by no means determined by organizational arrangements (Vanderstraeten, 2004). These arrangements neither determine the 'how' of learning nor restrict degrees of freedom available to interaction. They are in the environment of the communication system of the classroom and personal systems of students, and as such cannot interfere with the autopoiesis of communications and thoughts. As Borch (2011) succinctly formulates, "it is not the students and the teacher that communicate, but rather communication itself. Teacher and students are merely prerequisites for the autopoietic organization of communication" (p. 36). The same rationale applies to organizations such as departments, schools and school boards that are the prerequisites of classroom order. As Luhmann states, "it would be fully unrealistic to believe that [such] organizations could program the internal dynamics of the class" (Luhmann, 2002, p. 161, my translation). Therefore, classroom interaction and personal systems of students and teachers are mutually opaque and cannot see into each other. This is to say that neither communication can control the thoughts or thinking processes of students, nor can students control the flow of communication. While both depend on the presence of each other, they are closed in their operations. The framing function of these arrangements goes so far as to create opportunities for a symbiosis between the individual and the social: from the perspective of the psychic systems, classroom interaction creates the ground for students to develop learning; and from the perspective of classroom interaction, personal systems –of students and teachers– are brought to willingly participate in the autopoiesis of the system by communicatively introducing their thoughts and reflections.

At a different level, the classroom system constitutes its autonomy without having recourse to either teachers or students. As it is mentioned in the first insight of the article, a concept from

Luhmann's theory of social systems that helps to distinguish the realm of the social from that of the personal is that of understanding (Kneer & Nassehi, 1991, Luhmann, 2013, pp. 218-219). Both psychic and social systems understand. Yet, while understanding is the constituting element of psychic systems, it is but one dimension of the communication triad and does not suffice to explain the realm of the social. That both systems understand highlights the necessity, but by no means the sufficiency of consciousness for communication:

> "The consciousness of individuals is the necessary condition of communication. However, consciousness does not communicate, it only understands by distinguishing between information and utterance, and carries this understanding towards a new selection of information and utterance" (Kneer & Nassehi, 1991, p. 349, my translation).

Both of these system types remain operatively autonomous from and opaque to one another. In the psychic system, thoughts emerge from the operation of observation, and exclusively connect to one another and to nothing else (the self-referential aspect). But thoughts are often about someone or something in the environment (the other-referential aspect). That students understand the same teaching materials differently might well be explained by the different distinction criteria they adopt. These distinctions are in turn informed by what Gadamer (2004, pp. 335-337) calls "historically effected consciousness". Distinction and indication will produce a new piece of information or thought. As a difference that makes a difference, this piece of information sets in motion – depending on the initial condition of the observing system– the formation of different thoughts[i].

Understanding in Luhmann's theory of communication (2012, pp. 113-250) emerges likewise from the operation of observation. Here, understanding is not understood in a hermeneutical sense, but rather in a formal sense, so as to distinguish the form of a verbal or non-verbal expression from its information content and to indicate one side. This understanding is not external to the interaction system –e.g. a psychic or personal system that participates in

[i] A teacher talks to a student and says "there might be an exam next week". Three students hear this statement and adopt different distinctions: e.g. student A works with the distinction exam/not-exam and indicates the positive side; student B works with the distinction might/might-not and indicates the negative side; student C works with the distinction drawing attention/making an announcement and indicates the former. Neither can students look into the mind of the teacher, nor can teachers look into the minds of students. This distinction can constitute an event of thought that disappears as soon as it emerges, and in order for the psychic system to function, it needs to replace it with another thought.

interaction–, but a construct of the observing system itself. Thinking back to the corpus, while the teacher's understanding might be formed independently of A's intention, it outlines the continuation of communication. That A pauses for 5 seconds could owe to his thinking but that does not stop the teacher from communicatively (mis)understanding this as the complexity of the question and reducing the complexity of the question. Larsen-Freeman and Cameron (2008) provide a comparable example of classroom interaction. A teacher might understand the uncomfortable silence or minimal response of students to questions asked as a lack of engagement or preparation and proceeds by either picking a good student to answer the question or provides herself the answer (pp. 212-215). In this instance, the teacher works with the distinction engagement/non-engagement or prepared/non-prepared. This distinction is made without having to take recourse to the intended distinction of the students. Had the teacher taken another distinction, sufficient /insufficient reflection time, as the authors suggest, she could have "shifted the classroom interaction system out of the minimal response attractor and into a different trajectory" (p. 215).

In conclusion, I would like to highlight that this paper is a first attempt to describe the dynamics of language education in classroom groupings from the perspective of social systems theory. As such, it is exploratory in nature and calls for other studies to explore the potential contributions this theoretical framework can make to our understanding of L2 development. Suggestions as to how to improve the learning and teaching experience depends on how well we can describe the dynamics of communication in classrooms. Perhaps the explanatory potential of social systems theory to describe language development from a systemic perspective is what L2 education in general and complexity informed research in the field of SLA in particular could take away from its theoretical counterpart.

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