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Complex Dynamic Systems and Language Education: A Sampling of Current Research – *Editorial*

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It has been twenty-five years since second language acquisition/development researchers and practitioners were introduced to chaos/complexity theory and its systems (variously referred to in our field as “complex systems,” complex adaptive systems,” and “complex dynamic systems”) (Larsen-Freeman, 1997). Unsurprisingly, the uptake of the new ideas was nonlinear. When they did attract a growing number of scholars, almost all of the research reports were descriptive—pointing out how language—its evolution, its use, its learning, and its teaching—were all complex, dynamic, nonlinear, emergent, feedback-sensitive, self-organizing, initial condition-sensitive, open, adaptive systems. In addition to these characteristics, because language is comprised of many interacting components and can be characterized by a number of scale-free power laws, such as Zipfian distributions, it indeed qualifies as a complex system.

Since the early days, what is now called complex dynamic systems theory (CDST), an amalgam of complexity theory and dynamic systems theory (see de Bot, 2017), has become prominent. Accompanying its prominence have been calls for researchers to move beyond description to empiricism in the quest to explain and intervene in complex phenomena (Al-Hoorie, Hiver, Larsen-Freeman, & Lowie, 2021), which in the case of this volume is the phenomenon of second language acquisition (SLA) or second language development (SLD). Such calls have also resulted in an ever-growing repertoire of research methodologies (Hiver & Al-Hoorie, 2020). Longitudinal designs with dense observations of a learner’s performance are most favored in order to understand the process of individual learners’ development, which is distinctive from that attested to by averaging the

performance of groups of learners (Lowie & Verspoor, 2019). And, since the empirical reality is that success in second language development varies across individuals, many of these studies attempt to account for learners' differential success.

For readers of the *International Journal of Complexity in Education* (IJCE), a brief introduction to the SLA/SLD nomenclature may be warranted. To begin with, SLA/SLD simply refers to the sequential acquisition of a language after an established first language. It is sometimes referred to as foreign language, world language, additional language, or modern language acquisition. It can take place at any age and by learners who already know multiple other languages. SLA/SLD can occur in both tutored (aka. instructed) and untutored (aka. naturalistic) contexts. The reason for the equivocation between SLA and SLD is that originally the field took its name from the field of first (or native) language acquisition. However, more recently, CDST researchers have argued that SLD is a more apt designation, given that language is an open complex system that has no endpoint (Larsen-Freeman, 2015), and is characterized by continuous development. Total convergence with the norms of a standard language may neither be desirable nor possible, and even if it were, the "target language" is always changing. This is because language and its use are mutually constitutive (de Bot, 2015). While this last statement may not seem remarkable to scholars from outside the fields of linguistics/applied linguistics, it is necessary to understand that these fields have long been under the powerful influence of the Cognitive Revolution, the leading contributor to which was Noam Chomsky. The impetus for his Transformational Generative Grammar, later reformulated as Universal Grammar, was to try to explain the universal success in the acquisition of a native language by children, who despite receiving allegedly impoverished, ungrammatical input, acquired their native language in relatively short order. Chomsky postulated the existence of an innate Universal Grammar that would facilitate children's accomplishing this amazing feat. His hypothesis fueled the search for formal abstract linguistic universals.

While the search continues among some scholars, many others prefer a newer account for both first language, L₁, and second language, L₂, development, which has been referred to as "usage-based" or "statistical learning," the learning of regular robust distributional patterns in surface-level linguistic features (such as word order), which obviates the need for any innate UG rules. Of course, one can write grammar rules to describe a language, and some language students benefit from them, especially when contrasted with the language(s) they already know, but these are neither the deep structure rules of UG, nor are they static or invariant. This is because languages are always changing through use, where the language resources of interlocutors are shaped in coordinated interaction or co-adaptation (Larsen-Freeman & Cameron, 2008). Adaptation introduces variation into the system. By perceiving increasing flux in the learner's language system, we know that a bifurcation or phase shift in the system is imminent (Verspoor, Lowie, & de Bot, 2021).

Moreover, systematic variation in the language of individual learners may suggest that an intervention, a teachable moment, is at hand.

The usage-based approach also ascribes more agency to learners than do traditional approaches. Rather than conceiving of learners as possessing an innate grammar that is activated simply by exposure to the target language, it conceives of learners seizing opportunities for learning that the environment affords. Agency is a relational concept. When learners are provided with “enabling conditions” by their teachers, for instance, they are encouraged to enact their agency (Larsen-Freeman, Driver, Gao, & Mercer, 2021).

Theoretical constructs in CDST have replaced abstract decontextualized rules with contextualized patterns, have replaced innateness with domain-general mechanisms such as perception, analogizing, and memory, have recognized the individuality of learning trajectories, and have re-assigned responsibility for development from cognition alone to an agentive socio-cognitive process. Much more could be said about these ideas, which have truly transformed thinking in the field of language learning, but this orientation will hopefully be sufficient to provide a backdrop to the articles in this special issue. The five articles in this volume have been invited in order to exemplify excellence and diversity in L2 CDST scholarship, each of them focusing on different aspects of the dynamic nature of second language development: Zipfian distributions, learner agency, fluency development, pedagogical implications, and the dynamic characteristics of the educational landscape. Each has also been thoroughly reviewed, adjudicated, and revised. We provide a brief overview of each below for context.

Steinkrauss, Green, Verspoor, and Sun focus on a non-formal education setting and investigate the effect of home educational activities on the language development of two bilingual children. They examine these bilingual children’s development from a usage-based and a dynamic systems perspective, looking specifically at the verb-argument constructions (i.e., VACs) the children developed over the course of a year. Constructions are conventionalized form-meaning pairs that combine syntactic and lexical information. By tracing both the relationship between language input and production, and the individual learning trajectories of both children, Steinkrauss et al. were able to detail individual changes in how the children developed using these dense longitudinal data. Their data showed that participants’ use and learning of VACs followed Zipfian distributions, confirming the invariance of scale that is evident in language systems. That is, the more prototypical, prominent, and frequent verb lemmas were those committed to memory and used first before the learners expanded to using less frequent or learnable VACs. This Zipfian distribution has also been found in large-scale corpora but this study is a first given that it explores these patterns with finer-grained individual data at more developmental timescales. As hypothesized, the children’s language production was correlated with the caregiver input they received, and these correlations varied over time.

Interesting differences in individuals' patterns of development were also evident, allowing learners to start their development of a VAC with different central verbs. These variations in learners' points of departure from the input they received provide further evidence of the importance of initial conditions and the spatio-temporal dependence of the system's development on those conditions.

Nitta and Baba's study positions learners' L2 development as driven less by conventional computational views of input processing and tied more to their deliberate, intentional, and proactive choice to engage in opportunities for language learning and use in the classroom. Learner agency, the central focus of their study, has been recognized as a complex and dynamic construct that is "relational, emergent, spatially, and temporally situated" (Larsen-Freeman, 2019, p. 73). Nitta and Baba adopt an integrative framework for studying learner agency—the New Big Five model (McAdams & Pals, 2006)—that contributes to understanding the complexities of individual thought and action. This multilayered framework consists of three levels: dispositional traits, characteristic adaptations, and integrative life narratives, and it enables a dual focus on the uniqueness and general aspects of the human mind. By collecting multiple forms of data over 30 weeks, Nitta and Baba were able to examine sustained trajectories of student motivation and engagement, investigate the learners' language production and task performance, and tap into their reflections and self-evaluations of their goal pursuits in the language classroom. Their data showed how learners pursued proximal goals linked to more intermediate and distal goals. Of interest in this study are the ways in which the learners co-adapted with the contexts they were embedded in and how learner agency depends on multiple factors that overlap and interact interdependently, with some factors in the system playing a larger role at certain times for learner agency but not at others. These adaptive interactions shed light on how functionally significant patterns of learner agency emerge from initial states, persist in context, and adapt or change through time.

Evans' study examines the notion of fluency in second language speech production. Fluency generally refers to the degree to which speech flows quickly and smoothly. It also encompasses the extent that the flow of speech is interrupted by pauses, hesitations, false starts, and so on. SLD scholars are interested in the interrelationship of factors that affect the fluency of speakers' utterances, the effects of individuals' language learning experience on fluency, and the ways that fluency can be enhanced through language instruction. While scholars have recently begun to view fluency as a system in its own right that comprises cognitive, socio-contextual, and linguistic components (Hepford, 2017; Segalowitz, 2016), fluency research still relies primarily on frequency counts that measure quantitative changes and reveal a more-is-more conception of the construct. Evans' study of one learner's fluency development at a fine-grained level challenges this notion and proposes that in addition to investigating "changes in degree" or charting increases or decreases in

the frequency of fluency and disfluency features, fluency research must recalibrate to study qualitative “changes in kind” and how the changing quality of learners’ L2 speech can shed light on their development. The data in this study provide evidence that the frequency of typical disfluency features should not automatically be assumed to represent regressions in proficiency. Examining these qualitative changes in fluency from a functional and relational perspective can provide new developmental insights into how L2 speech fluency develops.

Smit, Holtman, Lowie, van Dijk, and Verspoor look closely at the notion of pedagogical translanguaging in their study. Pedagogical translanguaging is the planned, deliberate, and flexible use of two or more languages in the same lesson—a practice that is recommended as a way to approximate the actual language-use behaviors of multilingual speakers in multilingual contexts. In most language classrooms there are at least two languages competing for attention: the L1, which is often the dominant language used by teachers and learners outside the classroom, and the target L2, which is the central focus of the teaching-learning process taking place in the classroom. While theoretical explorations describe the potential of translanguaging to enable students and novice language users to draw on their different languages as resources for communicating and making meaning, pedagogical translanguaging that emerges out of teacher-student interaction in the classroom is still underexplored. In this study, Smit et al. investigated pedagogical translanguaging by analyzing teacher-student L2 classroom interactions across 39 lessons in a sample of 2594 pairs of teacher questions and student answers. By zooming in on pairings of teacher questions and students’ responses, they highlighted a seeming trade-off in various question-response scenarios in which teacher questioning results in (a) getting an answer and (b) getting an answer in the L2. Their detailed analyses show that using the foreign language as the language of instruction and pedagogical translanguaging are useful for different purposes and function as complementary, rather than competing, strategies in a language teacher’s repertoire.

Fogal adopts a system mapping approach in his study to investigate Shakespeare studies in L2 secondary school classrooms in Ontario, Canada. A system mapping approach to educational research foregrounds relationships, relational structures, and interdependencies in system boundaries and behavior. It also entails a process-focus that allows exploration of co-adaptation and emergence as characteristics of change and development in the educational landscape. Through such an approach, Fogal examines the specific impact of L2 literature and literary studies as a tool for L2 development and how this emerges in the teaching, learning, and administrative landscapes of the focal schools. His data analysis of practices and perceptions across these school districts involved qualitative descriptive analysis, spatial mapping for salient categories, and hierarchical cluster analysis. Doing this not only enabled Fogal to identify the relative strength of

influence of the factors at play in each setting, it also provided some indication of group differences and similarities for these influential factors. Fogal's findings from unique groups of stakeholders reveal some discrepancies between the educators' and learners' perceptions of L2 literature as an affordance for L2 development. He frames these distinct outlooks on what is driving learning and differences in how stakeholders interpret the educational space as opportunities to steer L2 development by gathering additional input from all stakeholders when trying to assemble system-wide information. Fogal contends that this multi-layered information from diverse stakeholders and particular corners of the educational landscape are precisely what is needed for educational research to provide clear-eyed guidance and objectives for teaching and learning.

We hope by bringing this research, which represents the broad spectrum of complex dynamic systems characteristics of second language development and second language pedagogy, to the attention of a wider audience of educators and education researchers that we will be able to join forces and advance our collective understanding of teaching and learning, informed and inspired by a complex systems perspective.

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