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A COMPLEX DYNAMIC SYSTEMS THEORY PERSPECTIVE ON SPEAKING IN SECOND LANGUAGE DEVELOPMENT

Wander Lowie and Marjolijn Verspoor

1 Introduction/Definitions

Complex Dynamic Systems Theory (CDST) addresses the process of language development over time, rather than the outcomes of a process. The process is commonly described in terms of patterns of change, which include stages of development in variability, stabilization, and destabilization. The general goal of CDST-inspired studies is to come to an understanding of the way in which the complex interaction of numerous forces leads to behavioural changes, to understand how development comes about. If there is one conclusion that we can safely draw from about 20 years of research into second language development from a CDST perspective, it is that language development is a highly individual developmental process; language development is not predetermined, but emerges from the interaction and coordination of subsystems, also referred to as “self-organization” (Smith & Thelen, 2003).

The term “systems” is central in systems theories like CDST. A system is the conglomeration of connected elements that form a coherent whole (Bertalanffy, 1995). The elements in CDST are referred to as subsystems, which are also systems that may again consist of subsystems. For instance, the language system is embedded in the larger system of cognition, which in turn is embedded in the larger system of the human being, which is embedded in the larger system of a speech community. The language system itself consists of several embedded subsystems, like phonology and vocabulary, with language-specific subsystems for multilinguals.

Subsystems are open and all these systems are connected regardless of the degree of embeddedness. The changes in coordinated and interdependent subsystems form the foundation of the dynamic and non-linear nature of development. As changes in any of the subsystems may lead to changes in other subsystems, development is characterized as an iterative process in which each stage in development is based on the system’s preceding state. And since the combination of subsystems and the nature and timing of their interaction is essentially unique for each person, this leads to an iterative developmental process that is strongly individual and cannot be predetermined. The logical consequence of this is that CDST-inspired studies tend to be longitudinal case studies that focus on the process of development.
A growing number of CDST-inspired studies have shown that although the steps in language development may be globally similar among learners, the timing and the magnitude of the development strongly depend on individual differences and on changes in the interacting factors that contribute to the learner’s development, including the learner’s context or environment. CDST studies are characterized by longitudinal observations of individual learners with dense measurements, allowing for reflections on the individual process of development rather than focusing on generalized products of learning for groups of learners at one moment in time.

So far, most CDST studies in second language development have focused on the development of writing for different levels of learners in various contexts, but a small number of studies have also focused on speaking, which is quite complex. The number of interacting subsystems relevant for speaking is relatively large, as speaking is generally less controlled than writing, and the contexts in which speaking is used are generally natural and ecological. For oral production, the operation of the skills is coupled with context, including the dyad. This is clearly shown by the occurrence of alignment and convergence during speech. People have a tendency to adjust to the context, and likewise the context will then adjust to the speaker, leading to an active form of coordination of the relevant subsystems. The short-term developmental process of the speaker is coupled with that of other speakers and can be found in all or several of the relevant subsystems, from timing and articulation in the speaker’s pronunciation to the use of non-verbal gestures.

Another typical characteristic of dynamic systems is the self-similar nature of embedded subsystems, also referred to as fractals. Each time we zoom in to a dynamic structure, similar patterns can be perceived. The repeated patterns are clearly illustrated in Mandelbrot sets, but can also be seen in many naturally occurring phenomena like cauliflowers and trees. The pattern of the skeleton of the tree is repeated in increasingly smaller structures, from branches to leaves. Also, in the time domain fractals have been identified in dynamic systems, when a certain pattern of variability is repeated at smaller timescales (Rhea et al., 2014). Most evidence for fractal structures in the time domain have been found at the short timescale of language processing. During speech comprehension, a hierarchy of linguistic structures has been identified in neural tracking at different timescales (Zhang & Ding, 2017). Moreover, a fractal dimension has been found in the variability of speech production during simple naming tasks in the L1 (Holden et al., 2009), as well as in second language naming tasks (Plat et al., 2018). A fractal structure has also been identified in the diachronic development of syntactic complexity (Evans & Larsen-Freeman, 2020).

In the following parts, we will contextualize CDST research in a historical framework and discuss critical issues. We will then discuss the strongly developing methods for process-based research relevant for speaking and will mention some challenges and future directions for the CDST framework.

### 2 Historical Perspectives

CDST is founded in well-accepted dynamic theories of physics, mathematics, and demography. Over the past three decades, applications of CDST to cognition and psychology have been very influential (Thelen & Smith, 1994) and applications to language development and second language development have caused a major turn in applied linguistics. Two of the most recent turns that have influenced our thinking about second language development today occurred in the late 1990s, when psycholinguistic and neurolinguistic experimental
methods became an accepted line of research. The two shifts have been referred to as the Social Turn and the Dynamic Turn.

The Social Turn (see Block, 2003 for a detailed critical review), initiated by the seminal and controversial paper by Firth and Wagner (1997), was a strong negative reaction to the idea that language learning can be investigated through controlled experiments. A theoretical perspective closely associated with the social turn is Sociocultural Theory (SCT), linking society to individual development. For second language learning, the central premise of SCT is that any form of human cognitive development is essentially mediated by cultural artefacts (Lantolf & Thorne, 2006). Consequently, language development cannot be studied outside its authentic communicative context. Levine (2020) argues that SCT and CDST are commensurable and complementary frameworks.

The second major paradigm shift, the Dynamic Turn (de Bot, 2015), shares several of its assumptions with the social turn and its theoretical impacts. Similar to SCT, dynamic theories do not consider language development as isolated activity in the cognitive domain. But different from SCT, Dynamic theories do not emphasize the opposition between cognition and sociocultural artefacts, but stress their integration. Both theories consider language development as the ongoing, emerging process of an integrated holistic system, which includes a wide range of connected, embedded and embodied subsystems. The onset of this development dates back to 1997, when Diane Larsen-Freeman published a groundbreaking paper on Complex Adaptive Systems in *Applied Linguistics* (Diane Larsen-Freeman, 1997). The paper emphasized the dynamic nature of language development, which is described as a journey with no end state. Years later, the dynamic turn was reinforced by a number of papers and books, such as Herdina and Jessner (2002), de Bot et al. (2005, 2007), Larsen-Freeman and Cameron (2008), Dörnyei (2009), and Verspoor et al. (2011). Some authors used the term Dynamic Systems Theory, while others used the term Complex System, but the main theoretical implications were the same. Therefore, it was decided to use the combined term Complex Dynamic Systems Theory (CDST) (de Bot, 2017).

Today, an increasing number of scholars are doing CDST-inspired research into second language development. The focus of their studies is diverse, from very fundamental studies on the self-organizing nature of language use in real time (Plat et al., 2018) to theoretical considerations about CDST research (Hiver & Al-Hoori, 2016), studies that focus on the identification stages of development as they emerge over time (Baba & Nitta, 2014); process-based research that focuses on the development of accuracy and complexity by studying variability in second language development (Spoelman & Verspoor, 2010); and pedagogical implications of a CDST framework (Levine, 2020). For practical reasons, most studies focus on writing, though recently some work on different aspects of the dynamic development of speaking has been published (Hepford, 2017; Lowie et al., 2018; Polat & Kim, 2014; Roehr-Brackin, 2014; Yu & Lowie, 2019). We will elaborate on these contributions in Part 4.

The dynamic nature of acquisition has also been addressed from a theoretical angle. Following Browman and Goldstein (1992), Lima Júnior (2013) proposes that a child’s first words may not be stored and accessed as separate phonemes, but as “holistic patterns of articulatory routines” (Browman & Goldstein, 1992, p. 39). The frequent repetition of microlevel elements leads to the emergence of macrolevel patterns. That is, the pre-linguistic units gradually develop into gestural units of contrast. During acquisition, the child distinguishes and adjusts his/her emerging gestures and, simultaneously, learns how to coordinate them, as the development of the ability to produce all the gestures of a word requires their coordination. Lima Júnior (2013) concludes that such a CDST and experiential perspective on acquisition
may alter not only our view of first language acquisition, but also has implications for L2 acquisition. Because of the iterative processes and eventual entrenchment of patterns (or attractor states in CDST terms), L2 learners associate L1 sound patterns to unknown patterns of the L2, which reminds us of Flege’s Speech Learning Model (1995, 1999), in which he argues that since adult L2 learners often fail to distinguish a certain L2 sound from a close L1 sound, they may classify the L2 sound under a (prototypical) phonological category of their entrenched L1 categories.

3 Critical Issues and Topics

CDST approaches to second language development focus on the continuous process of development rather than products of development. They have revealed the complex interaction of subsystems over time and have shown that second language development, especially within the domain of speaking, is a highly individual process. Despite the valuable deliverables of this approach in a relatively short time span, there are several limitations and challenges that the application of CDST faces.

It is important to realize that CDST is not a model of second language speech. Rather, it is a frame of reference within which we can analyze and understand development, an “all-encompassing, and multidimensional view on reality” (Lowie & Verspoor, 2015), or a meta-theory (Larsen-Freeman, 2015). Critics of CDST have often pointed out that unlike the classical definition of scientific theory, a meta-theory such as CDST does not lead to specific predictions and falsifiable hypotheses. Hulstijn (2020) argues that, similar to other meta-theories like Darwin’s theory of evolution, “Language as a Complex Adaptive System is falsifiable in principle but [is] not likely to be falsified” (2020, p. 8).

Related to this is the observation that findings from longitudinal case studies cannot be generalized to populations of second language learners. As we explain in Part 5, not only is it difficult or even impossible to generalize longitudinal observations on (multiple) case studies, but also it is undesirable to make statements about the interaction of variables over time for groups of language learners. While group studies can answer research questions about the general interaction of variables at one moment in time, CDST studies can answer research questions about the process of development over time. For instance, product-based studies can show the effect of starting age on the quality of L2 pronunciation after a fixed number of years of exposure by comparing a group of early starters to late starters, or the effect of the learner’s L1 on the quality of L2 pronunciation by comparing representative groups of learners (Derwing & Munro, 2013). Conversely, a process-based study can investigate how the development evolves over time, and can, for instance, explore how the vowel production of an L2 learner changes over time, as it initially switches between L1 and L2 realizations, and gradually develops in the direction of the target realizations after overshooting the values of matched native speaker controls for some time (Verspoor et al., 2021).

Another critical issue that logically follows from the dynamic, time-dependent focus of CDST studies is that the timescale or temporal window is a fundamental choice. The focus on particular subsystems and the timescale selected for a study represent the level of granularity of the study (Hiver & Al-Hoori, 2016). While some studies report on macrolevel development over a period of 3 years (Spoelman & Verspoor, 2010), other studies focus on microlevel development over a time span of 10 minutes (Plat et al., 2018). The choice for the timescale depends on the development expected at that timescale for the subsystem(s) under investigation. This choice can be pragmatic, but should also be based on theoretical starting
points. Unfortunately, a focus on the relevance of timescales and the fractal nature of language comprehension and production, especially for the second language, has been largely underexplored.

Finally, a critical issue is the choice of measures of (written or spoken) language production in time series. When, depending on the timescale, every hour, day, week, month, or year repeated measurements are taken of language production, we must be sure that the measures are representative for the production at that moment. Measures that have typically been used in CDST research are holistic assessment by trained raters or analytic assessment of language using measures of Complexity, Accuracy, and Fluency (CAF). The introduction of analytic measures of CAF has been a step in the objective evaluation of language development (Ortega, 2003), and analyses can conveniently be run on (transcribed) samples using Natural Language Processing (NLP) tools (https://www.linguisticanalysis.tools) for linguistic complexity and lexical sophistication. Suitable PRAAT-scripts are available for the automatic analysis of aspects of Fluency (De Jong & Wempe, 2009). However, the consistent application of suitable measures, especially for clausal, phrasal and lexical complexity has been a point of concern (Norris & Ortega, 2009). Different measures tend to be sensitive to specific levels and types of development and the substantial literature on this topic is still growing and the choice of suitable measures is getting more and more sophisticated (see for instance Housen et al., 2019; Kyle et al., 2020). An important concern from a CDST perspective is that probably no single measure can adequately represent an L2 proficiency level (for a discussion see Lowie et al., 2017).

4 Current Contributions and Research

The number of publications that take a CDST perspective to second language development has been growing in the past 15 years and is still increasing. Although most issues discussed in these papers are relevant for second language development in general, including speaking, the number of studies that specifically focus on speaking is limited. The reason for this may be that spoken data usually take an additional step of transcription before analyses can be done. Another likely reason is that the number of factors that affect speaking, and in particular spoken interaction, leads to high levels of inter- and intra-individual variation. And yet, speaking may also be the most interesting focus, as it represents genuine implicit language use (Dykstra-Pruim, 2003) and is less affected by conventions. Speaking is complex and interactive, and tends to be less monitored and controlled than writing. In a comparison of spoken language with and without pre-task planning time, Yuan and Ellis (2003) found that planning time positively affected language complexity. In most speaking situations, no extra time is available for planning.

An important claim of CDST research is that second language development is “individually owned” (Lowie et al., 2018). For example, the study by Chan et al. (2015) explores intra-learner variability in a comparison of speaking and writing data of monozygotic twins. The twins were extremely similar in virtually all respects, including the school environment and the amount and type of language contact out of school. In a longitudinal study spanning a period of 8 months, the twins performed 100 writing tasks and 100 speaking tasks. The results of this study showed that the development of speaking over time was highly variable for both learners. Furthermore, the study also showed that even these identical twins showed meaningful differences in their patterns of language development. An analysis of three syntactic complexity measures over time showed that the complexity of spoken language for both learners was higher than written language in the beginning, which corroborates the
findings reported in Dykstra-Pruim (2003). However, for one of the learners this shifted to a reverse effect over time and the complexity in that twin’s writing was higher than in spoken language. These data show that the iterative, process-based analysis of second language development is the effect of the dynamic interaction of changing variables. Even minute differences at one point in time may lead to large differences over time in a non-linear developmental trajectory.

A recent study by Yu and Lowie (2019) describes the dynamic paths of the development of speaking skills of Chinese speakers of English in a longitudinal case study focusing on complexity and accuracy over a period of 4 months. The study shows much variability and tentatively points to a relationship between the amount of variability and the degree of development: increased variability tends to coincide with developmental jumps in speaking (as measured by lexical diversity as well as in accuracy). However, the most interesting finding in this study was that accuracy and fluency show a strong and interesting dynamic relationship. Although during the early stages of development a competitive relationship was found between accuracy and fluency, this shifted toward a supportive relationship in the course of the data collection period, as illustrated in Figure 3.1. The figure shows a moving window of correlations between the variables, illustrating the change of the correlation between these variables over time. Initially, the learners may have been slowed down by a limited availability of resources (particularly apparent in participant B), while at later stages of development they manage to find a balance among different linguistic subsystems. This finding is in contrast to findings from a single case study by Polat and Kim (2014), who found that their participant made progress on complexity, but not on accuracy. A possible explanation of the difference between the studies could well be that Polat and Kim investigated an untutored learner, while the participants in the study by Yu and Lowie received formal instruction.

In addition to complexity and accuracy, Hepford (2017) included fluency in a single case study of oral L2 development in a naturalistic setting over a period of 15 months. Eliciting language production using a rich variety of speaking tasks, she investigated the interaction of the CAF in combination with global proficiency measures and motivation. She found clear non-linear and self-organizing development as a result of interconnected subsystems like the

![Figure 3.1 Moving correlations between syntactic complexity and accuracy for participants (A) and (B). Reprinted from Yu and Lowie (2020) with permission](image-url)
learner's motivation. While the relationship among most complexity measures remained relatively constant over time, the fluency measures varied as an effect of the amount of cognitive strain the learner experienced. This detailed case study, including a wide variety of changing factors over a considerable time, shows that for oral production, fluency tends to be the dimension of CAF that is most sensitive to contextual changes.

A practical longitudinal study of L2 phonological development (Verspoor et al., forthcoming) illustrates the significance of variability in language production. This example focuses on the development of the phonological system of a 5-year-old American boy (B) who learned Dutch in a naturalistic setting. His Dutch pronunciation was traced for about a year (Lowie, 2013) by means of weekly measurements of speech production. The current example concentrates on the development of the Dutch closed front rounded vowel /y/. In English, all rounded vowels (/u/, /ʊ/, /o/, /ɔ/) are back vowels, and there are no rounded front vowels. In Dutch, most rounded vowels are also back vowels, but /y/ is one of the exceptions. For English learners of Dutch, the production of /y/ provides a major challenge, as it requires a new combination of entrenched English articulators (see Flege, 1999). See Figure 3.2 for an illustration of these options.

We observed that there was a seemingly random variation between variants of /i/ and variants of /u/, with the occasionally combination of the two as a diphthong /ui/. The development is far from linear and shows a highly variable developmental trajectory (see Figure 3.3). In the first few weeks, B varies between the rounded /u/ and non-rounded /i/, with the occasional diphthong /iu/, but later on, his productions tend towards the target /y/ much more often. We argue that this type of variability is not intentional and not caused by any factors, but shows that the learner is aiming for a target sound and is constantly trying it out until he approaches native like productions. The variability is functional in that without trying and experimenting to aim for a target form, there would be no change.

5 Main Research Methods

Since CDST studies focus on the emergence of language over time, the inclusion of a time dimension is typical for this line of research. And even though change over time can be inferred from measurements or observations at two moments, typical for CDST studies is
that the process of development is investigated by following learners on a large number of occasions. The number and density of the observations is determined by the magnitude and speed of development expected. At a relatively early stage of development during which a learner has intensive language contact, more change can be expected that at a later stage of development with limited language contact (for a discussion see Lowie, 2017). For longitudinal case studies, the number and denseness of observations could be compared to what is the Power in a group study (Murakami, 2020) and they form important considerations for the design of a CDST study. The timescale of a study is at least equally important and may vary from the lifespan to weeks (Spoelman & Verspoor, 2010) or from minutes in the observation of classroom interaction (Smit et al., forthcoming) and changing motivation (Wanninge et al., 2014) to milliseconds in reaction time studies of spoken performance in a naming task (Plat et al., 2018).

Figure 3.3 Longitudinal measurement of the production of the participant’s Dutch front rounded vowel /y/, represented by the first three formants: F1 (darkest shade), F2 (medium shade) and F3 (lightest shade)

The necessity for the use of case studies is reinforced by the limitations of studying the development of groups of people over time. The development of groups of people can only be accomplished under the assumption that the changes of variables over time are identical for all the members of the group. This is referred to as the requirement of ergodicity (Lowie & Verspoor, 2019; Molenaar, 2015). Regarding the non-linear nature of development, groups of people are not likely to fulfil this requirement. This implies that for longitudinal studies with several observations over time, case studies are the most appropriate possibility. This observation leads to an important distinction of dimensions of research. While group studies can evaluate effects of variables and their interaction at one moment in time, case studies can reveal aspects of the process of development over time. Process-based studies that monitor non-linear development over time and product-oriented studies at one point in time are therefore complementary and can address different research questions. For instance, product-based studies can show the effect of starting age on the quality of L2 pronunciation
after a fixed number of years of exposure by comparing a group of early starters to late
starters, or the effect of the learner’s L1 on the quality of L2 pronunciation by comparing
representative groups of learners (Derwing & Munro, 2013). Conversely, a process-based
study can investigate how the development evolves over time, and can, for instance, explore
how the vowel production of an L2 learner changes over time, as it initially switches
between L1 and L2 realizations, and gradually develops in the direction of the target rea-
lizations after overshooting the values of matched native speaker controls for some time
(Verspoor et al., 2021).

In CDST studies of second language development, several methods have been used to
explore the development in longitudinal case studies. Two methods have been dominant,
each related to different types of research questions: the analysis of variability over time and
the analysis of relationships of subsystems over time. Both analyses use moving windows
techniques to enable observing stepwise change over time while reducing the effect of local
peaks. Although many different techniques are available to answer a variety of research
questions, we will mention only one to illustrate the type of analysis.

For the analysis of variability over time especially, graphical tools are used to visualize
development. One such instrument is that of min–max graphs, in which a moving window of
minimum, mean, and maximum is used to identify changes in the amount of variability
(Van Dijk et al., 2011). This is illustrated in Figure 3.4. In these analyses it has frequently
been observed that increased variability tends to coincide with a jump in development (see
for instance Yu & Lowie, 2019). The significance of the jumps and the changes in the amount
of variability are commonly tested by using Monte Carlo simulations. These are permutation
tests in which the data are resampled a significant number of times (for instance 10,000) to
determine the coincidence of the data observed. Similar simulation analyses to determine
the significance of changes over time have been done using Change Point Analyses (Baba
& Nitta, 2014).

Several methods have been used for the analysis of relationships of subsystems over time.
After smoothing the data to eliminate extreme peaks and after detrending the data, the
relationship among the subsystems is analyzed using growth models like precursor models

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**Figure 3.4** Moving min–max graph illustrating changes in the amount of variability in a child’s use of
spatial prepositions. Reprinted from Van Geert and Van Dijk (2002) with permission
Using these models, the complex dynamic interrelationship of several subsystems has been analyzed. For instance, Caspi (2010) analyzed the relationship of four dimensions of receptive and productive vocabulary in second language use, whereas growth models tend to be rather advanced techniques, also more straightforward analyses have been used, like moving correlations (Verspoor & Van Dijk, 2011). In these analyses, a moving window of correlation between maximally two subsystems is used. Moving correlations may show that even when the overall correlation between two subsystems is low, this may be due to a change over time from a negative to a positive correlation, as is shown for the relationship between the finite form ratio (words/FB) and sentence structure (simple/compound) in Figure 3.5 (from Verspoor & Van Dijk, 2011).

The techniques mentioned here are only a small portion of the available analyses for longitudinal data with dense measurements. After an initial discussion of CDST methods by Larsen-Freeman and Cameron (2008), a practical guide for CDST methodologies by Verspoor et al. (2011), and guidelines for data collection by Lowie (2017) and by Murakami (2020), a very comprehensive overview of techniques was compiled recently by Hiver 2019. Although most CDST-inspired papers have used quantitative analyses, several valuable longitudinal case studies have used qualitative analyses (Lesonen et al., 2017; Roehr-Brackin, 2014). Both studies provide detailed qualitative analyses of the development over time of a specific linguistic construction or way to express meaning in the L2. Since CDST is a relatively young line of second language research, the methods of analysis can be expected to advance in the years to come.

6 Recommendations for Practice

All longitudinal studies thus far from a CDST perspective that trace learners over a longer period of time show variation (differences among similar learners) and variability
(differences over time within a learner), sometimes with strong ups and downs, sometimes with subsystems becoming more stable. This has important implications for researchers, teachers, and learners.

For researchers, it means that if we want to investigate the process of development, we must collect longitudinal data of single learners. Of course, this can be a small group of learners in a similar situation or a single learner. We must know what we are looking for and why as there should first be some theoretical motivation to investigate so we know the time needed and the measures we might trace. For example, if there is an instructional intervention on giving feedback on particular L2 sounds as cross-sectional studies have found positive effects, then we need to trace the effects of such interventions not only during the intervention, but also have several measuring moments after the intervention. In such cases, we could measure longitudinally in several longitudinal post-test sessions, for example, for 1 week about a month after the intervention and another week 2 months after the intervention. In making these decisions, the researcher should make an estimate on how long it takes to acquire a certain skill and when it may be assumed to become rather stable.

For teachers, it means that they need to recognize that learning is a process of trial and error and that language use and language development cannot be distinguished. Also, some subsystems may need to be in place before others can develop. The conclusion that language learning is strongly individually determined may not be good news for teachers or school administrators, but explains the need for personalized learning. The variable nature of the individual learning trajectory also illustrates the need for different approaches to assessment, in which awareness of development over time using portfolios may be more suitable than summative assessment at one moment. Moreover, it is important to realize that there is no monocausality in (language) development. When applied consistently, a CDST implication for teaching requires a strongly ecological and holistic framework of second language pedagogy. A fully worked out application of CDST pedagogy in an ecological framework is found in Glenn Levine’s recent MLJ Monograph (Levine, 2020).

7 Future Directions

Despite the growing number of CDST-inspired studies of second language development and despite the advancement of methods and analyses, additional methodological innovations are required for further development of the field. One of the challenges is the paradox of the research dimensions. There is a continuous desire for generalizations about the process of language development. However, on the one hand, it is impossible to generalize individual data, while on the other hand, groups of learners cannot be followed over time due to ergodicity constraints. One possible way around this problem is to use cluster analyses to identify ergodic ensembles of learners showing similar behaviour over time. The first steps in this direction have been made (Peng et al., 2020), but there is still a long way to go. The recent book by Hiver and Al-Hoorie (2019) mentions several other promising methods for future development.

The missing link for speaking research is the CDST analysis of interaction over time during conversation. Promising developments have shown the application of GridWare (Hollenstein, 2013) to create dynamic state space grids that analyze the attractor states in interaction. The work of Smit et al. (2017) on student–teacher interaction in the classroom setting is a promising step in this direction.
Further Reading


In this contribution, Hiver and Al-Hoori review CDST research and sketch new directions for investigating second language development within this framework. The authors provide a template for methodological considerations for scholars who aspire to carry out CDST-inspired research.


This is a comprehensive and very accessible overview of all aspects of CDST applications to research into second language development. A must-read for people interested in this framework.


Levine has written a very comprehensive monograph on ecological language pedagogy using the CDST framework as a starting point. He works out all implications of complexity in an up-to-date discussion of language teaching in the ecological context of world readiness.


This is a study that specifically focuses on studying oral skills from a CDST-perspective, partly in contrast to writing skills.

References


