

Enacting a process ontology in applied linguistics: A synergy statement from an interdisciplinary Groningen-based group of scholars

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Abstract This paper addresses explanation, generalizability, causality, and non-ergodicity in L2 learning through the lens of Complex Dynamic Systems Theory. We make a plea for synergy and complementarity when researching L2 learning. We argue that both group-level studies as well as longitudinal case studies with dense data continue to be needed.

Keywords complex dynamic systems, non-ergodicity, case-study research, generalization

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Academic progress in the social sciences and humanities rarely proceeds in a linear fashion (Van Geert, 2025). It is also shaped by reciprocal interactions among researchers within interdisciplinary networks with roots in for instance psychology, pedagogical and educational sciences, and applied linguistics (Van Geert & De Ruiter, 2022). Through these interactions, ideas are exchanged, adapted, and extended and from this process new theoretical and methodological perspectives might emerge. In a network of scholars, each researcher contributes in a unique way, by bringing specific perspectives and questions into the system. Our own biographies illustrate how chance encounters can result in shifting perspectives and interdisciplinary collaborations. Wander Lowie, for instance, had just finished his dissertation at the University of Groningen under the supervision of Kees de Bot (Lowie, 1998). De Bot, who had previously worked in Nijmegen, had just taken over the Applied Linguistics chair in Groningen, which had unexpectedly become vacant after the sudden passing of Herman Wekker. At the same time, Paul van Geert, a professor of developmental psychology had been supervising the dissertation of Marijn van Dijk. Van Dijk's work focused on continuity, discontinuity and variability in early first

language development (see Van Geert & van Dijk, 2002; Van Dijk & Van Geert, 2007). Van Geert had arrived at the moment in time at which an assessment committee had to be assembled. De Bot accepted Van Geert's invitation to assess Van Dijk's thesis (2004). What emerged from Van Dijk's "rite de passage" was a collaboration between applied linguists Lowie, De Bot, and Verspoor with behavioral scientists Van Dijk and Van Geert, that is still ongoing. Years after Van Dijk's thesis defense, the interdisciplinary collaboration (Lowie, Van Dijk and De Bot) led to the supervision of Nienke Smit's thesis, which was titled "Get it Together" (2021). By that time, Lowie, together with Verspoor and De Bot, had developed a research strand (as well as an MA and PhD program) in which the terminology and the practical application of complex dynamic systems thinking was consolidated.

What the authors of this contribution and Wander Lowie share is a curiosity for what is complex and dynamic about developmental trajectories in language, learning and teaching. We might count and add up the years of our lives and careers that we have dedicated to applying and advancing Complex Dynamic System Theory (CDST), but the aggregate numbers are hardly reflective of our intertwined individual and collective trajectories, be it pre- or post-retirement age. Our interconnected biographies illustrate the non-ergodic nature of development in our academic work.

1 Complex Dynamic Systems Theory as an ontological lens

The metatheoretical principles of Complex Dynamic Systems Theory (CDST) may act as an ontological lens that helps us understand change processes (Van Geert & De Ruiter, 2022). CDST, an inherently interdisciplinary theoretical framework, offers principles like self-organization, emergence, variability and stability which are helpful when studying developmental phenomena (Van Dijk et al., 2024). Lowie's contributions demonstrate how CDST principles can be operationalized through rigorous individual analyses. As such, his work has also influenced the individual research trajectories of collaborators and PhD students. The *Modern Language Journal* paper by Atkinson and colleagues (2025), reprinted in this issue (Lowie, 2026), illustrates how Lowie fosters synergy between different research perspectives on second language development and teaching. Instead of framing theoretical differences as opposing camps, Lowie consistently seeks points of complementarity, promoting dialogue across theoretical traditions rather than conflict.

Lowie's research examines intraindividual variability and relationships between language variables within individuals, for instance through CAF (complexity, accuracy, and fluency) measures (Yu & Lowie, 2020). Lowie was among the first applied linguistics scholars who started working with detailed descriptive analyses and statistical techniques such as cluster analysis, fractal analysis, and retrodictive modeling (De Bot, 2015). Lowie states that "No variability implies that no learning is occurring" (Lowie, 2026, p. 6). His work is aligned with this claim and in doing so, he has advanced CDST theoretical

foundations by illustrating how language development is a process with characteristics that can be best understood by adopting fine-grained analytical methods to study change in dense longitudinal data (e.g., Lowie & Verspoor, 2019; Plat et al., 2018).

2 Generalization, non-ergodicity, causality and explanation

An important part of practicing science is to be aware of how underlying and implicit ontologies are enacted in and through the work of the scientist. This can be performed by making assumptions explicit and by evaluating to what extent claims hold up to scrutiny. In his contribution Lowie reiterates a common criticism of studies using the metatheoretical CDST lens: “Critics argue that the focus on case studies limits the ability to generalize findings to larger populations” (Lowie, 2026, p. 4). We will elaborate on this by focusing on the concepts of generalization, non-ergodicity, causality and explanation. These concepts are important in understanding the complementarity of standard population-based and case-based studies. In the standard approach, generalization is basically limited to applying information based on samples of independent individuals to larger samples, and, in the end to generalizing to the population (e.g. the population of Dutch adult learners of English) (Van Geert, 2011). However, generalization is much broader than this line of reasoning and, we argue, should also involve generalization to theory. For instance, we should also question to what extent does a particular time-serial case study generalize to a specific theory of dynamics, processes or mechanisms? An example that illustrates this problem is the L1 study by Van Dijk et al. (2013) about how case studies of co-evolving child speech and child-directed speech over the course of months generalize to an underlying dynamic model of child-adult interactions.

If, as in the standard approach, general knowledge is conceived of as knowledge that is true of a particular population, then individuals are specific cases of that population to which that knowledge applies. For instance, if a correlation between the success of L2 learning and motivation holds for a particular population, then the correlation holds for any individual in the population, plus or minus the effect of random factors. This brings us to the issue of ergodicity (Lowie & Verspoor, 2019) and the broader issue of statistical homology between inter- and intra-individual variability. Ergodicity means that the behavior of a single individual over a long period of time is statistically the same as the behavior of a large group at a specific moment in time. If the general-to-specific relation holds true for L2-learning, then L2 learning must be an ergodic process. This implies that L2 learning must be a stationary process with a fixed average and standard deviation, which is clearly untrue. Case studies of L2 development demonstrate that the learning process is highly idiosyncratic, that is person-specific, and that L2 learning is not an ergodic process. Individual development has its own dynamics and results from the interactions of many components on several levels of organization and with

characteristic timescales. This illustrates that there is no homology between statistical properties of a sample of individual cases and samples of states of individual processes. This absence of homology is a generalizable finding, irrespective of how many such case studies have been done (a number of cases that represent the population in an illustrative sense suffices). Since the question about the underlying dynamics of L2 learning cannot be answered by group studies, case studies of L2 learning based on sufficiently dense time series of observations continue to be needed, which supports our argument that group studies and case studies are complementary.

Lowie (2026) argues that “complex dynamic systems consist of an infinite number of changing components”, that “no component has causal priority” and that multicausality must be the norm (pp. 2-3). These statements are easily and often misunderstood as implying that everything explains everything else, hence, that complex dynamic systems theory explains nothing, and that it does not provide guidance for practical action or causal explanation. We are convinced that such a conclusion cannot be drawn, because we need to reckon with at least two important facts.

First, there are various theories of what explanation and causation actually mean. Van Geert and De Ruiter (2022) discuss the difference between – and complementarity of – manipulation causality and process causality. The first focuses on which factor, event or intervention makes a difference, given the nature of a particular system (e.g. which form of instruction is probabilistically related to a statistically significant outcome in L2 learning in a particular population). The second provides an explanation in the form of a process, from a given starting point through sequences of steps to a particular outcome or “production”. This can be observed for instance in the interactions between teachers and learners. Understanding the teaching-learning process provides insight in how teachers might adapt their teaching strategies and how learners might adapt their learning strategies. Our study about pedagogical translanguaging illustrates how L2 teachers who ask many questions but receive few answers in the L2 may increase responsiveness by mixing their use of both the L1 and L2 (Smit et al., 2023).

Second, multicausality and interwoven timescales and levels of organization (activity patterns, brain processes etc.) can be described in the form of specific networks of interacting components, in particular by focusing on components that are open to observation and interaction in real time. Examples are networks of different kinds of activity, perception, affordances of the environment etc. By focusing on the properties of such networks, specific properties can be predicted and used in scientific and practical action. For instance, these networks may contain so-called “hubs”, that is, components that link many other components and that can serve as leverage points for teachers. In some learners, this leverage point can be foreign language anxiety, in others it might involve specific contexts of communication (Freeborn et al., 2023). Finding such leverage points requires adaptive learner-context interactions and teacher openness for the idiosyncratic and interactive nature of the learning process.

3 Still learning: how the work will be relevant in the future

As stated earlier, Lowie argues for synergy between different (and in some aspects contrasting) research perspectives on second language development and teaching. Synergy literally means “to work together” (Michel et al., 2025). Building on insights from coordination dynamics (Kelso & Engström, 2024), complex systems are characterized by fundamental complementarities. Complementarity means that the world must be understood in terms of functionally intertwined apparent opposites. They are positions that coexist and define one another. One such complementarity concerns system and process: the notion of a system cannot be separated from that of process, and vice versa. A second key complementarity is that between variability and stability. Depending on the problem and context, the emphasis may be on either of the two, without ever being an issue of exclusion. Together, these complementarities clarify how synergy can emerge from perspectives that appear to be in tension rather than contradiction.

The interest in process-oriented research, across research fields, is on the rise in the social sciences and humanities. CDST has stimulated the adoption and development of new analytical methods suited to capturing non-linear developmental trajectories (see for instance the work on individualized interventions in youth care (Strunk & Lichtwarck-Aschoff, 2019), studies in cognitive development (Judd et al., 2024) and classroom interactions (Esqueda Villegas et al., 2025)). For applied linguistics, the CDST framework has broadened the range of research questions, particularly by focusing on developmental change and short-term interaction dynamics in second language learning (Freeborn et al., 2023; Wu et al., 2025). Within L2 dynamic systems research, studies currently typically address three central concerns: individual differences in developmental pathways, complex interactions among linguistic variables, and variability within the same learner over time. Lowie (2026) wrote “I am still learning” (p. 1). To all of us, the beauty of studying functionally intertwined apparent opposites through the CDST ontological lens affords us to stay lifelong learners.

Personal note

Dear Wander,

As a team we can only, in a characteristically non-linear fashion, invite you to circle back to the contribution which you have just read: it sums up our shared history. For the future, we would like to add our heartfelt wish here: may you ice-skate and cycle into your dynamic new phase of life with the same flexibility, energy, humor, and data-driven spirit that we have come to appreciate so much. As a closing line, we would like to reiterate the final sentence of our contribution: to all of us, the beauty of study-

ing functionally intertwined apparent opposites through the CDST ontological lens affords us to stay lifelong learners. Thank you for learning, collaborating and changing together.

Nienke, Paul, Kees, and Marijn

Author contributions

Nienke Smit: conceptualization, writing – original draft, project administration; Paul van Geert: conceptualization, writing – review and editing; Kees de Bot: conceptualization, writing – review and editing; Marijn van Dijk: conceptualization, writing – review and editing.

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