

Advancing applied linguistics: Implications for learners, classrooms, and language technologies

Rasmus Steinkrauss¹, Hanneke Loerts¹, Greg J. Poarch¹ and Sake Jager¹

¹*University of Groningen*

Abstract This contribution examines how Complex Dynamic Systems Theory reframes individual differences in SLA/T as emergent, context-sensitive, and non-linear processes. It discusses implications for longitudinal research on learner variability, multilingual classroom attitudes, and technology-enhanced learning, including CALL and generative AI. We argue that variability is meaningful and that group-based and individual longitudinal approaches should be treated as complementary in Applied Linguistics.

Keywords complex dynamic systems, computer-assisted learning, individual differences, longitudinal research

Article history

Received: February 15, 2026

Accepted: June 1, 2026

Online: October 14, 2026

Corresponding author

Rasmus Steinkrauss, r.g.a.steinkrauss@rug.nl

Response article

This article is part of a festschrift in honor of Wander Lowie. It is a response to Lowie, W.M. (2026). A complex dynamic systems approach to L2 development as a metatheory of language learning and teaching. *Dutch Journal of Applied Linguistics* 15: DOI 10.51751/dujal26925, reprinted with permission from Atkinson et al. (2025).

Author contributions

Funding information

Statement of interest

Statement of technology use

Supporting information

See p. 6–7

In his contribution, Lowie (2026, this issue; reprint of Atkinson et al., 2025) articulates Complex Dynamic Systems Theory (CDST) as a theoretical lens for understanding individual differences in second language development. Rather than treating variability across learners as reducible to fixed traits or static predictors, Lowie frames learners as complex, dynamic systems whose trajectories emerge from the ongoing interaction of cognitive, affective, social, and contextual factors. In Lowie's account, development is inherently non-linear, punctuated by variability that should be construed not as noise but as meaningful evidence of system change. Moreover, he critiques approaches that rely on cross-sectional group averages, arguing instead for longitudinal, intra-individual designs capable of capturing variability and temporal change. This process-oriented view shifts explanatory emphasis from static traits to dynamic interactions and emergent patterns over time.

Building on Wander Lowie's perspective, the present reflection examines the implications of a complex dynamic systems perspective for (research into) the individual learner, the multilingual classroom, and technologies in Second Language Development (SLD) and teaching.

How to cite Steinkrauss, R., Loerts, H., Poarch, G.J. and Jager, S. (2026). 'Advancing applied linguistics: Implications for learners, classrooms, and language technologies', *Dutch Journal of Applied Linguistics* 15: DOI 10.51751/dujal27680

Copyright © Author(s); licensed under Creative Commons Attribution 4.0

1 The individual learner: Variability and performance

A central implication of Lowie's perspective concerns the tension between generalizing to larger populations and focusing on individual trajectories. He does not dismiss traditional statistics, but stresses that we should recognize "that research methods only address specific questions" (2026, this issue, p. 5). Furthermore, traditional research in the field often relies on aggregating across individuals to identify patterns and more "global grand-sweep effects" in larger groups (p. 2). Lowie highlights that doing so may very well mask individual non-linear pathways that are crucial for our understanding of a learner's development over time.

Development is change over time and it is usually not linear. Learners can be seen as a complex system in their own right and their developmental process cannot be fully captured by using averages and "product" measures. As highlighted by Lowie, we need multiple longitudinal case studies to uncover patterns that would be masked in aggregated group studies. A key goal of such longitudinal learner data studies is often to identify inter-individual variability – the differing developmental paths among learners – and intra-individual variability – the fluctuations within a single learner's trajectory. For example, Lowie and Verspoor's seminal 2019 study of 22 Dutch learners of English revealed considerable inter-individual variability in the learners' text quality development over one year: no two learners developed in the same way (see also Fig. 1 in DeWilde et al., this issue, for a reanalysis of these data). Importantly, none of the traditional individual difference factors predicted the learners' development rates, but the amount of intra-individual variability did: greater individual variability in text quality over the year predicted larger overall gains. As Lowie notes, "variability in language production is related to developmental steps" (2026, this issue, p. 4).

This mechanism transcends individual cases, illustrating how "longitudinal case studies are most suitable to explore the principles and mechanisms of the developmental process" (2026, this issue, p. 5). It also counters Pallotti's (2022) critique that CDST's focus on case studies limits generalizability. More specifically, the discovery of this mechanism lays the foundation for two testable hypotheses (Verspoor & De Bot, 2022): Higher intra-individual variability is 1) a sign of the diminished stability of a system, and 2) associated with more development in the system (e.g., larger gains in proficiency).

With Van Dijk and colleagues (2025, p. 8), we argue that CDST-inspired Applied Linguistics is now at a critical juncture to move from exploring variability (Hiver et al., 2022) to testing hypotheses about developmental processes (Li & Zheng, 2025). While investigations testing the first hypothesis are still rare (e.g., Huang et al., 2022), the second has explicitly been tested (and confirmed) by multiple recent studies (e.g., Baba & Nitta, 2021; Gui et al., 2021; Huang et al., 2021; Lowie & Verspoor, 2019; Pfenninger & Kliesch, 2023; Qin et al., 2024).

In this process, a crucial challenge for Applied Linguistics, apart from the problems of determining how to measure variability (Verspoor & De Bot, 2022) and separating

measurement-related from performance-related variability (Thelen & Smith, 1994, p. 86; Wu et al., 2025), will be to go beyond merely quantifying variability to exploring its function in language learning.¹

If variability enables organisms to find better adaptive solutions (Thelen & Smith, 1994), if “there is no selection of new forms if there is no variation” (Lowie & Verspoor, 2019, p. 191), then what are the selected new forms of language use that constitute a better adaptation to a specific communicative context? When greater variability in, for example, a measure of complexity, accuracy or fluency (CAF) correlates with greater gains in that measure, how does this reflect selecting a more fitting language strategy? Studies examining how learners explore different strategies for communicative purposes (e.g., Lesonen et al., 2021, on expressing evaluation, varying between verbal and adjectival constructions; Verspoor et al., 2008, on expressing negation using different constructions) may offer a path towards answering this question, shifting the focus from variability as a statistical predictor to its functional role in fostering developmental gains.

2 The social context: Attitudes and multilingual classrooms

Lowie’s CDST perspective foregrounds the relational, context-embedded nature of learning processes. Individual differences are thus understood not as isolated attributes but as emergent outcomes of systemic interaction within environments that include pedagogical practices, peer interactions, learner identities, and experiential histories. This theoretical move resonates with broader calls in Applied Linguistics to attend to the ecological and developmental complexity of language acquisition.

Although Lowie does not specifically address multilingual classrooms, applying his CDST insights to contexts characterized by linguistic diversity – such as Dutch primary school settings in which learners may have varied home languages and multilingual repertoires – illuminates important considerations for research and practice. One such consideration concerns students’ attitudes toward the inclusion of home languages in instructional contexts. In their recent study, Albaugh and Poarch (2025) investigate how primary school students perceive the inclusion of home languages, revealing that many hold neutral rather than strongly positive attitudes toward incorporating home languages into classroom practices, and that proficiency, usage, and identity interact in shaping those attitudes.

From a CDST perspective, these attitudes can be seen as part of a dynamic repertoire of learner beliefs and identity constructions that interact with classroom norms and learning experiences. Learners’ dispositions toward home language inclusion are not fixed preferences but evolving patterns shaped by ongoing engagement with peers, the curriculum, and their own linguistic histories. A dynamic account encourages researchers to examine how students’ attitudinal trajectories change over time as they experience

different classroom practices, and how these shifts correlate with academic engagement and language development outcomes.

Pedagogically, integrating CDST with findings like those of Albaugh and Poarch suggests that educators should design learning environments that acknowledge and adapt to variability in learners' attitudes and repertoires, rather than imposing one-size-fits-all inclusion policies. CDST thus supports more responsive, context-sensitive approaches to multilingual pedagogy that treat both linguistic practices and individual attitudes as emergent, interactive phenomena that evolve through classroom engagement.

In sum, Lowie (2026) invites a dynamic, process-sensitive reconceptualization of individual differences, and – when complemented with empirical work – underscores the value of attending to attitudinal and repertoire dynamics in multilingual educational settings.

3 Beyond the classroom: Technology and SLA/T

Finally, Lowie's CDST perspective on SLD also fits in naturally with contemporary views on computer-assisted language learning (CALL). He argues that “the teacher's task is to create optimal conditions for learning to develop. These conditions should allow individual learners to build on their own learning experiences and encourage them to use language freely in a safe environment.” (2026, this issue, p. 5). Creating optimal conditions for learning by building on the affordances of technology constitutes the core of CALL practice and research (e.g., Doughty & Long, 2003). CALL recognizes that language learning is a highly individual process in which technology may be used to create adaptive, personalized learning experiences and to provide safe and engaging learning environments conducive to language development (Chapelle & Sauro, 2017; Ziegler & González-Lloret, 2022).

A distinction is traditionally made between tutorial and tool applications of technology (Hubbard & Siskin, 2004). Tutorial applications embody aspects normally associated with the role of the teacher, such as providing guidance, explanations, and assessment. Tool applications, by contrast, relate to the use of generic computer applications, such as email, chat, and video conferencing, for language learning. Informed by cognitive interactionist and sociocultural traditions, Task-Based Language Teaching (TBLT) provides a well-known framework to help teachers to select and combine technology applications for engaging students in meaningful tasks, while heeding linguistic aspects of task performance at the same time (González-Lloret, 2024).

The CDST perspective helps to better perceive technology as an external influence in formal and informal SLD settings, with widely varying learning trajectories for individual learners, in which classroom based-teaching provides at best a small window of opportunity. CDST invites us to also look outside this window and consider the role of technology in the broader context for language development over time.

In this respect, Generative AI (GenAI), which is likely to affect education and professional and personal lives like no technology before, provides many of the affordances experts have been looking for in CALL during the past 30 years (cf. Hubbard & Schulze, 2025). The text or voice-based chat interface offers unprecedented possibilities for individual tutoring, situated multimodal dialogue in virtually any language, image and video generation in support of real-life tasks in TBLT and content knowledge on any topic in Content-and-Language-Integrated Learning (CLIL). And giving learners control of the learning process aligns perfectly with the well-established concepts of promoting learner agency and autonomy.

The role of the teacher in navigating these resources for designing optimal conditions for language learning is more challenging than ever (Ohashi et al., 2025). Indeed, some AI companies would claim that the role of the teacher will soon be redundant (Huddleston Jr, 2025). However, in line with Lowie's argument, it should be recognized that language learning "rarely happens in isolation" (2026, this issue, p. 6). It occurs in a process of social interaction, which builds on learners' lived experiences – for which GenAI cannot offer an alternative. SLA/T is "relational and ecological" (Atkinson et al., 2025, p. 56) and in designing opportunities for learning, person-to-person interactions should be integrated, with and without technology as the situation requires.

In relation to CALL research, CDST promotes a stronger focus on development over time, inviting longitudinal studies which go beyond the usual timescale of classes taught for a specific period. Several CDST studies in CALL in which Lowie was involved as a PhD supervisor exemplify this approach (Peng, 2021; Peng et al., 2020, 2022). Even more could be gained, as suggested by Lowie (2026, this issue, p. 6), by implementing personal portfolios to demonstrate the learner's evolving communicative competencies over time. Digital portfolio tools, such as Mahara (<https://mahara.org/>) and recognized models, such as the European Language Portfolio (<https://www.coe.int/en/web/portfolio>), are available to support this approach. New avenues for longitudinal research are also facilitated through Learning Analytics tools integrated in many learning management systems today. Although, as argued above, this would still provide no more than a limited view of the complex process of SLD going on over time.

To conclude, we view generalization based on group data and non-linear time-series data based on individuals as complementary – the former for summarizing more general tendencies, the latter for illuminating dense and non-linear pathways underlying language development – and, in line with Lowie, argue that both types of research are needed for advancing Applied Linguistics.

Personal note

Sake: Dear Wander, we have shared an interest in using technology for language learning from the early 90's when we both started in the English Department until today. Our

paths separated professionally – you focused on language learning and I on technology – but our friendship deepened and we continued to work together in innovation projects and in the Applied Linguistics programme on technology-related topics. Although our professional careers have now formally come to an end, our friendship continues and our interest in technology will probably continue to develop in innovative ways!

Rasmus: Dear Wander, I feel incredibly lucky to have had you as a close colleague and head of our chair group. Your kind, sensible, and sensitive approach to everything, and your leadership style based on integrity, openness, and a consideration of everyone involved was a blessing to witness. In our meetings, I enjoyed tremendously how we would continually dive deeper into theoretical discussions and end up with more questions than answers. I will miss this. But most of all, I will miss your support and guidance – and our talks about (university) politics, food, and cats.

Greg: Dear Wander, it has been a genuine privilege to teach the “Theory of Second Language Development” course alongside you over the past six years. I deeply appreciate the flexibility and care you brought to both our teaching and our grading practices. At the same time, I have also learned a great deal from your thoughtful perspectives on university and faculty policy. Your collegiality, judgment, and steady presence made university life much more pleasant (not so much the cycling with you, though). You will be sincerely missed, both in the classroom and as a trusted colleague and friend.

Notes

- 1 It must be noted that stability also has its function for development. If, to take a random example, a chair group in Applied Linguistics is considered a system in Lowie’s terms, namely “composed of coupled components working together to achieve a collective purpose” (2026, this issue, p. 2), then the stability provided by the head of the group (the full professor) can afford the other components, a.k.a. his colleagues, the freedom to develop and thrive individually.

Author contributions

Rasmus Steinkrauss: conceptualization, Writing – original draft, Writing – review and editing; Hanneke Loerts: conceptualization, Writing – original draft, Writing – review and editing; Greg J. Poarch: conceptualization, Writing – original draft, Writing – review and editing; Sake Jager: conceptualization, Writing – original draft, Writing – review and editing.

Funding information

No funding was received for this study.

Statement of interest

The author(s) have declared that there were no conflicting interests.

Statement of technology use

No AI-based generative technology was used in the preparation of this manuscript and the execution of the research that the manuscript reports upon. Or see: Technology Use | Dutch Journal of Applied Linguistics (dujal.nl)

Supporting information

None.

References

- Albaugh, C.L., & Poarch, G.J. (2025). Sure, I can, but do I want to? Exploring attitudes toward Home Language inclusion in the classroom: Perspectives of primary school students. *Journal of Multilingual and Multicultural Development*, 1-19. <https://doi.org/10.1080/01434632.2025.2589338>
- Atkinson, D., Mejía-Laguna, J., Ribeiro, A.C., Cappellini, M., Kayi-Aydar, H., & Lowie, W. (2025). Relationality, interconnectedness, and identity: A process-focused approach to second language acquisition and teaching (SLA/T). *The Modern Language Journal*, 109(S1), 39-63. <https://doi.org/10.1111/modl.12982>
- Baba, K. & Nitta, R. (2021). Emergence of multiple groups of learners with different writing-development trajectories in classroom: Growth mixture modeling. *Journal of Second Language Writing* 54, 100856. <https://doi.org/10.1016/j.jslw.2021.100856>
- Chapelle, C.A., & Sauro, S. (2017). *The Handbook of Technology and Second Language Teaching and Learning*. Wiley Blackwell.
- Doughty, C.J., & Long, M.H. (2003). Optimal psycholinguistic environments for distance foreign language learning. *Language Learning & Technology*, 7(3), 50-80.
- González-Lloret, M. (2024). The future of language learning teaching in a technology-mediated 21st century. *The Modern Language Journal*, 108(2), 541-547. <https://doi.org/10.1111/modl.12928>
- Gui, M, Chen, X., & Verspoor, M. (2021). The dynamics of reading development in L2 English for academic purposes. *System* 100, 102546. <https://doi.org/10.1016/j.system.2021.102546>
- Huang, T., Steinkrauss, R., & Verspoor, M. (2022). Learning an L2 and L3 at the same time: help or hinder? *International Journal of Multilingualism*, 19(4), 566-582. <https://doi.org/10.1080/14790718.2020.1779726>
- Huang, T., Steinkrauss, R., & Verspoor, M. (2021). Variability as predictor in L2 writing proficiency. *Journal of Second Language Writing* 52, 100787. <https://doi.org/10.1016/j.jslw.2020.100787>
- Hubbard, P., & Siskin, C.B. (2004). Another look at tutorial CALL. *ReCALL*, 16(2), 448-461. <https://doi.org/10.1017/S0958344004001326>
- Hubbard, P., & Schulze, M. (2025). AI and the Future of Language Teaching: Motivating Sustained Integrated Professional Development. *International Journal of Computer-Assisted Language Learning and Teaching*, 15(1), 1-17. <https://ideas.repec.org/a/igg/jcallt/v15y2025i1p1-17.html>
- Huddleston Jr, T. (2025, March 26). *Bill Gates: Within 10 years, AI will replace many doctors*

- and teachers – humans won't be needed "for most things." CNBC. <https://www.cnn.com/2025/03/26/bill-gates-on-ai-humans-wont-be-needed-for-most-things.html>
- Hiver, P., Al-Hoorie, A.H., & Evans, R. (2022). Complex Dynamic Systems Theory in Language Learning: A Scoping Review of 25 Years of Research. *Studies in Second Language Acquisition* 44(4), 913-941. <https://doi.org/10.1017/S0272263121000553>
- Lesonen, S., Steinkrauss, R., Suni, M., & Verspoor, M. (2021). Dynamic usage-based principles in the development of L2 Finnish evaluative constructions. *Applied Linguistics*, 42(3), 442-472. doi:10.1093/applin/amaa030
- Li, H., & Zheng, Y. (2025). Exploring the Emergence of Global-Level J-shaped Patterns From Local-Level Dynamics in L2 Syntactic Complexity Development: A CDST Perspective. *International Journal of Applied Linguistics*, 35(4), 1967-1981. <https://doi.org/10.1111/ijal.12744>
- Lowie, W. (2026, this issue). A complex dynamic systems approach to L2 development as a metatheory of language learning and teaching. *Dutch Journal of Applied Linguistics*. <https://doi.org/10.51751/dujal26925>
- Lowie, W.M., & Verspoor, M.H. (2019). Individual Differences and the Ergodicity Problem. *Language Learning*, 69(S1), 184-206. <https://doi.org/10.1111/lang.12324>
- Ohashi, L., Hillis, M., & Dykes, R. (2025). *Artificial Intelligence in Our Language Learning Classrooms*. Candlin & Mynard ePublishing.
- Pallotti, G. (2022). Cratylus' silence: On the philosophy and methodology of complex dynamic systems theory in SLA. *Second Language Research*, 38, 689-701. <https://doi.org/10.1177/0267658321992451>
- Peng, H. (2021). *A Holistic Person-Centred Approach to Mobile Assisted Language Learning* [University of Groningen]. <https://doi.org/10.33612/diss.172696334>
- Peng, H., Jager, S., Thorne, S.L., & Lowie, W. (2020). A holistic person-centred approach to mobile-assisted language learning. In W. Lowie, M. Michel, A. Rousse-Malpat, M. Keijzer, & R. Steinkrauss (Eds.), *Usage-based dynamics in second language development* (pp. 87-106). Multilingual Matters. <https://doi.org/10.21832/9781788925259-007>
- Peng, H., Lowie, W.M., & Jager, S. (2022). Unravelling the Idiosyncrasy and Commonality in L2 Developmental Processes: A Time-Series Clustering Methodology. *Applied Linguistics*, 43(5), 891-911. <https://doi.org/10.1093/applin/amac011>
- Pfenninger, S., & Kliesch. (2023). Variability as a functional marker of second language development in older adult learners. *Studies in Second Language Acquisition* 45, 1004-1030. <https://doi.org/10.1017/S0272263123000013>
- Qin, W., Li, H., & Zheng, Y. (2024). Group trends and individual variability in writing development: A descriptive grammatical complexity analysis. *International Review of Applied Linguistics in Language Teaching* 62(1), 37-60. <https://doi.org/10.1515/iral-2023-0011>
- Thelen, E., & Smith, L.B. (1994). *A dynamic systems approach to the development of cognition and action*. MIT Press.
- Verspoor, M., Lowie, W.M., & Van Dijk, M. (2008). Variability in Second Language Development from a dynamic systems perspective. *Modern Language Journal*, 92(2), 214-231. doi:10.1111/j.1540-4781.2008.00715.x

- Verspoor, M. & de Bot, K. (2022). Measures of variability in transitional phases in second language development. *International Review of Applied Linguistics in Language Teaching*, 60(1), 85-101. <https://doi.org/10.1515/iral-2021-0026>
- Van Dijk, M., Lowie, W.M., Smit, N., Verspoor, M., & Van Geert, P. (2025). Complex dynamic systems theory as a foundation for process-oriented research on second language development. *Second Language Research*, 41(4), 805-819. <https://doi.org/10.1177/02676583241246739>
- Wu, M.Y., Steinkrauss, R., & Lowie, W.M. (2025). Variability analysis using CAF measures. In Lowie, W.M., Rosmawati, & de Wilde, V. (Eds). *Research Methods in Applied Linguistics* (pp. 167-190). John Benjamins. <https://doi.org/10.1075/rmal.14.09wu>
- Ziegler, N., & González-Lloret, M. (Eds.). (2022). *The Routledge Handbook of Second Language Acquisition and Technology*. Routledge. <https://doi.org/10.4324/978135117586>