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Editorial: Social physics and the dynamics of second language acquisition

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Editorial on the Research Topic
Social physics and the dynamics of second language acquisition

This Research Topic was motivated by a desire to stimulate interest in exploring the relevance of physics to second language (L2) development, an endeavor deemed by the vast majority on "both sides of the aisle"–physics and applied linguistics–as unimaginable. Although the field of applied linguistics over the last 2 decades has seen growing discussion of complexity theory, direct interaction with physics has remained sparse, as has the use of mathematics as a tool of theorizing. The main impediments are both technical and conceptual. Technically, direct engagement with insights from physics requires knowledge of physics and mathematics. Conceptually, there has been a prevailing perception in applied linguistics that natural science is about the physical world, while L2 acquisition is more of a humanities subject, as it concerns human cognition and behavior.

The present Research Topic defies the general perception and operationalizes the assumption that physics and mathematics have much to contribute to our understanding of L2 development. In particular, they can be enlightening about some of the recalcitrant issues associated with (adult) human learning of non-primary languages. This Research Topic features four papers, a synopsis of which follows.

Addressing the notion of a critical period in language development and a chronic debate surrounding it in L2 research, Han and Bao extend an interdisciplinary theory, Energy Conservation Theory for L2 Acquisition (ECT-L2A), to a widely observed attainment gap between child and adult L2 learners. Invoking the physics laws of energy conservation, angular momentum and gravity, ECT-L2A draws analogies between physical energies and L2 learning energies - kinetic energy for motivation, potential energy for the influence of the target language, and centrifugal energy for the deviation between the learner's first language and target language, and theorizes the dynamics of L2 attainment. ECT-L2A not only theoretically and geometrically confirms the existence of a critical period, but also mathematically identifies three learning periods: critical, post-critical, and adult. The authors close with three sets of questions corresponding to the three learning periods, inviting empirical investigations.

Kim reports on a partial validation of ECT-L2A, focusing on the dynamic role of kinetic energy, that is, L2 motivation and aptitude, vis-à-vis L2 attainment. The study measures motivation and aptitude as well as grammatical ability in 203 adult Spanish-speaking learners of L2 English, statistically analyzing their relationships. Among the findings, (a) aptitude holds a positive correlation with attainment; (b) motivation decreases with advancing attainment; and (c) a combination of aptitude and motivation against grammatical ability yields a non-linear trajectory, as predicted by ECT-L2A. Therefore, the study confirms ECT-L2A's depiction of the changing role of L2 "kinetic energy," and, simultaneously, debunks the mainstream understanding of motivation as playing a static role in, or having an isomorphic relationship with, L2 attainment.

Studying language use as a complex system, Tilsen seeks to pin down linguistic behavior as a non-equilibrium, open system. In order to overcome the challenges of defining the system and its components, Tilsen conducts a longitudinal experiment. He creates an 'insulated' system free from external influences and observes the interaction among the system components within. The closed system comprises an ad-hoc social network with 8 participants playing 535 dyadic map-navigation games for 10 weeks. The analysis of the data reveals orderly states, "an exponential decay-like pattern" over time amid seemingly disordered linguistic behaviors. Participants' linguistic behavior changes as a result of the aggregated effects of communicative interactions and it percolates through the social network. The study exemplifies a methodological approach to studying a putatively open, non-equilibrium system, which leads to useful inferences about language change.

Finally, Van Geert presents a dynamic systems model of L2 learning. The building of this model begins with a number of fundamental assumptions. The overarching assumption is that a learner's proficiency changes at any moment in time, manifested as a (re)distribution of potentialities, incurred by the learner's changing circumstances of using the L2. Another major assumption is that the learning process is normative in that the learner seeks to conform to the L2 speaking community (through interactions with native speakers of the L2). Accordingly, the model operates on two dynamic components: the L2 learner (i.e., represented by their changing proficiency) and the learning environment (e.g., the learner's social interlocutors). Focusing on system rather than agent dynamics, the model uses ratio scales and treats the two components categorically, with a view to uncovering systematic, intra-individual variations, and in turn, inter-learner variations.

The four studies, theoretically and empirically, demonstrate the plausibility as well as the feasibility of applying a physics lens to studying language development phenomena. But most importantly, they showcase the viability of adapting a fundamental physics method to studying language development. The method begins by creating or assuming a closed system (i.e., a well-defined system) and traces its dynamic process over time within individual learners and, by extension, between learners. Crucially, such a system encompasses a three-dimensional interaction involving the learner, the environment, and time. As shown, the physics and mathematics informed approach channels explanations of the learning phenomena in question and enables predictions to be made. Both ECT-L2A and the dynamics systems model are forecasting models.

Still, the physics-informed approach may take years if not decades to gain traction, due to the long-entrenched perception in the field of applied linguistics (and psychology, for that matter) of the uniqueness of human behavior and the concomitant rejection of physics as relevant. Nonetheless, we believe that this topic collection of papers marks an indelible beginning.

We hope that the work presented here will spark interest between physics and social sciences (humanities included) in examining the interfaces across these disciplines and in simultaneously uncovering universalities and idiosyncrasies, which we believe are true for both natural and social phenomena. Such endeavors will ultimately help to advance a holistic and comprehensive understanding of complexity and causality in the relationship between the physical world and humanity.

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