

The Terraced Labyrinth Framework For Modelling Language Emergence

Part Two - The External Model

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Introduction

The Terraced Labyrinth model of language and language learning originated in the field of Evolutionary Computation as an alternative to the standard fitness landscape. Language evolution and acquisition, along with other dynamical systems, exhibit epochal evolution—"...behavior in which long periods of stasis in an evolving population are punctuated by sudden bursts of change." (Crutchfield and van Nimwegen, 1999, p. 1) The Terraced Labyrinth differs from the usual fitness landscape in that it utilizes a subbasin and portal architecture to model emergence as a phase transition between levels within a multidimensional framework. An understanding of the separation of scale is necessary to comprehend the place of Second Language Acquisition (SLA) in the current model. Acquisition is a form of emergence, a phenomenon that seems to have a fractal presence in our space-time continuum. Painted in broad strokes, it stretches from the Big Bang instant when Planck-length superstrings began to sing out existence in 11 dimensional Calabi-Yau shapes (Green, 1999), through the coalescence of hydrogen and helium, the flash of nuclear fusion, the formation of solar systems, and the jump from inorganic to organic. Narrowing the focus to our earthly biosphere, life emerged,

and adapted under the random variables of gravity, atmospheric composition, and catastrophic collisions with cosmic debris to the tune of epochal evolution. Mammalian, primate then hominid minds coevolved with social systems through the Peircian levels of Iconic, Indexical, and Symbolic consciousness until reaching today's post-modern level of language and culture (Deacon, 1992 ; Mithen, 1995 ; Noble and Davidson, 1996). Sausaurre referred to *langue* and *parole*, Chomsky discussed *performance* and *competence*, and Hymes talked of *linguistic competence* versus *communicative competence*. This paper, however, will focus on language acquisition at two levels, Part 1, which was presented last year, will introduce the Terraced Labyrinth, and will introduce the neurolinguistics and psycholinguistics of the internal model, while Part 2 will concern itself with an external model of sociolinguistics. The reader should keep in mind that the two sections do not refer to a linear progression, one does not follow the other, rather they are nonlinear and simultaneous, merely separated by the phase transition of emergence and scale.

1 Terraced Labyrinth-The External Model

1.1 Vygotsky's Zone of Proximal Development

Human language is a social construct, and it is divided into subbasins or modules called speech communities. Language classes straddle the fuzzy boundaries between the L1 and the L2. The sum of the individual student genotypes forms the class genotype, and the jump from the consciousness of a single learner to the group consciousness of the class is a phase transition from a microstate to a macrostate. This is a phase transition on a fractal scale of magnitude. Though the mechanism is the same, this should not be confused with the phase transition of language emergence within the singular consciousness of the individual student as it moves through a portal to a subbasin on a higher hierarchical level. Two of the commonest examples in the physical world of phase transitions are ice melting to become water, or the molecules of iron moving into a bipolar spin alignment as it is transformed into a magnet. The macrostates (phases) on either side of the transition are distinguished by different sets of macroscopic variables, and passing through a phase transition is creating or destroying macroscopic variables and making or breaking the symmetries associated with them (Crutchfield and van Nimwegen, 1999). The physicist and Nobel Laureate Murray Gell-Mann refers to this focus on different scales in a complex adaptive system as 'fine graining' (Gell-Mann, 1994).

The Russian psychologist L. S. Vygotsky, when speaking of a child's L1 acquisition, had this to say :

We propose that an essential feature of learning is that it creates the zone of proximal development ; that is, learning awakens a variety of internal development processes that are able to operate only when the child is interacting with people in his environment and in

cooperation with his peers. Once these processes are internalized, they become part of the child's independent developmental achievement." (Vygotsky, 1978)

From this it can be inferred that the internal Terraced Labyrinth framework can only operate in conjunction with the external Terraced Labyrinth, and one cannot occur in isolation from the other. They are partners in the dance of a dynamic, nonlinear, complex adaptive system.

1.2 Variable Components of the Classroom

The six classes of variables that effect the fitness, or probability of mastering a feature once the constellation is completed, are :

1. Students
2. Teacher(s)
3. The materials
4. The environment
5. The administration
6. Society/Culture

Section 1 explained the mechanism by which *students* acquire the L2. Though we are focusing on the classroom environment, it should be understood that the term 'classroom' could have a wide range of meanings for the L2 student. Beyond the traditional school classroom, the 'classroom' of an ESL student can also include daily life in the L2 speaking country. If a student is self-taught, then the 'classroom' can be the student's home. The student variables include the number, gender, and ages of the other students, the L2 level(s) of other students, and disabilities-blindness, deafness, etc. It should be pointed out that communication takes place at the level of equivalent constellation, so one or more of the participants in a conversation may not be able to use all of their activated basins.

When two or more students of multiple levels engage in communication, the level of the discourse must remain at the level of comprehensible input accessible to the student on the lowest terrace.

The *teacher's* job is to move the optimum number of students through portals to higher terraces. The 'teacher' is always one of the variables, even in a situation where the student is self-taught. The leverage point in the classroom) is the teacher. He or she should be the catalyst that triggers language emergence. The teacher has control, though always only partial, of the other five variables. It should be kept in mind that classes can devolve just as easily as they can evolve. Increased chaos can be the cause of broken connections, and miscommunication. Chaos can be thought of as random variations in the variable values. However, measured doses of chaos are an aid to acquisition, so it is the teacher's job to focus and regulate it.

The *materials* come in many forms. The most common is the textbook, but, in the 21st century world of high tech language learning, computers, CALL software, videos, DVDs, mp3 players and the Internet are all possible sources for material. It is essential that the teacher choose the optimum combination of materials (in light of the other variables) to facilitate the student's progress through the terraced labyrinth. Connections to previously acquired language levels will increase the total classroom genotype's fitness level.

The *environment* in which learning takes place can help, hinder or be neutral. For example, which is better, a huge old lecture hall with fixed desks, or a modern CALL lab with the latest computers? A comfortable den ; the streets of a big city ; a tree-shaded college campus-harsh winter and shivering students can detract from optimal learning

as much as the white sands and palm trees of a Thai beach paradise. As in most situations, the middle path between the extremes is probably the most favorable.

In most situations the best *administration* is one that is invisible. The administration should provide qualified teachers with the freedom to teach the class in the appropriate manner. The worst administration imposes unrealistic goals and painful restrictions on the classroom environment. In the case of self-taught students, the administration is another term for the local government.

The *society* variable is multileveled. First the culture of the L2 must be taken into consideration. Afghan Dari, British English, Japanese, Mexican Spanish, Swahili etc. all need to be taught differently. Then the relationship between the other variables and the culture of the L1 must be accounted for. Islamic countries are rather unfavorable towards women in education, whereas a class in California might be more concerned with indoctrinating the student with radical feminism or Gay Pride than it would be with providing meaningful examples of past tense irregular verbs in a context more relevant to the student's actual lives.

1.3 The Terraced Labyrinth Classroom

The Terraced Labyrinth model of language emergence is not meant to replace previous models, but to compliment them, using complexity to provide a new perspective to understanding the classroom. The evolutionary biologist Dr. Stuart Kauffman of the Santa Fe Institute and the physicist Per Bak of Brookhaven Laboratories combined their expertise in autocatalytic sets and self-organized criticality to model populations co-evolving on NKCS Fitness Landscapes. (Kauffman, 1995, Bak, 1996) When applying their fitness landscape model to language emergence, we find that the students tend

to move between attractors. A classroom will have students moving between the ordered realm and the chaotic realm, and it is the teacher's job to direct the students to the 'edge of chaos'. Emergence is synonymous with self-organized criticality. Looking at the model from a Terrace Labyrinth perspective, activities that push the student to the 'edge of chaos' combine equilibrium with just enough unpredictability (chaos) so as to provide optimum conditions for the students' constellations to be set to the next target language portal. The subbasin and portal architecture can then be viewed as a multi-layered hierarchy of fitness landscapes. It is this multidimensionality of emergence that their model was lacking, and which is a necessity when applying it to the language classroom.

The computer scientist John H. Holland, the creator of the genetic algorithm, abstracted seven basic elements common to all complex adaptive systems (CAS). He divides these into four properties ; *aggregation*, *nonlinearity*, *flows*, and *diversity*, and three mechanisms ; *tags*, *internal models*, and *building blocks*. He further points out the CAS "have lever points, wherein small amounts of input produce large directed changes. Knowing more about lever points would, in turn, provide us with guidelines for effective approaches to cas-based problems" (Holland, 1995 p.). Holland's model of a CAS provided excellent examples of how a population of agents, students in the classroom situation, flow and connect and interact, but, in our opinion, it only shows how they evolve through a series of link subbasins of equal fitness. In the Terraced Labyrinth model the lever points could be the constellation settings for a specific ability's portal. The tree-like image allows us to view another dimension of CAS, one that stretches from the internal

structure of the individual agents to the co-evolution of a classroom full of agents interacting on multiple levels simultaneously.

The political scientist, Robert Axelrod, and the professor of information science, Michael D. Cohen, use game theory and management science to propound on the organizational implications of harnessing complexity (Axelrod and Cohen, 1999). In their view the managers, who, in our classroom model would be the teachers, should exploit three qualities in order to improve their organizations, i.e., the classroom. These three qualities are *variation*, *interaction*, and *selection*. These three qualities are a distillation of the much more general elements mentioned by John Holland as the seven basics. In the classroom, focusing on these three generalizations would probably be the most efficient way to allow the optimum number of students to explore the subbasins and set the constellations of the terraced labyrinth. But, once again, the focus of the Axelrod and Cohen model of complexity is on a distinct level of interconnected subbasins on a single terrace of the language tree, and not on the whole interconnected process of second language acquisition. Unfortunately a more detailed examination of this model for harnessing complexity is beyond the limited scope of the present paper.

2 Conclusion

Complexity-based frameworks for modeling language acquisition all offer more realistic pictures of this nonlinear, dynamic process than the traditional linear and reductionist models favored by mainstream linguists. While these models are able to distill the patterns of language emergence and offer fresh insights from their various perspectives, they failed to include the multidimensional pattern of the hierarchical

whole, especially across the major boundary between the mechanism of language emergence within an individual and the fractal jump in scale to language emergence in a social setting. By including these complexity-based frameworks in its subbasin, constellation setting, and portal architecture the Terraced labyrinth model eliminates these problems, as well as explaining the difference between learning and acquisition, the step-like pattern of punctuated equilibrium found in all language emergence, and the complexly entwined nature of the relationship between neurolinguistics, psycholinguistics and sociolinguistics

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