Emergentism

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The Mysterious Process

Saussure (1916) characterized the units of language as linguistic signs, the signifiers of linguistic form and their associated signified functions, concepts, or meanings. In Saussure's view linguistic signs arise from the dynamic interactions of thought and sound—from patterns of usage: "what happens is neither a transformation of thought into matter, nor a transformation of sound into ideas. What takes place is a somewhat mysterious process by which 'thought-sound' evolves divisions, and a language takes place with its linguistic units in between these two amorphous masses" (pp. 110–11). Thus began structuralist linguistics, the study of language as a relational structure, whose elemental constructions derive their forms and functions from their distributions in texts and discourse. This approach had significant impact upon applied linguistics too. Fries, the founder of the English Language Institute at the University of Michigan, distinguished between lexical and structural meaning, with structural meaning concerning the patterns relating a particular arrangement of form classes to particular structural meanings. In this view, language acquisition is the learning of an inventory of patterns, as arrangements of words, with their associated structural meanings. Fries' (1952) *Structure of English* presented an analysis of these patterns. Harris, founder of the first US linguistics department at the University of Pennsylvania, developed rigorous discovery procedures for phonemes and morphemes based on the distributional properties of these units. For Harris, form and information (grammar and semantics) were inseparable. He proposed that each human language is a self-organizing system in which both the syntactic and semantic properties of a word are established purely in relation to other words, and that the patterns of a language are learned through exposure to usage in social participation (Harris, 1991).

Structuralism, the dominant approach in linguistics for the earlier part of the 20th century, was overtaken in the 1960s by generative approaches. Grammar became top-down and rule-governed, rather than bottom-up and emergent. It was modularized, encapsulated, and divorced from performance, lexis, social usage, and the rest of cognition. The analysis of linguistic structures as functional patterns and their "somewhat mysterious" emergence from usage was no longer pursued within generative linguistics.

Yet language and cognition are mutually inextricable; they determine each other. Language has come to represent the world as we know it; it is grounded in our perceptual experience. Language is used to organize, process, and convey information, from one person to another, from one embodied mind to another. Learning language involves determining linguistic structures from usage and this, like learning about all other aspects of the world, involves the full scope of cognition: the remembering of utterances and episodes, the categorization of experience, the determination of patterns among and between stimuli, the generalization of conceptual schemas and prototypes from exemplars, and the use of cognitive models, metaphors, analogies, and images in thinking. Language is used to focus the listener's attention to the world; it can foreground different elements in the theatre of consciousness to potentially relate many different stories and perspectives about the same scene. What is attended is learned, and so attention controls the acquisition of language itself. The functions of language in discourse determine its usage and learning. Language use, language change, language acquisition, and language structure are similarly inseparable. There is nothing that so well characterizes human social action as language. Cognition,

consciousness, experience, embodiment, brain, self, and human interaction, society, culture, and history are all inextricably intertwined in rich, complex, and dynamic ways.

Despite this complexity, despite its lack of overt government, instead of anarchy and chaos, patterning pervades the complex system of language. The patterns are not pre-ordained by god, by genes, by school curriculum, or by other human policy, but instead they are emergent from the interactions of the agents involved—synchronic patterns of linguistic organization at numerous levels (phonology, lexis, syntax, semantics, pragmatics, discourse genre . . .), dynamic patterns of usage, diachronic patterns of language change (linguistic cycles of grammaticization, pidginization, creolization, . . .), ontogenetic developmental patterns in child language acquisition, global geopolitical patterns of language growth and decline, dominance and loss, need and education, etc.

Various disciplines within cognitive science (including cognitive psychology, child language studies, cognitive linguistics, corpus linguistics, and connectionism) focus upon their own local patterns of interest to try to understand the processes by which they come about. But above and beyond these particular specialties, other approaches (including emergentism, complex adaptive systems, and dynamic systems theory) recognize that there are general principles which characterize the emergence of patterns in complex systems whatever their content or scale. This entry will first consider some of the specific disciplines focusing upon the patterning of information and its creation in human mind, brain, culture, and society, before introducing the study of emergence itself. It concludes with a view of language as a complex adaptive system (CAS).

Local Perspectives upon the Mysterious Process

An overview of the ways in which relevant disciplines are studying the origins of patterns in language can be conveniently organized by first focusing upon Saussure's linguistic sign. However effective, this does not imply that the structure of language is primary, far from it—we should look to meaning and social communication for that.

The closest modern parallel to the sign as a basic unit of language representation is the *construction* as studied broadly within approaches which fall under the general umbrella of *usage-based theories* of language acquisition, views which hold that we learn language incidentally while engaging in communication. Constructions are the fundamental units of language acquisition and reflect the most direct embodiment of learners' communicative intentions. Some of the basic tenets of usage-based approaches to language and its acquisition, many of them explicitly addressed by Saussure (1916), are:

- Language is intrinsically linked to human cognition and processes of perception, attention, learning, categorization, schematization, and memory.
- Language is intrinsically symbolic, constituted by a structured inventory of constructions as conventionalized form–meaning pairings used for communicative purposes.
- Adult language knowledge consists of a continuum of linguistic constructions of different levels of complexity and abstraction. Constructions can comprise concrete and particular items (as in words and idioms), more abstract classes of items (as in word classes and abstract constructions), or complex combinations of concrete and abstract pieces of language (as mixed constructions). Consequently, no rigid separation is postulated to exist between lexis and grammar.
- Constructions may be simultaneously represented and stored in multiple forms, at various levels of abstraction (e.g., concrete item: table+s = tables and [Noun] + (morpheme +s) = plural things).

- Linguistic constructions (such as the caused motion construction, X causes Y to move $Z_{path/loc}$ [Subj V Obj Obl]), e.g., "He pushed it along" or "Crotchety Aunt Gemima grumbled the baby up to bed") can thus be meaningful linguistic symbols in their own right, existing independently of particular lexemes. Nevertheless, constructions and the particular lexeme tokens that occupy them resonate together, and grammar and lexis are inseparable.
- Language structure emerges ontogenetically from usage in particular contexts. Development is slow and gradual, moving from an initial heavy reliance on concrete items to more abstract linguistic schemas. This process is crucially dependent on the type and token frequencies with which particular constructions appear in the input. Storage of wholes depends on token frequency, schematization depends on type frequency.

Allied approaches researching the interplay of language and cognition concentrate upon broadly different facets of patterning (with some overlap at the intersections):

Cognitive linguistic analyses of language catalogue the inventory of the construction, investigating the ways in which constructions are symbolic, their defining properties of morphological, syntactic, and lexical form being associated with particular semantic, pragmatic, and discourse functions (Croft & Cruise, 2004).

Corpus linguistic analyses of large collections of language show how there are recurrent patterns of words, collocations, phrases, and constructions, that syntax and semantics are inextricably linked, and that grammar cannot be described without lexis, nor lexis without grammar (Sinclair, 1991).

Construction grammar analyses of language show that much of communication makes use of fixed expressions memorized as formulaic chunks, that language is rich in collocational and colligation restrictions and semantic prosodies, and that the phrase is the basic level of language representation where form and meaning come together with greatest reliability (Goldberg, 2006).

Psychological analyses *of perception* investigate the ways in which human embodiment and our perceptuo-motor systems govern our representation of the world and the ways that language can guide our attention to these representations (Barsalou, 2008).

Associative learning theory analyzes how the learning of constructions as form-meaning pairings, like of all cue-outcome contingencies, is affected by: factors relating to the form such as frequency and salience; factors relating to the interpretation such as significance in the comprehension of the overall utterance, prototypicality, generality, redundancy, and surprise value; factors relating to the contingency of form and function; and factors relating to learner attention, such as automaticity, transfer, overshadowing, and blocking (Ellis, 2002, 2008b).

Cognitive theories of categorization and generalization analyze how schematic constructions are abstracted over less schematic ones that are inferred inductively by the learner in acquisition (Harnad, 1987). Prototypes, exemplars which are most typical of a category, are those which are similar to many members of that category and not similar to members of other categories. People more quickly classify sparrows (or other average-sized, average-colored, average-beaked, average-featured specimens) as birds than they do birds with less common features or feature combinations like geese or albatrosses. Prototypes are judged faster and more accurately, even if they themselves have never been seen before—someone who has never seen a sparrow, yet who has experienced the rest of the run of the avian mill, will still be fast and accurate in judging it to be a bird. Such effects make it very clear that although people do not go around consciously counting features, they nevertheless have very accurate knowledge of the underlying

frequency distributions and their central tendencies. The prototype emerges as the conspiracy of memorized exemplars.

Constructionist child language researchers gather dense longitudinal corpora in order to chart the emergence of creative linguistic competence in children's analyses of the utterances in their usage history and their abstraction of regularities within them (Tomasello, 2003).

Learning theory recognizes three major experiential factors that affect cognition: frequency, recency, and context (Anderson, 2000). Learning, memory, and perception are all affected by frequency of usage: the more times we experience something, the stronger our memory for it, and the more fluently it is accessed. The more recently we have experienced something, the stronger our memory for it, and the more fluently it is accessed. The more times we experience conjunctions of features, the more they become associated in our minds and the more these subsequently affect perception and categorization; so a stimulus becomes associated to a context and we become more likely to perceive it in that context. The power law of learning describes the relationships between practice and performance in the acquisition of a wide range of cognitive skills—the greater the practice, the greater the performance, although effects of practice are greatest at early stages of leaning, thereafter diminishing and eventually reaching asymptote. The power function relating probability of recall (or recall latency) and recency is known as the forgetting curve. These three factors pervade the emergence, form, access, and processing of all mental representations.

Connectionist, *competition*, and *rational* models of language demonstrate the ways in which generalizations emerge from the conspiracy of memorized instances, the ways in which different cues and their cue reliabilities compete for activation, and the ways in which these representations provide the best model of language that is available from the learner's sample of experience, one that is optimized in its organization for usage (Bates & MacWhinney, 1987; Elman et al., 1996; Anderson & Schooler, 2000; Christiansen & Chater, 2001).

Psycholinguistic theories of the mental representation of language show that fluent language users are sensitive to the relative probabilities of occurrence of different constructions in the language input and to the contingencies of their mappings to meaning (Ellis, 2002; Gaskell, 2007).

Probabilistic and frequency-based theories of language analyze how frequency and repetition affect and ultimately bring about form in language and how probabilistic knowledge drives language comprehension and production (Bybee & Hopper, 2001). Distributional analyses of language also show the importance of Zipf's law (that the frequency of words decreases as a power function of their rank in the frequency table) at all levels in determining the structure and network characteristics of linguistic systems and the effects of these properties on learning (Ferrer i Cancho & Solé, 2001).

Sociocultural theory analyses how language learning takes place in a social context, involving action, reaction, collaborative interaction, intersubjectivity, and mutually assisted performance, and how individual language learning is an emergent, holistic property of a dynamic system comprising many dialectic influences—social, individual, and contextual—involving the learner in a conscious tension between the conflicting forces of their current interlanguage productions and the evidence of feedback, either linguistic, pragmatic, or metalinguistic, that allows socially scaffolded development (Lantolf & Thorne, 2006).

The Scientific Study of Consciousness, its neural correlates, and its involvement in learning and memory (Koch, 2004) shows there are different forms of language learning; broadly, the implicit tallying and chunking that take place during usage (Ellis, 2002) and explicit learning in the classroom, sometimes a consequence of communication breakdown (Ellis, 2005, sections 3–4). Implicit learning from usage occurs largely within modality and

involves the priming or chunking of representations or routines within a module, with abstract schemas and constructions emerging from the conspiracy of memorized instances. It is the means of tuning our zombie agents, the menagerie of specialized sensori-motor processors that carry out routine operations in the absence of direct conscious sensation or control. It is largely automatized. It operates in parallel. In contrast, conscious processing is spread wide over the brain and unifies otherwise disparate areas in a synchronized focus of activity. Conscious activity affords much more scope for focused long-range association and influence than does implicit learning. It brings about a whole new level of potential associations. It operates serially. Consciousness too is dynamic; it is perhaps the prototype example of an emergent phenomenon: the stream of consciousness is one of ever-changing states, each cued by prior state and perceptual context, the units of consciousness being identifiable as patterns of brain synchrony in time. The dynamics of language learning are inextricably linked to the dynamics of consciousness, in neural activity and in the social world as well.

As these diverse research efforts illustrate, language usage involves agents and their processes at many levels, and we need to try to understand language emergence as a function of interactions within and between them. This is a tall order. Hence Saussure's "mysterious process" and his observations that

> to speak of a "linguistic law" in general is like trying to lay hands on a ghost. . . . Synchronic laws are general, but not imperative. [They] are imposed upon speakers by the constraints of common usage. . . . In short, when one speaks of a synchronic law, one is speaking of an arrangement, or a principle of regularity. (pp. 90–1)

Nevertheless, a hundred years of subsequent work within the disciplines introduced above has put substantial flesh on the bones, as you will see if you follow up on the readings. And more recently, work within emergentism, CAS, and dynamic systems theory (DST) has started to describe a number of scale-free, domain-general processes which characterize the emergence of pattern across the physical, natural, and social sciences. The next section considers language in this light.

Common Mysteries of Emergence

Emergentism and *complexity theory* (Elman et al., 1996; Ellis, 1998; MacWhinney, 1999; Ellis & Larsen-Freeman, 2006; Larsen-Freeman & Cameron, 2008) analyze how complex patterns emerge from the interactions of many agents, how each emergent level cannot come into being except by involving the levels that lie below it, and how at each higher level there are new and emergent kinds of relatedness not found below: "More is different." These approaches align well with DST, which considers how cognitive, social, and environmental factors are in continuous interactions, where flux and individual variation abound, and where cause–effect relationships are nonlinear, multivariate and interactive in time (Ellis & Larsen-Freeman, 2006; de Bot, Lowie, & Verspoor, 2007; Ellis, 2008a).

"Emergentists believe that simple learning mechanisms, operating in and across the human systems for perception, motor-action and cognition as they are exposed to language data as part of a communicatively-rich human social environment by an organism eager to exploit the functionality of language, suffice to drive the emergence of complex language representations" (Ellis, 1998, p. 657). Language cannot be understood in neurological or physical terms alone, nevertheless—neurobiology and physics play essential roles in the complex interrelations; equally from the top down, though language cannot be understood purely by introspection, conscious experience is an essential part too.

Language considered as a CAS of dynamic usage involves the following key features.

- The system consists of multiple agents (the speakers in the speech community) interacting with one another.
- The system is adaptive; that is, speakers' behavior is based on their past interactions, and current and past interactions together feed forward into future behavior.
- A speaker's behavior is the consequence of competing factors ranging from perceptual mechanics to social motivations.
- The structures of language emerge from interrelated patterns of experience, social interaction, and cognitive processes.

The advantage of viewing language as a CAS is that it provides a unified account of seemingly unrelated linguistic phenomena including variation at all levels of linguistic organization; the probabilistic nature of linguistic behavior; continuous change within agents and across speech communities; the emergence of grammatical regularities from the interaction of agents in language use; and stage-like transitions due to underlying nonlinear processes.

Characteristics of Language as a CAS

The following are seven major characteristics of language as a CAS, which are consistent with studies in language change, language use, language acquisition, and with the computer modeling of these aspects, which is a core component of CAS research (The Five Graces Group, 2009).

Distributed Control and Collective Emergence

Language exists both in individuals (as idiolect) as well as in the community of users (as communal language). Language is emergent at these two distinctive but interdependent levels: an idiolect is emergent from an individual's language use through social interactions with other individuals in the communal language, while a communal language is emergent as the result of the interaction of the idiolects. Distinction and connection between these two levels is a common feature in CASs. Patterns at the collective level (such as bird flocks, fish schools, or economies) cannot be attributed to global coordination among individuals; the global pattern is emergent, resulting from long-term local interactions between individuals.

Intrinsic Diversity

In a CAS, there is no ideal representing agent for the system. Just as there is no ideal representative consumer in an economy; similarly, there is no ideal speaker-hearer for language use, language representation, or language development. Each idiolect is the product of the individual's unique exposure and experiences of language use (Bybee & Hopper, 2001). Sociolinguistics studies have revealed the large degree of orderly heterogeneity among idiolects, not only in their language use but also in their internal organization and representation.

Perpetual Dynamics

Both communal language and idiolects are in constant change and reorganization. Languages are in constant flux, and language change is ubiquitous (Hopper, 1987; Ellis, 2008a). At the individual level, every instance of language use changes an idiolect's internal organization.

As we define language primarily through dynamical rules rather than by forces designed to pull it to a static equilibrium, it shares, along with almost all complex systems, a fundamentally far-from-equilibrium nature (Holland, 1995).

Adaptation Through Amplification and Competition of Factors

CASs generally consist of multiple interacting elements, which may amplify and/or compete with one another's effects. Structure in complex systems tends to arise via positive feedback, in which certain factors perpetuate themselves, in conjunction with negative feedback, in which some constraint is imposed (for instance, due to limited space or resources). Likewise in language, all factors interact and feed into one another.

Nonlinearity and Phase Transitions

In complex systems, small quantitative differences in certain parameters often lead to phase transitions, that is, qualitative differences. Elman (2005) points out that multiple small phenotypic differences between humans and other primates (such as in degree of sociability, shared attention, memory capacity, rapid sequencing ability, vocal tract control, etc.) may in combination result in profound consequences, allowing means of communication of a totally different nature. Also, in a dynamic system, even when there is no parametric change, at a certain point in a continuous dynamic, system behavior can change dramatically, going through a phase transition. For example, constant heating of water leads to a transition from liquid to gas without having any parametric change. In language development, such phase transitions are often observed, for example developmental "lexical spurts" which often lead to rapid grammatical development (Bates & Goodman, 1997).

Sensitivity to and Dependence on Network Structure

Network studies of complex systems have shown that real-world networks are not random, as was initially assumed, and that the internal structure and connectivity of the system can have a profound impact upon system dynamics (Barabási, 2002). Similarly, linguistic interactions are not via random contacts; they are constrained by social networks. The social structure of language use and interaction has a crucial effect in the process of language change, and language variation and the social structure of early humans must also have played important roles in language origin and evolution.

Change is Local

Complexity arises in systems via incremental changes, based on locally available resources rather than via top-down direction or deliberate movement toward some goal. Similarly, in a complex systems framework, language is viewed as an extension of numerous domain-general cognitive capacities such as shared attention, imitation, sequential learning, chunking, and categorization. Language is emergent from ongoing human social interactions, and its structure is fundamentally molded by the preexisting cognitive abilities, processing idiosyncrasies and limitations, and general and specific conceptual circuitry of the human brain. Because this has been true in every generation of language users from its very origin, in some formulations language is said to be a form of cultural adaptation to the human mind rather than the result of the brain adapting to process natural language grammar (Christiansen & Chater, 2008). These perspectives have consequences for how language is processed in the brain. Specifically, language will depend heavily on brain areas fundamentally linked to various types of conceptual understanding, the processing of social interactions, and pattern recognition and memory. It also predicts that so-called "language areas" should have more general, prelinguistic processing functions even in

modern humans and, further, that the homologous areas of our closest primate relatives should also process information in ways that makes them predictable substrates for incipient language. Additionally, it predicts that the complexity of communication is to some important extent a function of social complexity. Given that social complexity is in turn correlated with brain size across primates, brain size evolution in early humans should give us some general clues about the evolution of language. Recognizing language as a CAS allows us to understand change at all levels.

Future Directions: Dynamic Structure

As the diverse research cited in this entry illustrates, understanding the emergence of language requires the full range of techniques of cognitive, social, and natural science. But more than that, it requires an overarching framework of emergentism, CAS, and DST.

A common opposition within linguistics is the contrast between Saussure and Vygotsky, between structuralist approaches to language and those that emphasize the processes of language use in social interaction, between thin and thick descriptions. Vygotsky's (1935/1986) *Thinking and Speaking* addresses that same mystery as Saussure's, and makes equal resort to metaphor; for example, "Consciousness is reflected in the word like the sun is reflected in a droplet of water" (p. 285). "The relation between thought and word is a living process; thought is born through words. A word devoid of thought is a dead thing, and a thought unembodied in words remains a shadow. The connection between them, however, is not a preformed and constant one. It emerges in the course of development, and itself evolves" (p. 255). Language emerges both in the Saussurian sign and the Vygotskian process.

Language and usage are like the shoreline and the sea.

SEE ALSO: Chaos/Complexity Theory for Second Language Acquisition; Cognitive Linguistics of Second Language Acquisition; Connectionism; Construction Grammar; Corpus Study: Cognitive Implications; Dynamic Systems Theory Approaches to Second Language Acquisition; Interaction Approach in Second Language Acquisition; Linguistic Relativity; Sociocultural Theory

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