Cybernetic Systems Approaches and Language Change: The Nicaraguan Sign Language Case and Principles of Evolution

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The emergence of a new sign language in Nicaragua over the past 25 years highlights selection and information as key components in language change. Theoretical perspectives informed by cybernetic systems theories, such as those put forth by anthropologist Gregory Bateson and developmental psychologist Jean Piaget identify principles common to both evolutionary and ontogenetic processes, though the expression of these principles differ in these analytically distinct processes. Unlike other approaches, cybernetic theories account for the range of interacting phenomena in several domains; environmental, biological, social and cultural (including linguistic). The history of this new sign language, including specific grammatical changes, and ethnographic observations show that cybernetic perspectives clarify factors involved. For example, borrowed linguistic forms, emerging grammatical constraints and even referential confusion during discourse are all more understandable in light of systems-level perspectives.

Dan Slobin argues that older individuals have introduced the new elements in this emerging language, not children. Ann Senghas and her colleagues have argued that deaf Nicaraguan children have introduced grammar to Nicaraguan Sign Language. These seemingly opposing views can be resolved with cybernetic perspectives that account for both universal evolutionary principles and historical particularism, thereby unifying approaches to historical change and ontogenetic development—without conflating the two.

1. Introduction

The emergence of a new sign language in Nicaragua over the past 25 years highlights information and selection as key factors in language change, both ontologically and historically. More specifically, selection by language users as they acquire and modify their first language plays a key role in the historical change of a new language, suggesting that, at least in this case, first language acquisition processes have historical (or evolutionary) effects. Perspectives informed by cybernetic systems theories, such as those put forth by anthropologist Gregory Bateson (1979) and developmental psychologist Jean Piaget (1979) help us identify principles common to both ontological and evolutionary processes, even linking these processes in the case presented here, though the expression and mechanisms of these principles may differ in these two analytically distinct domains. Cybernetic theories, especially those incorporating processes of self-modification, account

for the range of interacting phenomena across domains; environmental, biological, social and cultural (including linguistic).

The case of *Idioma de Señas de Nicaragua* (ISN) (a.k.a. Nicaraguan Sign Language [NSL] in the psycholinguistic literature) has received attention from cognitive scientists, psycholinguists, and linguistic anthropologists, among others. So far, much of the discussion of this case has focused on it as a test for Universal Grammar theories, including Derek Bickerton's (1984) Language Bioprogram Hypothesis (LBH) and abrupt creolization (e.g., Kegl & McWhorter, 1996). Steven Pinker (1994) has used this case to support his innatist theories, while others (e.g., Senghas, 1997, 2003; Polich, 1998) have highlighted social and cultural factors.

In this paper, I reexamine psycholinguistic studies (Senghas, 1995, 2000; Senghas & Coppola, 2001; Senghas, Senghas & Pyers, 2003), and my own extended ethnographic fieldwork (Senghas, 1997, 2003) which highlights language and sociocultural issues, including child language socialization and language ideologies. After a brief synopsis of the historical circumstances of the emergence of ISN, I review spatial coreference in verb agreement (e.g., ISN signs for SEE and PAY can be formed with and without spatial modulation indicating agreement with the object), as one example of specific structural changes in ISN over the past 25 years, presenting examples of ISN data discussed by A. Senghas and Coppola (2001) and Senghas, Senghas and Pyers (2003). Finally, I revisit ethnographic events described elsewhere (Senghas, 1997; 2003), and show that cybernetic perspectives can identify and clarify factors involved in the emergence of structural changes in ISN that were previously inadequately explained. For example, borrowed linguistic forms, emerging grammatical constraints, and even referential confusion during discourse are all made more understandable in light of systems-level perspectives that account for both individual (ontological) development and historical change.

Dan Slobin (2003), drawing on Morford's (2002) analysis of the ISN case, has argued that older individuals have introduced the new structural elements in this emerging language, not children. Ann Senghas and her colleagues have argued that deaf Nicaraguan children have indeed introduced new grammatical structures to their sign language. These seemingly opposing views can be resolved with cybernetic perspectives that account for both universal evolutionary principles *and* historical particularism, thereby unifying approaches to historical change and ontological development—without conflating the two.

2. Brief History of a New Language

The history of ISN has been dealt with more extensively elsewhere (Senghas, 1997, 2003; Senghas, Senghas, & Pyers, 2003; Polich, 1998). I will review the most significant aspects relevant here. Prior to 1977, the Pre-Emergence Period, deaf individuals in Nicaragua were usually isolated from one another, developing idiosyncratic *homesign* systems (Goldin-Meadow & Mylander, 1984) to meet their communicative needs for interaction with their hearing families and other acquaintances. Unlike other situations where deaf people interact frequently, no conventional sign language was established in Nicaragua at this time. However, in 1977, a special education program was established in Managua, in which deaf students were brought together in significant numbers. Originally, approximately 25 deaf students attended, with the enrollments quickly increasing to over 100. In 1980, a vocational program for adolescents was opened, where deaf individuals were able to interact with one another while learning trade skills. This period from 1977 through the mid-1980s can be considered the Initial Contact Period. By

the mid-1980s, we see the beginnings of an established linguistic community, with the founding of a Deaf association eventually controlled and directed by its Deaf members, dictionary projects documenting the new sign language, and efforts to include Deaf individuals as linguistic models in the special schools. I refer to this last period as the Sustained Contact Period, which continues through the present.

(1)   Figure 1: Early Stages of ISN

The Initial Contact Period (see Figure 1) bears further attention here. During this period, we see young children and adolescents (kindergarten through sixth grade, and later
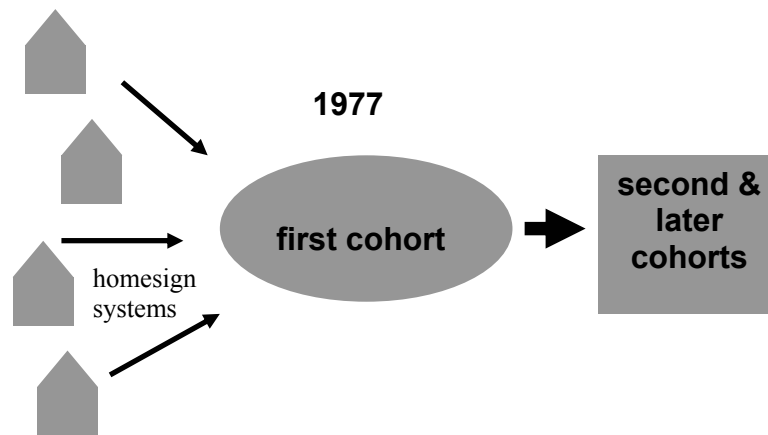
teenagers) brought together in primary school and vocation training. These children, especially the youngest ones, were still within an early enough ontological developmental stage to acquire a first language (Newport, 1990). Yet at first they were not presented with an existing, grammatically rich sign language as a model, instead developing a new sign language through social interactions, often on the playgrounds.

Over the last 25 years, sign language in Nicaragua has continued to change, developing an increasingly larger lexicon and more complex grammatical structure, allowing signers to communicate more effectively and concisely. In the early 1990s, the Ministry of Education formally adopted sign as a mode of instruction and has encouraged special education teachers to use signing in their classrooms for deaf students. The oldest signers are now in their 30s and 40s, some now parents. While there are still no official census figures available, the community of signers has certainly grown to number in the hundreds. ANSNIC, the national Deaf association, now has affiliated clubs in many of the larger Nicaraguan cities and towns, including Managua, Leon, Granada, Matagalpa, San Marcos, among others. These have become social centers for Deaf Nicaraguans, with many social activities where signing is typically used.

There is no doubt that the signing of deaf Nicaraguans over the past 25 years has undergone significant systematic changes, some examples of which we shall see in the next section. Explanations for these various changes, however, are still being considered, among them: Universal Grammar (including Bickerton's LBH); the interplay between innate and learned traits; biological and sociocultural processes (not to be conflated with innate and learned, as learned traits can have lasting biological effects); and ontological development and historical processes of change. Let us now consider a current debate regarding the role of ontological development in historical change of ISN.

3. Ontological Development as a Structuring Factor in Language Change

Ann Senghas, using elicitation experiments, has been analyzing changes in specific grammatical constructions employed by Nicaraguan signers (Senghas, 1995, 2000; Senghas & Coppola, 2001). Her studies show that the first cohort of signers has a systematic NVNV pattern, while later cohorts include NNVV and NVVN patterns in their repertoire. In order to use these variable orders unambiguously, grammatical markers must be used to disambiguate syntactic relationships. As with other sign languages, ISN exploits space to this end. By incorporating movement into the signing of verbs, and by directing that movement toward or away from specific points in physical space that have been previously established as representing an individual or an object, signers are able to unambiguously mark subject-object agreement. Illustration 1 below shows the Nicaraguan signs for SEE and PAY. Note that the first form of each sign is produced without spatial agreement. The second form of each, signed towards the signer's left, makes use of spatial agreement.

(2)   Illustration 1.

SEE (without and with spatial modulation)   PAY (without and with spatial modulation)
(From Senghas & Coppola 2001.)

Ann Senghas has explored the differing patterns in the signing of the first and second cohorts of Nicaraguan signers and concludes that only later cohorts are capable of consistently differentiating spatial relationships, a necessary capacity for spatial coreference to be employed as a grammatical distinction (Senghas & Coppola, 2001; Senghas, Senghas & Pyers, 2003). Apparently, the first cohort members have passed beyond the ontological developmental stage during which they would have acquired such specific differentiation as an automatic capacity. Now, even with repeated exposure as adults, they can no longer acquire the trait. Thus, their signing echoes a previous state of the emerging language when spatial coreference was not yet established.

However, Ann Senghas argues further that the second cohort members introduced the grammatical constraint of spatial coreference (Senghas & Coppola, 2001; Senghas, Senghas & Pyers, 2003). Members of this second cohort *were* still within the ontological stage of development during which they could acquire the capacity for spatial coreference at the time they reached the (childhood) stage of first language (L1) acquisition when multiple word order constructions are normally acquired. Taking advantage of a previously unexploited opportunity, the second cohort members, as children, selectively used spatial differentiation to disambiguate grammatical relationships. Their increasingly consistent use of spatial coreference thus changed the linguistic environment for

themselves and all later learners, and thus introduced a historical change to the language. (Keep in mind that members of the first cohort of signers, because of the impoverished linguistic environment they experienced as children, arrived at this L1 stage as late adolescents or adults, too late to acquire the grammatical trait. This would not be true for any of the later cohorts.) For this reason, Ann Senghas and others (including myself) have argued that children can be seen as introducing grammatical structure to ISN.[1]

3.1. Challenges

Dan Slobin (1997) has challenged claims that children introduce grammar and is skeptical of nativization claims such as those of Bickerton and Pinker. He argues instead that children may simply use "the grammatical elements more frequently and more fluently" (2003). Slobin indicates that the ISN forms identified by Ann Senghas (1995) are used (perhaps less consistently, but used nevertheless) by the first cohort, and therefore he sees little evidence that the younger children are actually introducing the new forms.[2] However, the positions of Slobin and Ann Senghas may be more aligned than as first appears, and their dispute may be as much an issue of terminology as theoretical paradigm. Slobin apparently prefers to reserve the term *innovation* for the first use of a new form (c.f. Slobin, 2003), perhaps without reference to actual intent of meaning associated with that form's first use. Slobin agrees with Morford's (2002) use of *grammaticization* to describe the automation of newly-adopted grammatical constraints, what Ann Senghas has considered "innovation" or "creation of grammar." (I return to this issue below.)

Slobin (2003) has also suggested, correctly, that it is hard to determine from current published data whether or not first cohort signers used differentially spatialized forms with meaningful intent or not. Indeed, new elicitation experiments, or analyses of more naturalistic use of sign from an existing corpus, might help clarify this point. Yet Slobin's challenges do not negate Ann Senghas' findings that: a) the first cohorts are unable to consistently differentiate space; b) the first cohort signers do not share conventionalized orientation for spatial coreference across individuals; and c) second cohort signers are able to consistently differentiate space and do indeed share conventionalized orientation for spatial coreference across individuals (which are prerequisites for spatial coreference as a grammatical device).

4. Differentiation, Information, and Cybernetic Perspectives

Slobin's challenges do beg the question: what counts as grammatical innovation? What makes a form new? I argue that the "newness" or innovation comes when an actual difference is *newly perceived* as difference, thus creating information, or "difference that makes a difference" (Bateson, 1979, p. 228). The focus on information immediately suggests to me that cybernetics may provide useful insights. At this point, I would like to define cybernetics as it was originally envisioned and then discuss its elaboration within anthropology. Following that, I shall return to the ISN case and discuss the usefulness of cybernetic perspectives to the study of language.

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[1] I would *not* argue, however, that *only* children are introducing grammatical constraints. Many lexical forms (some borrowed from other sign languages) and other signing patterns are certainly introduced by older signers.
[2] Slobin, in his article of 2003, does allow that children may indeed have introduced spatial coreference in ISN.

4.1. Original Cybernetic Perspectives

The term *cybernetics* was introduced by Norbert Wiener in 1948, identifying "the entire field of control and communication theory, whether in the machine or in the animal, by the name of *Cybernetics*" (p. 19). A significant intent of this theoretical paradigm is to bridge the inanimate (machine) and animal worlds, including social or group effects, describing emergent phenomena with an eye towards causative explanation. The abstraction of information as a focus of scientific study, its creation, manipulation, and transfer among individuals (organic or mechanical, including components) and groups, is the fundamental contribution of this approach. Weiner anticipates social implications of cybernetic theory, and its problematic promise for social sciences, in his final chapter, "Information, Language, and Society."

The notions of *feedback* and feedback loops, especially within homeostatic systems (i.e., dynamic equilibria), are central elements of cybernetic theories, and are perhaps the elements most commonly associated with cybernetic systems. In a stable system, information is fed back in to the system, and decisions are made based on the information, including corrections that might be necessary to return the system to one or another desired state. An everyday example of a homeostatic system can be seen in a heating and air conditioning system, in which a thermostat continuously measures the room temperature, signaling to the system whether heating or cooling is required to bring the temperature within the established range of acceptable values.[3]

4.2. Anthropological Elaborations: Morphogenesis

Clearly, cybernetic theory is relevant to anthropology, which from its disciplinary beginnings has realized that understanding human organization and behavior is highly contingent upon understanding human communication, and understanding how and why humans create information and share it. Franz Boas insisted that his students learn the languages of the peoples they studied, for how else could one document the native worldviews and how they were represented or explain why individuals would act in specific ways?

Not surprisingly, in their efforts to develop cybernetic theory so that it would account for human patterns of behavior, Wiener and his colleagues consulted with anthropologists Gregory Bateson and Margaret Mead (Wiener, 1948). Bateson himself had already developed a related concept of *schismogenesis*, a theoretical description of the ways that individuals differentiate their social roles and expectations with respect to one another. (His extended discussion of schismogenesis is presented in his analysis of Naven ritual among the Iatmul of Papua New Guinea (Bateson, 1952/1936).) Schismogenetic processes involve information about the state of a social system and its members. This information is created and used by members as they participate in (or withdraw from) social interaction, while making use of cultural conventions and expectations to frame their actions.

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[3] This is an example of a negative-feedback system; the feedback tends to oppose the changing state of the system in order to bring it back to a desired state. Positive feedback, when the feedback augments the state of the system, is demonstrated by the too-frequent examples of a microphone receiving sound from the speakers of the very amplification system that it originally provided with a signal. The sound/signal is continuously amplified, increasing in volume until someone or some mechanism dampens the sound/signal, or until the system overloads and fails.

Homeostatic descriptions (cybernetic or otherwise) have long been employed in anthropology. E. E. Evans-Pritchard (1940) described Nuer society and its culture as such a system. Roy Rappaport (1967) has presented what amounts to a very elaborate homeostatic model in his account of Tsemba ritual behavior and social relations as a "'ritually regulated ecosystem' and refers to the Tsemba and their human neighbors as a 'ritually regulated population'" (p. 28; c.f., also, Rappaport, 1968, 1971). Yet structural and systemic change must also be addressed, for human societies and their cultures are not static, mechanical systems, but organic systems subject to evolutionary pressures, and prone to change. For example, Douglas Goodfriend (1940) criticizes Evans-Pritchard's homeostatic account for not addressing social and cultural change, and for confusing the sociocultural system itself with its structures (Goodfriend, 1982, 1983). Goodfriend explicitly turns to cybernetic theory which, he argues, can account for change of structures, and eventually, the whole system.

Indeed, this brings us to Bateson's most significant insight. Cognition itself brings with it the ability to create forms, or *morphogenesis*, especially directed change of forms, including self-modification (Bateson 1979, p. 140). While Bateson's focus ultimately centers on the mind, its creation of information as it becomes aware of "difference that makes a difference," and the mind's subsequent ability to modify relationships in both its environment and itself, the principles Bateson explores have significant implications for the study of language. Language is information, linguistic information about (other) information that can be transferred among individuals because it is structured in particular ways that are within the range of expectations held by those communicating individuals. But expectations can change with experience, as we can see with any case of first language acquisition.

4.3. Unifying Ontological and Historical Change in ISN

Because of their self-awareness (conscious or otherwise), and their awareness of the relative effectiveness of their linguistic communications, members of the second cohort of Nicaraguan signers, as children, were able to add a new constraint, spatial coreference, to their signing. This constraint, without necessarily adding new forms, selectively used existing linguistic forms in a new way that, in effect, increased the amount of information conveyed by those available forms, creating a difference that would thereafter make a difference in ISN. Whether this process is considered grammaticization or innovation of new grammatical constraints, it raises the issue of links between ontological language development and historical language change (i.e., the evolutionary change of a language). These links are information and selection.

In both ontological development and historical language change, individuals must make choices among several linguistic options. Ultimately, it is the overall effectiveness of the communication patterns chosen that determine which forms continue in use. That effectiveness can only be measured by the speakers (or, in this case, signers) themselves, who must evaluate the effectiveness of their linguistic choices based on information they receive back from their environment. Yet, ontological development passes through particular stages, and the human individual, due to accumulating biological changes resulting from both growth and experience, is not equally modifiable at all stages, as we see with the limited period of opportunity for L1 acquisition (Newport, 1990). In the case of ISN, the absence of a community of adult signers as models seems to have prevented

the first cohort of signers from progressing through all the typical stages of L1 acquisition before their respective periods of opportunity passed.

To understand the creation of linguistic information (i.e., linguistic morphogenesis) and subsequent circumstances of selection of linguistic forms, we must account not only for biological capacities, but also for the larger ecology of the individuals involved. Many factors will come to bear on the selection process of linguistic forms, including a range of sociocultural factors not directly related to language itself, but linked only by their salience as determined by speakers/signers in historically particular situations. In the Nicaraguan case, ideological factors associated with deafness, oralism, pedagogy, and even national identity are significant sociocultural factors (Senghas, 1997, 2003) that combine with those of L1 acquisition. Thus ontogenetic development and historical change must not be conflated in this case, and yet clearly are co-articulating phenomena.

While Ann Senghas has identified a new grammatical constraint involving spatial coreference, I have also observed other new linguistic forms used by Nicaraguan signers, including some forms that have not been generally adopted. Initialized signs, signs that incorporate a handshape corresponding to a letter in written Spanish, are now used fairly frequently in ISN (e.g., CLEAN/SHINY [LIMPIA] with an L handshape, ASSOCIATION [ASOCIACIÓN] with an A handshape, and FAMILY [FAMILIA] with an F handshape).[4] This construction has likely been borrowed from other sign languages, such as ASL, which use this pattern extensively. One pattern that has not been maintained, however, bears mentioning. In 1995, I observed an attempt to make the emerging sign language more like Spanish. Deaf adults teaching language seminars at the deaf association in Managua tried to introduce two distinct forms of the verb TO HAVE (TENER): TENGO (1st person singular) and TIENE (3rd person singular). By placing the T handshape on different sides of the chest (ipsilateral vs. contralateral locations), signers could potentially differentiate these forms (Slobin might call this invention of ipsilateral/contralateral distinction of first and third person forms a grammatical innovation). Yet despite considerable effort, this particular form never caught on. It seemed to introduce more confusion than it clarified, and so was apparently not selected by ISN signers for perpetuation. Perhaps this form was a contender in a competition for verbal agreement constructions, losing out to the now-prevalent spatial coreference that has been discussed above.

I should also mention another ethnographic experience from my 1995 field session. Frequently, I observed confused discourse among Deaf signers about the intentions of the Swedish Federation of the Deaf (SDR), who were underwriting several of the projects conducted by ANSNIC, the national Deaf association with a center in Managua, the capital city of Nicaragua. At the time, I assumed that this was a sociocultural issue, one of understanding cultural expectations (or not) and possible motivations. It did not occur to me then, alas, that the confusion may have been as much a linguistic issue as a sociocultural one, and so my field notes reflect the content of the discussions more than the linguistic particulars. Here again, though, we see the ways that selection may actually play out. Individuals who are successful at explaining or communicating about important social issues may, by their success, end up playing proportionally larger roles in their community and influencing the choices of others.

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[4] Here I follow the convention of using uppercase terms to indicate glosses for ISN signs, with corresponding local Spanish terms included.

5. Concluding Remarks: The Ecology of Language

Language, then, can be considered a system with an ecology. Ontological development and historical change (evolution) are processes in this ecology and interplay with other processes, including biological and sociocultural factors. New linguistic forms, in both the short and long term, within the idiolect of an individual or the sociolect of the group, are subject to selection. Such selection involves the language users' evaluations of the success of linguistic forms relative to the users' intentions, a system of information feedback and modification. From a systems level perspective, it is not just the first innovation of a new form that constitutes a change in the language's grammar but the selection for continued use of that form that marks a *structural* change.

Gregory Bateson's cybernetic approaches, such as those explored in *Steps to an Ecology of Mind* (1972) and *Mind and Nature* (1979), provide a useful paradigm in which we can analyze language change. As an anthropologist, Bateson focuses on social processes, but the ecological orientation reaches beyond a single discipline, implicating anthropology, biology, psychology, linguistics, and several other disciplines. This ecological orientation is echoed in developmental psychologist Jean Piaget's *Biology and Knowledge* (1979), but with a greater emphasis on biological mechanisms supporting the emergence of cognition.

In a sense, the ISN case has its own ecology, drawing the attention of psycholinguists and scholars interested in understanding first language acquisition, who selectively explore the patterns, identifying the emerging differences that make a difference. What remains to be seen is how much information we ultimately draw from this case.

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