Spatial and Temporal Differentiation in Nicaraguan Sign Language: The Emergence of Structure

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The recent emergence of a new sign language among deaf children and adolescents in Nicaragua provides an opportunity to study how linguistic features of a language arise and spread. New features that arise must be successfully transmitted from one generation to the next to survive as part of the language. During this transmission, language form is shaped by both the characteristics of ontogenetic development within individual users and by historical changes in patterns of interaction between users. To capture this process, changes over the past 25 years will be examined within two domains: expressions of the manner and path of movement in motion events, and expressions of spatial location. These data reveal that, as the new language is learned, holistic and analog expressions are being replaced by discrete, combinatorial expressions. It appears that these new form-function mappings arise among child learners who functionally differentiate previously equivalent forms. The new mappings are then acquired by their age peers and by subsequent generations of children who learn the language, but not by adult contemporaries. As a result, language emergence is characterized by a convergence on form within each age cohort, and a systematic mismatch in form from one age cohort to the cohort that follows. In this way, each age cohort, in sequence, systematically transforms the language environment for the next, enabling each new cohort of learners to develop further than its predecessors.

My talk today is about the origin of the structure in language. One of the hallmarks of language is the use of a discrete digital signaling function, as opposed to analogue systems. These elements are joined compositionally to give language its infinite productive power. Another attribute is that the symbols are arbitrary in their relation to their referents. It may be that these are part of an innately endowed language ability, or we may simply have very good pattern learning abilities that enable us to detect recurrence. Language involves both general cognitive abilities coupled with cumulative cultural complexity. Each generation builds upon the set of language tools provided by a particular linguistic culture. This learning is not exactly faithful to the environment, because it takes the current structure and adapts it, building in greater complexity. In a typical language learning situation, it is very difficult to differentiate the evolutionary and environmental contributions to structure in language. The presence of a fully formed language in the environment masks the contribution of the learner.
In order to examine the contribution of the learner, it is important to study language acquisition in environments that are not optimally rich. One example is research on homesign, which are systems that develop in the homes of deaf children who grow up without exposure to a sign language. Often, the child is the only deaf member of the household, and together with the family, the child will develop a gestural communication system. Susan Goldin-Meadow and colleagues have shown that these homesign systems can develop some of the kinds of structure that you see in mature languages, but not all.

Homesign systems are not mature languages, but they have 1) basic word order, 2) contrasts between different kinds of subjects and objects, 3) conventions for communicating who did what to whom in a very basic way, and 4) discrete referential symbols. Thus, it is possible to find some core aspects of language in homesign. Similarly, a deaf child of deaf parents who learned sign language late in life and who were not fluent signers was able to transition into a full grammatical language that was richer than the model. In both kinds of cases, the output language was richer than the input. However, without the rich bundles of structure provided by the deaf signers, the homesign children did not get richer than simple single-level constructions. This rules against the argument that children come into the world equipped with a full grammar that is ready to go. What abilities are applied for the child to arrive at a full language?

To address this question, I want to focus on a new sign language that has arisen in Nicaragua. This situation has an advantage over the homesign cases in that we can examine multiple transitions across a couple of generations. Moreover, the materials that the children here were exposed to were much more raw than those of the child with the late-learning deaf parents. In this case, they created a language from the gestures that were used in everyday life by hearing people speaking Spanish.

Before the 1970s, there were no social structures that enabled deaf people to come into contact with each other. In particular, there were no opportunities for inter-generational contact among deaf children and older deaf people. They were isolated in their homes, there were a few clinics and schools set up that never had more than 15 children together, and deaf children were never together for more than a couple of years. Before 1970, there was no sign language available in Nicaragua. Deaf people were not allowed to marry and in fact, they are still not allowed to own property.

In the late 1970s, a new school for special education was set up and 50 deaf children were admitted to the entering class. The school also served children with other disabilities, and it was somewhat segregated by disability. In particular, the deaf children were in dedicated deaf classrooms. The educational instruction was all in Spanish, but they had no success at learning Spanish—there was none of the kind of support that is needed to teach a spoken language to these children. That first cohort of children started to communicate with each other gesturally. It was easier for them to make up their own language than it was for them to have access to this language that they could not hear. In the early 1980s, a vocational school for special education was started, which many of the graduates of the elementary school attended. As adolescents, that first cohort became a key group because they were the ones who first started to sign what is now Nicaraguan Sign Language. Each year, new children have entered the school and learned the sign language from the older children around them,
and their language has continued to grow and expand. By the mid-1980s, there were 200 children in these schools, and now there are around 800-1000 signers of Nicaraguan Sign Language in Managua.

For research purposes, I divided this group into 3 cohorts, however, this is really a continuum because there are new children entering every year. The first cohort comprises those who entered from the late 1970s to the early 1980s. The second cohort are those from the early 1980s to the late 1980s. The third cohort are those from the 1990s to today. A cross-section of these groups today reveals a record, like rings of a tree, of the stages of the language. After the first cohort developed a language and stabilized to a degree, the second cohort quickly learned what the first cohort developed and expanded it, and the third cohort learned from the second cohort. To the degree that language stabilizes at adolescence, we will see differences between these cohorts. Any gap between younger and older cohorts reflects a contribution of the newer cohort.

I am going to show you three examples of sign language conversations among pairs of signers. The first example is of two first-cohort signers who have been friends since they were about four years old. One aspect of first-cohort conversation, even if you can not follow what is happening, has to do with the form. The size of the signing is quite large, the signs are relatively deliberate and easy to segment, and there is a lot of feedback from the listener. There is not always an assumption of understanding.

[Prof. Senghas shows a video of a conversation among two first-cohort signers of Nicaraguan Sign Language.]

The next video shows two second-cohort signers, and you should notice that the signing is more in the wrist and elbow, so the space is smaller, it is faster, and crucially, there is less checking for feedback.

[Prof. Senghas shows a video of a conversation among two second-cohort signers of Nicaraguan Sign Language.]

The next video shows a conversation of two third-cohort signers. The signing space is even smaller, faster, and it has a wonderful smoothness to it.

[Prof. Senghas shows a video of a conversation among two third-cohort signers of Nicaraguan Sign Language.]

They sign at the same time, something you can not do if you need a lot of feedback. Also, the language includes a lot of mouth movements.

These differences are interesting, but it is important to investigate the differences that contribute to linguistic structure. One is differentiation across time in describing motion events, and another is about space. Spoken languages also sequence across time, but they do not segment across locations. There are a couple of ways that languages could combine things. One is analogical, in which two elements such as red and white pigments are combined together to make pink, but you can no longer differentiate the elements. Another way is to have both red and white in a sequence.

I wanted to see how this language handled events that would lend themselves to analogue representation of motion events, like rolling down a hill. This is a complex
event in which there is a manner of movement, rolling, and a path, down. These attributes are necessarily bound together in the original event. Iconic representation of such events in the language would preserve the unitary nature of these events in the referential terms. Because co-speech gesture is the basis for these signs, I compared co-speech gestures of hearing Spanish speakers with the signs denoting these events.

The subjects watched a short cartoon that showed a character either rolling down a hill or climbing up a pipe, and then they would tell the story of the cartoon to a peer, while recorded on videotape. We analyzed how manner and path were coded for each of the three cohorts—whether manner and path were simultaneous or segmented in the gestures and signs.

[Prof. Senghas shows video clips of four different people gesturing and signing.]

Notice that the Spanish speaker's co-speech gesturing expresses the manner and path of movement simultaneously. The first-cohort signer did not combine manner and path, she left out the path and only designated the manner. The second-cohort signer described a lot about the manner, then, at the end, he showed a separate sign for the path. The third-cohort signer segmented manner and path.

For each of the participants, we looked at how often manner an path were segmented and assembled in a sequence. The Spanish-speaking gesturers never segmented manner and path. First-cohort signers did it almost a third of the time, but by the time the language got to the second and third cohort signers, this was the preferred way to describe manner and path. We can see a progression from the input in which all of these events are blended and holistic, to early sign which mostly takes structure from the event, to later sign in which there are mostly segmented combinatorial sequences. The later signers are not faithfully reproducing a motion pattern from the environment, they have learned to do something else.

Next, I will move to a different domain to observe segmentation in describing simple events. In events like a man giving something to a woman, there are many things happening at the same time—a man is giving, a woman is receiving, and something is being transferred. Different kinds of events have different numbers of participants involved in them, and so different verbs will require different numbers of arguments. For example, sleeping takes one argument, I sleep; pushing takes two arguments, I push you; giving takes three arguments, I give you a cup. Once you designate an event and participants, the grammar has to link those participants to the event to represent the roles the participants play in the event. Different languages code these in different ways—some use word order, and some sign languages use spatial differentiation.

In this study, first and second cohort signers watched very short events involving one or two participants. They were asked to produce a sentence-length sign describing each event.

[Prof. Senghas shows a video clip of a woman giving a cup to a man.]

The events varied in the number of potential arguments involved, and I was interested in how many arguments they linked to their verbs, and what devices they were using to link them. There was a difference between the first and second cohort. The first cohort used a very strict segmented word order, with one verb for each
argument. If there were two people involved, they each got their own verb—I did not observe things like woman give man, but, more typically, observed something like woman give man receive. If there was more than one argument with a verb, it would be an inanimate object, like woman cup give.

[Prof. Senghas shows a video clip of a person signing woman give man receive.]

Second-cohort signers used sentences like that, but they also tended to use more variable word orders, like man woman give receive. Interestingly, the order of the items was allowed to vary so that man woman give receive could refer to the same event as the latter example.

[Prof. Senghas shows a video clip of a person signing examples.] In these new constructions, word order does not unambiguously designate the relations among these arguments. Sign languages typically use signing space for grammatical agreement—you can move signs to and from specified locations in order to link them with arguments that you have associated with those locations. In order to do this, there must be differentiation in the signing space, in which the left sign does not mean the same thing as the right side.

I looked at whether these signers showed any systematic differentiation in signing direction in their sentences. They could use an unrotated representation that follows the direction the signer sees, or they could use a rotated representation that goes in the opposite direction—the event has been rotated into the signer’s perspective.

[Prof. Senghas shows video clips of a person signing examples of this.] For each of these utterances, I looked at how consistently signers used an unrotated representation, a rotated representation, or a mixed representation. The first cohort signers as a group do not seem to be using space in a systematic way. This is unexceptional for this group, though, because they rely on word order. The second cohort was systematically rotating. The next question is to ask what these different forms mean to these signers.

The next study looked at how these signers interpret these signed sentences. They were given a set of pictures to choose from and asked which ones could have been part of the event that the signers were describing. The set of pictures always included the original event and its mirror image, plus a couple of foils, and sometimes there was more than one correct picture. The first cohort signers would choose both the correct event and the mirror image event. The second cohort signers were more selective in choosing only one of the mirror-image events, the one that would yield a rotated sign. In some cases, these were not the same as what the signer intended because the signers were not perfectly consistent in using rotated signing space.

If the second-cohort signers were not getting consistent use of rotation in their input, then where did it come from? Next, I used a task developed at the Max Planck Institute for studying spatial language. The subjects in this procedure work in pairs, each in front of an array of 12 pictures. One signer describes a picture from the array, and the partner has to pick the matching picture from their array. The pictures were designed to use the same objects and the only differences were the relative locations
and orientations of the objects. To succeed in this task, the signers must share common symbols for the objects, but also must distinguish left from right in representing spatial relations. The first-cohort signers really struggled with this task; I was actually surprised by this. The second-cohort signers breezed through the task. In fact, half of the second-cohort signers used rotated and half did not, but they were able to negotiate the terms and work with through the task. The first-cohort signers did not differentiate at all and they had many errors. The use of spatial differentiation emerged during the time that the second-cohort signers were young, and they are not using a single system across both argument structure and contrasting orientation.

[Prof. Senghas shows video clips of pairs of signers performing this task.]

What happens when a first-cohort signer and a second-cohort signer do the task together? These two people are related; they are an aunt and nephew, and they live in the same household. During the task, he notices that there is something different about the way each of them signs and she keeps missing the items. He tries to explain to her how to do the task. Remember, his cohort learned the language from her cohort, and now, he is explaining the language in terms that she can not understand.

[Prof. Senghas shows a video clip of a pair of signers, each from a different cohort, performing the task.]

This difference between cohorts can not result from a hard-wired program for grammar because they should each have the same program, hence, the same grammar. It also cannot come from faithful pattern learning because he is not reproducing the same kind of language she is producing. It also is not coming from generations of cultural evolution because this is only a single generation yielding so many changes. There is something right about the transition idea, but it may apply at a shorter timescale. At the moment of transition, when a language is being passed down, that is the moment where any existing learning biases can have their impact. With a fragile language like this one—Nicaraguan Sign Language is very young and minimally structured—the learning biases have had a stronger impact than usual. The shared biases in this case will have a greater chance of sticking when the model can have less impact.

I want to step back for a moment to discuss iconicity and the arbitrariness of the symbol. In this case, it appears that segmentation is preferred by children and iconicity is disfavored. Languages end up being arbitrary because these other kinds of pressures are competing with the relationship between the form and its meaning. Iconicity is readily sacrificed to satisfy these other functions. If language were to preserve iconicity for meanings that are very similar, this would create difficulty when a linguistic expression aims to create a subtle distinction.

Where did the structure of Nicaraguan Sign Language come from? It comes from the nature of the development of the individual. As individuals are learning the language, the biases they have will give the language some of its structure—discreteness, combinatoriality, etc. At the individual level, there is great change, despite a relatively stable environment. Historical change is the consequence of repeated individual learning pressures. Evolutionary change is not the cumulative
effect of historical change; it is really more like the pressures on a vast time-scale favored individuals who could learn those kinds of things easily. Those who learned things in a segmented way held an advantage learning languages that are segmented. That advantage could accumulate over time. In modern humans, it would ensure that any new languages that emerge would have that kind of structure.

**APPLAUSE**

**Questions**

**Professor Robert Krauss:** In spoken English, when the perspective of the speaker and the hearer are different, there seems to be a preference for speaker to use the perspective of the hearer. But, that is not linguistic, that is really a convention of usage, and if you make the task hard enough, the speaker will revert to his/her own perspective. I wonder whether the arbitrariness that you point to in scene rotation is not a convention of language as much as a convention of usage.

**Professor Senghas:** So what you are saying is the language is arbitrary, but only in the concrete domain and not the abstract domain. You could still argue that the argument structure is not parasitic on talking about location, because in argument structure it is not arbitrary, despite arbitrariness in space. I am not really wedded to saying the distinction in the location of objects is grammatical, whereas the one in argument structure feels much more grammatical. One thing that makes it feel a little grammatical is how hard it is for them to do it the other way. It is more than just designating the directional terms, in fact, all of those pairs used opposing rotations, and three of them were best friend pairs. People are consistent in which one they use, but they do not notice that people are rotations from their own representation.

**Professor Robert Remez:** When I take the perspective of the young people, I see each cohort as improving the structural properties that they have to use. But, when I take the perspective of the old people, I see this more as a problem of language change, rather than language improvement. We know that all modern languages change, although it is hard to see the changes as improvements, especially when they produce things like assimilations. Labov says that if you want to know the way the language is going to change, think about the thing that young people do that you most deplore. Taking the perspective of the aunt talking to her nephew, my guess is that she does not see his more highly differentiated form of production as an improvement at all.

**Professor Senghas:** Actually, there are better examples of this than that one. One thing about all of these utterances I have shown you today that make a left-right contrast is that the later cohort produces a subset of the earlier cohort. In cases where she would sign either to the left or to the right, he will only sign to the left. So, it will never look wrong to her. It is always one of the things she could have done. What that means is he is rejecting an option in his input that is grammatical. When I ask the younger signers if they could do it either way, they said that you could not—one way was right and the other way was wrong. In this case, the younger people see the difference, and the older people can not see it. However, Shira Katseff and I have been doing work on the number system, and the number signs have changed dramatically.
One of the changes involves the number 15, which was originally something like this [Prof. Senghas makes a gesture with her right hand corresponding to a raised index finger followed by all five fingers], and then became something like this [Prof. Senghas makes a gesture with her right hand corresponding to a flicking of the index finger from the thumb.] I asked a second-cohort teaching assistant how the sign should be, and she made the first one, but when I asked her if she should make it the second way, she replied, "Uhk! I know the kids are doing that, and what is that? It is a flick, it is not even a number!" There is definitely this sense that some changes that do look like they are involving a loss of information are wrong or sloppy.

**A member of the audience (through ASL interpreter):** It is important for a receiver to know which perspective a signer is signing from. Once that is established, then you can go on and you understand. Each group has ways of working out their perspective—the younger signers seem to be establishing it in a more parallel manner. You need to focus on establishing perspective, and I think that that is incredibly important in any kind of developmental language. For signers, if we are seated next to each other, we have completely opposite perspectives. If I am signing, and someone is facing me, they tend to take my perspective. However, if they move next to me, they will take on the new perspective.

**Professor Senghas:** This is why I do the task side-by-side. Even though it is slightly less natural, I wanted to remove any possible justification for rotating to take on the receiver's perspective. So you have the shared perspective, and I wanted to see if there would be rotation that is not motivated by differences in perspective. In this case, the children are taking on the adult’s perspective more readily than the reverse, despite the typical finding that children are notoriously bad at perspective-taking.

**A member of the audience (through ASL interpreter):** Do the deaf adults have regular social interactions with each other? If not, that could be a reason that he adults have trouble understanding the children. They are not able to learn as well as the children, and they do not have interaction with other adults.

**Professor Senghas:** That is an important reason why I segregated by cohort, and not age. The adults over 40 do not have a lot of contact with other deaf people and their signing is not very strong. Adults between 20 and 40 have a social life entirely among deaf people, and their primary language is this sign language. It seems like under 40, they all have equivalent deaf community contact. All of the people whom I discussed are part of this community, so those first-cohort people are failing for a different reason.

**Professor Remez:** Let us thank Professor Senghas and adjourn.

**APPLAUSE**

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**Place:** Kellogg Center, Room 1512  
School of International and Public Affairs  
420 West 118th Street  
**Time:** 4:00 PM
Chair: Prof. Robert E. Remez, Barnard College, Columbia University

Rapporteur: Jennifer Pardo


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