# Research Article

## CHILDREN CREATING LANGUAGE: How Nicaraguan Sign Language Acquired a Spatial Grammar

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**Abstract—***It has long been postulated that language is not purely learned, but arises from an interaction between environmental exposure and innate abilities. The innate component becomes more evident in rare situations in which the environment is markedly impoverished. The present study investigated the language production of a generation of deaf Nicaraguans who had not been exposed to a developed language. We examined the changing use of early linguistic structures (specifically, spatial modulations) in a sign language that has emerged since the Nicaraguan group first came together. In under two decades, sequential cohorts of learners systematized the grammar of this new sign language. We examined whether the systematicity being added to the language stems from children or adults; our results indicate that such changes originate in children aged 10 and younger. Thus, sequential cohorts of interacting young children collectively possess the capacity not only to learn, but also to create, language.*

Children surpass adults at learning languages, even though adults are better at mastering most other complex bodies of knowledge (Johnson & Newport, 1989; Newport, 1990).[1] This suggests that some of the natural abilities involved in language learning may be operative only during an early, sensitive period (Lenneberg, 1967). It remains unresolved whether these abilities result from an innate knowledge of language structure, or from a heightened natural capacity to draw information from the environment (Chomsky, 1965; Newport, 1990).[2] That is, where do the patterns found in children's language ultimately originate—in the children or in their environment? Do inborn abilities enable children to produce patterns or discover patterns?

The challenge in studying children's capacity to learn language is that researchers cannot observe it operating in a neutral environment, or in isolation. They can only compare the effects of different language environments. Nearly all children's environments include a rich, fully formed language, making it difficult to distinguish prior knowledge of language from natural learning abilities. The rich language structure that children eventually acquire could come from either source. One solution to this dilemma is to identify exceptional situations in which the language environment is degraded. Learners may reveal the nature of their inborn resources as they enrich, or merely duplicate, the degraded input.

Previous research indicates that children can generate utterances of a complexity not available in their input. Deaf children who are not exposed to conventional language (spoken or signed) can develop rudimentary gestural communication systems called homesigns. These systems include regularities of word order (i.e., gesture order) not found in the gestures of their mothers (Goldin-Meadow & Mylander, 1984, 1998). Furthermore, a deaf child who learned American Sign Language solely from his nonfluent, deaf parents acquired rules they did not model, and consistently followed rules that they used only inconsistently (Ross & Newport, 1996; Singleton & Newport, in press).

Despite these known examples of the ability to enhance incomplete language, there are no known examples in which an individual produced a complete language *ab initio*. One might conclude that only the most core language structures are part of the child's innate endowment. If this is the case, no individual, nor group of individuals, should be able to acquire language without exposure to a rich language model.

Alternatively, the time required to originate a language may exceed a child's sensitive period, which presumably evolved to enable learning from a full language model. Without rich input, an individual may still have the resources, but not enough time, to create a new language. If time is the limiting factor, perhaps sequential cohorts of interacting individuals, successively building on the achievements of their predecessors, could effectively concatenate their individual sensitive periods into a combined period long enough to create a language. According to this model, only children are capable of creating a new language—children who are replaced by new children as they age.

The ideal test case would be a community of children and adults who have no other first language and are building a new language together. In such a case, where would the internal structure of the language come from? To answer this question, one must consider not just the collection of words in the language, but the grammatical elements that link those words together into longer utterances. If children's language-learning ability is necessary to create new languages, such structural complexity should emerge among children. Otherwise, development should stem from the individuals who are most cognitively mature, are most experienced with the language, and discuss the most complex concepts—that is, the adults.

In the present study, we investigated the birth of such a language within a new deaf community in Nicaragua. We examined the prevalence and function of newly emerging spatial devices over two cohorts of learners to determine whether grammatical systematicity in this language has come from children or adults. Our results indicate that it has arisen among the youngest children.

## HISTORY OF THE NICARAGUAN SIGNING COMMUNITY

Before the 1970s, deaf Nicaraguans had little contact with each other. There were periods when various classrooms and clinics were

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1. There is evidence that second-language learning is initially more rapid among adults than among young children (Snow & Hoefnagel-Höhle, 1978), although younger learners ultimately acquire a more nativelike competence. Additional studies suggest that adults can achieve native competence in a second language. These findings have led to a debate centered on the sensitivity of linguistic research instruments. For further discussion, see Hyltenstam and Abrahamsson (2000).

2. A second, equally intriguing question is whether the abilities that enable children to draw linguistic information from the environment, and to organize it into a linguistic system, are dedicated to the task of language learning, or are more general cognitive, or even social, abilities. The present article does not attempt to distinguish among these classes of abilities.

  

available to young children, but the lack of a unifying national educational system, societal attitudes that isolated deaf individuals, and marital patterns that generally precluded hereditary deafness prevented intergenerational contact and formation of a deaf community.

However, one school, founded in Managua in 1977 with 25 deaf students, expanded to include 100 students in 1979 when it became more publicly accessible. The following year, a vocational school opened for adolescents. By 1983, the schools served more than 400 deaf students (Polich, 1998). For the first time, a community existed, with continuity from childhood through early adulthood.

The schoolchildren all had hearing parents, and none knew any signing deaf adults. Teachers focused on teaching them to lip-read and speak Spanish, with minimal success. However, the children were allowed to communicate gesturally on the buses and school grounds. They soon began to converge on an early, rudimentary sign language (Kegl & Iwata, 1989; A. Senghas, 1995; R.J. Senghas, 1997).

Every year since 1980, new students of all ages entered school and learned to sign among their peers. The language-learning situation for each new cohort was extremely unusual in that their model was not a fully formed language. Nevertheless, Nicaraguan Sign Language developed rapidly. Researchers can take advantage of both the sequence of cohorts today and the range of ages at first exposure within each cohort to discover when the capacities that shaped the language were available.

In the present study, we selected a grammatical element of Nicaraguan Sign Language and examined its emergence with respect to these two factors (the sequence of cohorts and the age of the learners). We specifically wanted to choose an element of the language that enabled signers to string words together to form longer utterances, such as sentences and longer narration. Because we were seeking the creative origins of the language, we conservatively did not select elements that might arguably have been drawn directly from the (albeit impoverished) language environment, such as expressions that matched spoken Spanish, or signs borrowed directly from common Nicaraguan gestures. We instead chose a grammatical device not found in spoken languages: spatial modulations.

## SPATIAL MODULATIONS

Spatial modulations are typical building blocks in the grammars of sign languages, and are found in all sign languages studied to date (Supalla, 1995). Sign languages, like spoken languages, append grammatical elements to words. Many signs are produced neutrally in a central location in front of the chest. Altering the direction of, or modulating, a sign's movement to or from a nonneutral location constitutes appending a spatial modulation. In developed sign languages, spatial modulations perform various functions, such as indicating person or number; providing deictic, locative, or temporal information; or indicating grammatical relationships, such as a verb's subject and object. If Nicaraguan signing is becoming like other developed sign languages, one would expect such modulations to be appearing.

We looked for cases of spatially modulated signs in Nicaraguan signing to determine if they are indeed emerging as a part of the language. We also noted the contexts in which these spatial modulations appeared, in order to determine their function, and noticed a function that appeared to be emerging: the indication of shared reference. Multiple signs in a segment of discourse are often modulated with respect to a common location. We believe this use of a common location can link the signs grammatically (e.g., a noun and its adjective, or a verb and its object). For example, the sign "cup" in spatial location A, followed by the sign "tall," also in location A, could indicate that "tall" modifies "cup." Similarly, "see," "push," and "pay" might be produced in a common direction to indicate that different events happened to one man: He was seen, pushed, and paid. Figures 1a and 1b are examples of "see" and "pay" produced in neutral and nonneutral locations. In the nonneutral cases, the signs' shared spatial modulation indicates their link to a common referent.

However, movements to or from nonneutral locations also occur in contexts in which no such link is implied. For example, signers frequently shift locations to introduce new characters or topics, to indicate different points in time, or to adopt a rhythmic prosody, alternating from one side to the other. Some of these other uses may be alternative or competing grammatical uses of spatial modulations. For this reason, we needed to examine both who was using spatial modulations and how they were using them.

In this article, we present the results of analyses in which we examined whether spatial modulations are indeed in the process of emerging as a grammatical device in Nicaraguan signing, and if so, at what age signers are contributing to their emergence. The first analysis examined the prevalence of spatial modulations in signers' narratives. The second examined how often such modulations served a particular grammatical function: indicating shared reference. The third analysis measured signers' production rate, to see whether any of the emerging

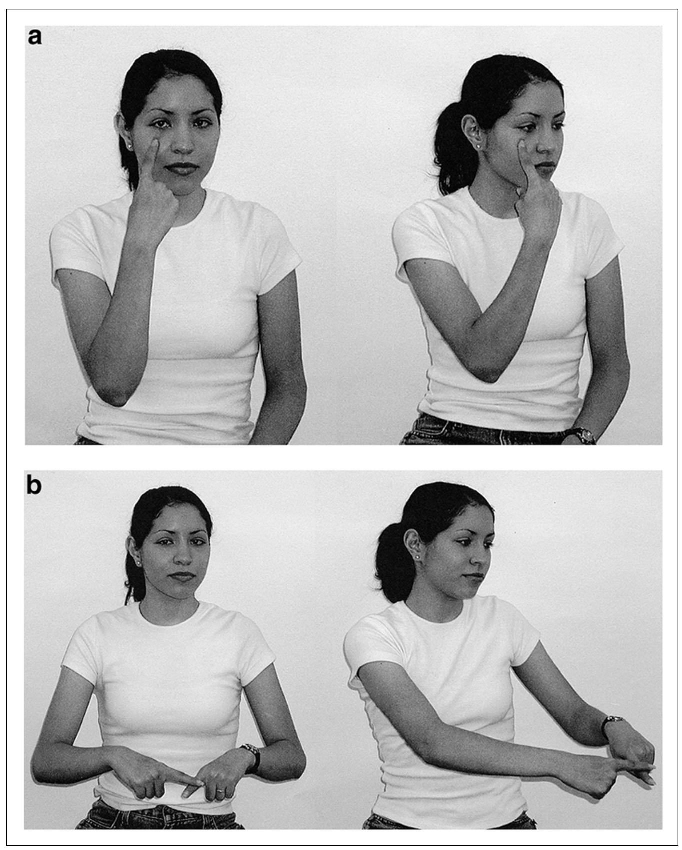


**Fig. 1.** The Nicaraguan Sign Language signs "see" (a) and "pay" (b), produced in a neutral direction and spatially modulated to the signer's left.

constructions accompanied a general increased fluency in the language. For each analysis, two sequential cohorts of signers were compared, to determine whether the language of a cohort developed as its members entered adulthood, or only while they were still young.

We expected earlier-exposed learners to be more proficient than later-exposed learners, an effect independent of cohort. For this reason, each cohort was divided into three groups based on the age at which participants entered the signing community. We then made comparisons between cohorts within these age-at-exposure groups. If children are responsible for the development of Nicaraguan Sign Language, emerging constructions would be most prominent in the second cohort, particularly among those children exposed at an early age.

## METHOD

### Participants

Twenty-four deaf Nicaraguan signers participated in the present study. Their age at the time of testing ranged from 7 years, 6 months to 32 years, 0 months ($M = 25$ years, 1 month). All participants had at least 4.5 years of exposure to Nicaraguan Sign Language. The year in which participants were first exposed to the deaf community ranged from 1978 to 1990, with the median at 1983. Participants were divided into two cohorts based on this median year: first cohort (1983 or before; $n = 13$) and second cohort (after 1983; $n = 11$). The age at which participants were first exposed to the deaf community ranged from birth to 19 years, 2 months ($M = 8$ years, 11 months). Participants were evenly divided into three groups based on age at exposure: early-exposed (before 6 years, 6 months; $n = 8$), middle-exposed (6 years, 6 months to 10 years; $n = 8$), and late-exposed (after age 10; $n = 8$).

### Procedure

Participants each viewed a 2-min animated cartoon and were then videotaped signing the story to a deaf peer. For each narrative, signing rate was computed, and the frequency and function of spatial modulations were coded. All narratives were collected prior to 1996.

### Coding of Videotapes

We first determined the prevalence of spatial modulations in each narrative. Signs produced in nonneutral locations, or incorporating any nonneutral locations into their movement, were coded as spatially modulated. Signs that involved two nonneutral locations were coded as having two spatial modulations. The prevalence of spatial modulations for a signer was defined as the number of spatial modulations produced per verb.

We then considered whether each spatial modulation occurred in a context of shared reference. We compared each spatially modulated sign with the spatially modulated signs that preceded it; if the most recent modulated sign that shared a referent with the current sign also shared its location, the current sign was coded as having a shared-reference use of spatial modulation. For example, a sequence in which “see” and “pay” were modulated with respect to the same location, indicating a single man who was both seen and paid, would constitute one shared-reference use of a spatial modulation. Any other uses of spatial modulations were coded as non-shared-reference uses of spatial modulations, or “other uses.” The prevalence of shared-reference uses of spatial modulations for a signer was defined as the number of shared-reference uses produced per verb.

For a measure of general fluency, we computed the overall signing rate of each signer. Signing rate was measured in morphemes, the smallest meaningful units in a language, produced per minute. For this analysis, each sign produced was counted as one morpheme. In addition, any modifications to a sign, or elements that were added to a sign and changed its form and meaning from the neutral form, were counted as additional morphemes. For example, the sign for “go” produced with both a spatial modulation and a nonneutral hand shape indicating that the actor was a human (as opposed to an animal or a vehicle) was counted as three morphemes.

One coder transcribed and coded the full set of narratives; a second coder transcribed and coded a subset of the narratives across both cohorts to establish reliability. Agreement between coders was .98 for spatial modulations, .96 for shared-reference uses of spatial modulations, and .92 for morphemes per minute.

### Comparisons

Use of spatial modulations and signing rate were compared between the two cohorts within each age-at-exposure group. Recall that the language of signers of the first cohort (who entered in 1983 or before) represents the input available to signers of the second cohort (who entered after 1983). Thus, for each analysis comparing the two cohorts, if the first cohort surpassed the second, then we could conclude that individuals with age and experience are responsible for developing the language; if the cohorts were equivalent, then the whole community is developing the language, and if the second cohort surpassed the first, then the newest learners are developing the language, going beyond their language models.

## ANALYSES AND RESULTS

### Prevalence of Spatial Modulations

The first analysis considered the prevalence of spatial modulations in signers’ narratives (Fig. 2). A 3 (age at exposure) × 2 (cohort) analysis of variance (ANOVA) was performed on spatial modulations per verb. Overall, the age at which the language was acquired affected the frequency of these forms, $F(2, 18) = 9.2$, $p = .002$. Furthermore, post hoc analyses using Fischer’s protected least significant difference (LSD) showed that early-exposed signers produced more spatial modulations than late-exposed signers ($p = .001$) and middle-exposed signers produced more spatial modulations than late-exposed signers ($p = .008$). No difference was detected between early- and middle-exposed signers ($p = .35$). That is, signers who entered the community by age 10 produced more spatial modulations per verb (early-exposed: 1.5; middle-exposed: 1.3) than those who entered after age 10 (late-exposed: 0.7).

Crucially, comparisons between the cohorts revealed that the second-cohort learners did not match their first-cohort models. Overall, the second cohort produced marginally more spatial modulations than the first, $F(1, 18) = 3.98$, $p = .06$. In particular, the early-exposed signers of the second cohort produced them significantly more than the early-exposed signers of the first cohort, $t(6) = 1.91$, $p = .05$, one-tailed. Even middle-exposed signers of the second cohort produced spatial modulations marginally more than middle-exposed signers of the first cohort, $t(6) = 1.87$, $p = .055$, one-tailed. In contrast, no difference was detected between cohorts among the late-exposed signers, $t(6) = -0.10$, $p = .46$, one-tailed. Thus, signers from the second cohort who were exposed by age 6 (and marginally, by age 10) surpassed their first-cohort models in their production of spatial modulations.

### Spatial Modulations for Indicating Shared Reference

In the second analysis, we considered the contexts in which these spatial modulations appeared, in order to examine the function they served for each cohort. We first determined which of the spatial modulations had occurred in a context of shared reference. We then compared the cohorts to determine whether this particular grammatical function fully accounted for the increase in spatial modulations observed in the first analysis.

We could not predict a baseline rate for spatial modulations that occur in a context of shared reference. If signers are shifting locations for any reason, in a narrated story involving a finite number of characters, some number of signs will necessarily share both referent and location by chance. Nevertheless, we assumed that, whatever the chance level, it is the same for both cohorts. Thus, any increase in shared-reference uses as the language was passed from the first to the second cohort represents development beyond chance in the use of spatially modulated forms.

The results presented in Figure 3 reveal that the higher prevalence of spatial modulations in the second cohort was indeed due to indications of shared reference. A 3 (age at exposure) × 2 (cohort) ANOVA showed that the two cohorts were strikingly similar in the frequency of spatial modulations with other uses (first cohort: 0.48; second cohort: 0.40), $F(1, 18) = 0.35$, $p = .56$. There were no significant differences detected between the two cohorts among the middle-exposed signers, $t(6) = 0.02$, $p = .49$; the late-exposed signers, $t(6) = -0.84$, $p = .22$; or even the early-exposed signers, $t(6) = -0.21$, $p = .42$ (all one-tailed).

In contrast, the cohorts differed markedly in frequency of shared-reference uses (first cohort: 0.63; second cohort: 0.88), $F(1, 18) = 6.33$, $p = .02$. The second cohort, particularly signers exposed by age 10, indicated shared reference more than the first. The difference between the cohorts was significant for the early-exposed signers, $t(6) = 2.16$, $p = .04$, and for the middle-exposed signers, $t(6) = 2.28$, $p = .03$, and not for the late-exposed signers, $t(6) = 0.18$, $p = .43$ (all one-tailed).

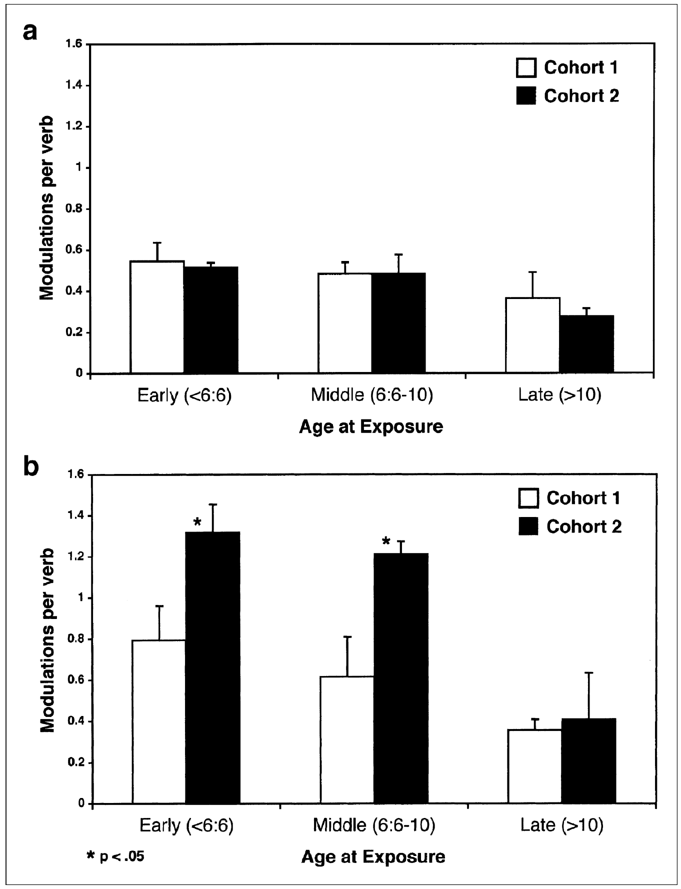


**Fig. 3.** Mean number of spatial modulations per verb with non-shared-reference uses (a) and shared-reference uses (b) produced by early-, middle-, and late-exposed signers of the first and second cohorts. Asterisks indicate a significant difference between cohorts within an age-at-exposure group.

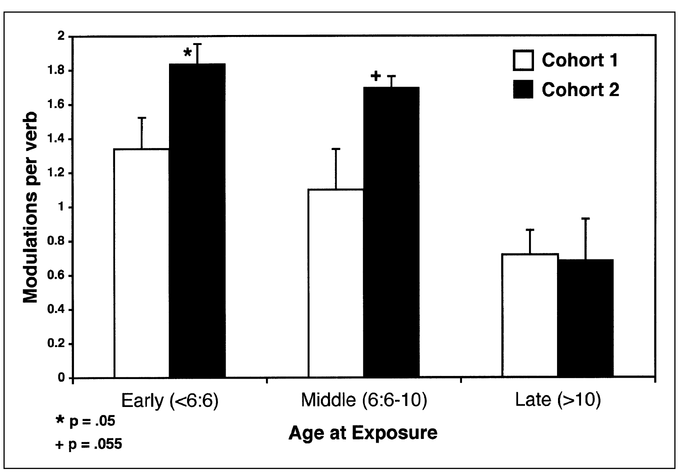


**Fig. 2.** Mean number of spatial modulations per verb produced by early-, middle-, and late-exposed signers of the first and second cohorts. Asterisks indicate a significant difference between cohorts within an age-at-exposure group.

Thus, second-cohort signers exposed before the age of 10 used disproportionately more shared-reference (but not other) spatial modulations than signers from the first cohort. Therefore, the differences observed in the analysis of the frequency of spatial modulations are fully accounted for by their being applied in contexts of shared reference by the early-exposed signers of the second cohort. These children were not merely boosting the frequency of spatial devices overall; rather, they were increasingly using them for a particular function: indicating shared reference.

### Signing Rate

If one considers the signing of the first cohort to be the target language of the second cohort, it may seem unusual to attribute differences between cohorts to growth in the language. Generally, such differences are presented as evidence that a younger group has not yet achieved adult competence. After all, the second cohort averaged fewer years of exposure to the language (8 years) than the first cohort (14 years). Perhaps the second cohort had not fully mastered the language, and had therefore not acquired all the uses of spatial modulations. To test this hypothesis, we compared the cohorts on a general measure of fluency that is unaffected by the specific function of individual constructions. We selected overall signing rate.

Like all languages, Nicaraguan Sign Language generates sentences, which can be analyzed into phrases, words, and then morphemes, the smallest meaningful units. For the third analysis, signing rate was defined as the number of morphemes produced per minute (mpm; see Fig. 4). A 3 (age at exposure) × 2 (cohort) ANOVA was performed on signing rate to determine whether the second cohort's difference in the use of spatial modulations was accompanied by greater or lesser fluency in the language. As expected, the age at which the language was acquired affected the rate of signing, $F(2, 18) = 9.72$, $p = .001$. Furthermore, post hoc analyses using Fischer's protected LSD showed that fluency was significantly greater for early-exposed than for late-exposed signers ($p = .005$) and was significantly greater for middle-exposed than for late-exposed signers ($p = .001$). No difference was detected between early-exposed and middle-exposed signers ($p = .51$). That is, signers who were exposed to the language by age 10 signed more rapidly than those who were exposed later (early-exposed: 262 mpm; middle-exposed: 240 mpm; late-exposed: 135 mpm).

More important, members of the second cohort signed more rapidly (234 mpm) than members of the first cohort (194 mpm), $F(1, 18) = 6.35$, $p = .02$. Specifically, the early-exposed signers of the second cohort signed more rapidly than their first-cohort models, $t(6) = 3.88$, $p = .004$. No difference was detected between the middle-exposed signers of the first and second cohorts, $t(6) = 1.25$, $p = .13$, or between the late-exposed signers of the first and second cohorts, $t(6) = -0.71$, $p = .25$ (all one-tailed). The early-exposed children of the second cohort signed more fluently, more quickly, and without hesitations, in a way that even the most experienced of their adult models did not.

It is unlikely, therefore, that the observed differences in use of spatial modulations between the two cohorts represent incomplete learning on the part of this second cohort. Rather, it is the first cohort's learning that is less complete; Nicaraguan Sign Language had evidently not yet stabilized in the early 1980s, when these first-cohort signers were still children.

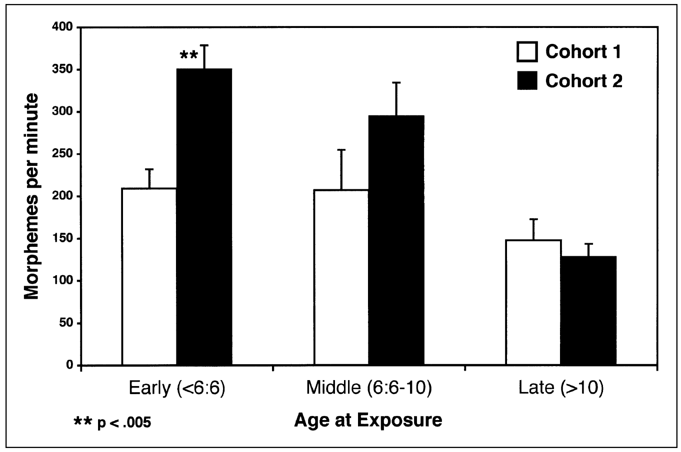


**Fig. 4.** Morphemes per minute produced by early-, middle-, and late-exposed signers of the first and second cohorts. Asterisks indicate a significant difference between cohorts within an age-at-exposure group.

## DISCUSSION

These results indicate that sequences of child learners are creating Nicaraguan Sign Language. We have captured a piece of the process in the changing use of spatial modulations. The first analysis shows that spatial modulations are more frequent in the signing of early-exposed signers of the second cohort than among early-exposed signers of the first cohort. This result indicates that the second cohort did not reproduce the language as it was produced by their first-cohort elders; rather, they changed the language as they learned it. The second analysis examined the function to which such spatial modulations are applied, and found that in the second cohort they are increasingly used for indicating shared reference. This use enables long-distance grammatical relationships among words, and brings the language closer to other, older sign languages. The third analysis reveals that these changes in use of spatial modulations are accompanied by an increase in overall fluency, and thus cannot be interpreted as a result of the learners' having acquired only a subset of a more extensive system. Drawn together, these results show that the youngest members of the second cohort, as children, surpassed their input, taking a partially developed language and systematizing it in a specific way. This finding is especially striking considering that the second cohort had had fewer years of experience with the language than the first cohort.

It may be tempting to see these results as evidence of regularization in children's production. However, there is an important difference between this and other acquisition studies: These data show a permanent, creative impact of children's learning capacities on their language. Recall that the participants were no longer young children of 3 or 4 at the time of testing. Thus, any regularizations they produced are not of the typical sort that one observes in 3- and 4-year-olds. Instead, these regularizations represent changes that have taken hold and persist in the language of today's adolescents. Nicaraguan Sign Language had evidently not yet stabilized in the mid-1980s, when the second-cohort learners arrived. Otherwise, this cohort would have shown the normal pattern of "unlearning" their "errors" and eventually adopting adultlike productions.

Furthermore, these children did not overextend the devices they observed. Rather, they applied them to a narrower function than found in their input. A signer who uses spatial modulations to indicate shared reference would produce a sentence in which "see" and "pay" are similarly modulated to mean only that a single person was both seen and paid. A signer who does not use spatial modulations in this way would produce the same sentence in reference to additional situations, including one in which one person was seen and another paid. Thus, the shared-reference version of the language is more specific; the same sentence has fewer possible meanings.

We are presently examining how first- and second-cohort signers comprehend sentences with spatially modulated signs, and are finding that only members of the second cohort interpret the modulations as limiting potential referents. Members of the first cohort, in contrast, do not constrain their interpretation of a verb's arguments based on the location of a sign (A. Senghas, 2000). We conclude that the second cohort has reanalyzed the location of spatially modulated signs as indicating something akin to co-indexing. By using this form systematically, they have increased the specificity of their language.

The fact that it took multiple cohorts to grammaticize Nicaraguan Sign Language suggests limitations on the input that will result in a new language. Although the first cohort, as children, had access to multiple sources of input (e.g., the interlanguage formed by older students in the early 1980s, family homesign gesture systems, and the gestures that accompany spoken Spanish), the language did not develop its full complexity by 1983. These initial resources were evidently insufficient for the first-cohort children to stabilize a fully developed language before entering adulthood. Nevertheless, over their first several years together, the first cohort, as children, systematized these resources in certain ways, converting raw gestures and homesigns into a partially systematized system. This early work evidently provided adequate raw materials for the second-cohort children to continue to build the grammar.

The emergence of Nicaraguan Sign Language offers an opportunity to examine the processes common to language learning, language change, and language genesis. Some linguists have proposed that child learners transform pidgins (simple systems developed by speakers of incompatible languages) into creoles (more complex languages that arise in later generations of such mixed-language communities; see Anderson, 1983; Bickerton, 1984, and following commentary; Sankoff & Laberge, 1973). It has been proposed that American Sign Language recreolizes each generation, as a high proportion of American Deaf parents learn American Sign Language late, and thus model a degraded version of it (Fischer, 1978; Newport, 1981).

Because even the oldest languages are not stable over generations, learning processes may account for patterns of historical language change over time (Slobin, 1977). Each generation leaves the distinctive mark of their learning process on the model they provide for their children. When children learn a mature language, the mark is a subtle one. Learners have evolved to learn languages with certain characteristics, and languages have presumably evolved to have those characteristics (Chomsky & Halle, 1968; Kiparsky, 1968; Pinker, 1994). Thus, in most cases, learners apply themselves naturally to learning, and closely match their model. Only in cases like this one, when the model is not a mature language, do these language-learning abilities show their transformational, creative capacity. The mark left by this generation of deaf Nicaraguans is an entirely new language, one that did not exist when they were born.

**Acknowledgments—**We thank the Nicaraguan Ministry of Education, the Melania Morales School for Special Education, and the Nicaraguan National Deaf Association for their enthusiastic participation. We also thank R. Aslin, H. Bleakley, J. Kegl, E. Newport, S. Pinker, J. Saffran, R. Short, D. Wilkins, and four anonymous reviewers for comments on previous versions. This work was supported by National Institutes of Health (NIH) Grant T32 DC00035 to the University of Rochester; by NIH Grant HD 18381 to Steven Pinker; by a Spencer Foundation Dissertation Fellowship (A.S.); and by a National Science Foundation Graduate Research Fellowship (M.C.). All participants or their parents gave informed consent.

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(RECEIVED 6/2/99; REVISION ACCEPTED 11/28/00)