INTERACTION ALONE CANNOT SUPPORT THE EMERGENCE OF A SPATIAL AGREEMENT SYSTEM IN A PAIRED INTERACTION CONTEXT

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We used an experimental semiotics approach to ask whether interaction between individuals in the same "generation" of language users (horizontal interaction) supports the emergence of a spatial agreement system like those of established sign languages. Pairs of hearing non-signers participated in an interactive gesture communication task designed to elicit the use of space. No pairs spontaneously generated a spatial agreement system as complex as those in established sign languages, but their strategies resembled such systems. We conclude that interaction promotes the genesis of linguistic structure, but is not solely responsible for the emergence of complex linguistic features.

1. Introduction

The emergence and evolution of Nicaraguan Sign Language (NSL) allows us to observe new grammatical devices developing as the language is acquired by different generations of users. We focus on the emergence of one particular linguistic feature: how space comes to be used to systematically express argument structure (Sandler & Lillo-Martin, 2006). The consistent use of this device has been demonstrated in second- but not first-cohort users of NSL (Senghas & Coppola, 2001); however, a detailed account of the mechanism of its emergence has been elusive. One possibility involves intergenerational transfer, the notion that this linguistic device conventionalizes as a result of children entering the community and reanalyzing input provided by existing community members (Senghas & Coppola, 2001; Senghas, 2003, 2010).

Naturalistic data cannot definitively show whether this is the case, nor provide answers as to the nature of the mechanisms that may be responsible for this particular language change. The current work therefore employs an Interactive Gesture Communication Paradigm (described later) to ask whether the emergence of linguistic use of space can occur without intergenerational transfer (that is, without the language being passed down to new children entering the language community). We assess whether hearing adults with no previous exposure to sign language can generate the linguistic use of space for argument structure within a single "generation" of interactive gestural communication. If interacting pairs of hearing adults can generate this linguistic feature, it may be the conditions of the environment (e.g., the opportunity for interaction given a limited focus on a particular task), rather than the nature of child brains, that promotes the genesis of linguistic structure.

1.1. *Spatial Agreement in Sign Languages*

Languages use different linguistic devices to represent argument structure, that is, to express how arguments relate to predicates. English, for instance, uses word order—in a basic sentence arguments that precede the verb are typically subjects or agents, and arguments that follow the verb are typically objects or patients (Greenberg, 1963). Other languages use morphological markings to designate the semantic or grammatical role of arguments. Many signed languages have a spatial morphological system for representing argument structure, which takes unique advantage of the modality in which these languages occur (e.g. Casey, 2003). Referents are linked to arbitrary spatial locations (locations which do not necessarily reflect the actual spatial configuration of the entities to which they refer), which serve as linguistic placeholders for the referents in the remainder of the discourse (Bellugi et al.,, 1987; Padden, 1988). Verbs can then be moved between referential loci ('R-loci,' Lillo-Martin & Klima, 1990) to express the thematic or grammatical roles of the referents with respect to the verb. Like case-markers in spoken languages, the starting and ending locations of the verbs serve as morphological markings; modulating verbs in this way is referred to as 'verb agreement'.

Senghas and colleagues (1997) and Senghas (2003, 2010) examined how spatial modulations (that is, moving manual gestures toward non-neutral locations) are used for argument structure across two generations of users (cohorts) of Nicaraguan Sign Language. While certain signers in the first cohort do spatially modulate their gestures, the cohort as a whole does not consistently produce or interpret such spatial modulations. The second cohort, in contrast, is consistent in their production and interpretation of spatial modulations that represent argument structure.

Sign languages can also analogically represent spatial relations that occur in the real world. It is therefore possible to use space to talk about "where" characters are located in addition to using space to talk about "who" did what.

The two uses of space are distinct for native users of established sign languages (Emmorey et al., 1995). While space is often used in established sign languages for "where," one crucial feature of the use of space for argument structure ("who") is that the *relative positions of R-loci can be decoupled from the real-world relative spatial locations*. Senghas (2003) showed that the use of space to represent argument structure in NSL did not arise directly from a use of space to describe the relative location of items. Instead, Senghas and colleagues (2001, 2003, 2010) propose that the process of intergenerational transfer is crucial for conventionalizing of the use of space for argument structure. Senghas (2010) suggests that the language acquisition mechanisms of the second cohort allowed a "reanalysis" of the input provided by the first cohort such that they made consistent a previously inconsistent use of space.

However, perhaps intergenerational transfer is not necessary -- first cohort signers of NSL had to conventionalize many aspects of language in a short time period—perhaps the grammatical use of space for argument structure simply required more resources than they had available. The experimental work discussed here tests whether the use of space for "who" (that is, a spatial agreement system) can be generated without intergenerational transfer.

The Interactive Gesture Communication Paradigm used here encourages the development of a spatial agreement in several ways: Participants stand, highlighting the affordances of their bodies and the possibility of using space to represent characters. The stimuli feature actions that typically elicit the use of spatial agreement in established sign languages. Finally, we structured the stimuli to first draw participants' attention to the use of space as a cue to the characters' identities, and then selectively removed this association to encourage them to make their uses of space more abstract.

1.2. *Method*

Thirty-eight pairs of hearing non-signers watched videos of simple events involving a single male and female actor (e.g. "a man taps a woman"). The producer described the events to a receiving partner without speaking. Receivers then selected a photo that matched the description of the event from an array of four. Participants took turns being the producer and the receiver in blocks of 8 trials for a total of 128 trials. Participants were randomly assigned to one of three conditions. In Condition 1, the male character was always on the left and the female character always on the right. In Condition 2, the locations of the characters in both the video stimuli and the comprehension array were randomized after half the trials. Condition 3 was the same as the second *except that* 50% of the trials in the second half of the study did not contain a picture in the comprehension array that exactly matched the video—it showed the correct semantic roles but the characters were in opposite spatial locations.

We began each condition with the characters in consistent spatial locations in order to draw participants' attention to the use of space as a potential

mechanism for representing the characters in the stimulus events. In Condition 1, we maintain this stability throughout the experiment to give participants as much chance as possible to take advantage of this environmental regularity in their productions.

However, observing a use of space in this condition does not allow us to conclude whether space is being used for "who" or for "where." Therefore, in Conditions 2 and 3, we manipulate the spatial locations of the characters in the stimulus videos and comprehension picture arrays so we can further probe whether participants that *do* use space are capable of using it to represent "who" or "where." In Condition 2, participants must attend to both the characters' spatial location (Left/Right) and their semantic roles (agent/patient) in order to successfully communicate the event. In this condition we wanted to confirm that participants could in fact specifically attend to the spatial locations of the characters (in addition to attending to their semantic roles).

In Condition 3, participants had to *ignore* the spatial locations of the characters and focus solely on the semantic roles of the characters. In this condition, we wanted to see whether participants who did use space to represent the characters when those characters' locations were consistent could *continue* that use of space for "who" when the consistency of characters spatial locations were disrupted.

1.3. *Results & Discussion*

Participants in all three conditions did use space in their event descriptions, but their uses of space aligned more with the use of space for 'where' rather than for 'who.' Participants moved their bodies to the left and to the right to indicate characters' relative spatial locations. However, when the reliable association of character identity and location was removed, comprehension and production of this strategy faltered, suggesting that participants were not using space to encode the thematic roles of the characters, but their actual spatial locations. In particular, no pairs of hearing signers in condition three used space in a way that could be successfully decoupled from the actual spatial locations of the characters—one member of one pair attempted to do this, but in the trials where this participant used the strategy in production, the receiver had a great deal of difficulty interpreting the strategy (and it was soon abandoned?).

Receivers were allowed to interact with the producer to request clarifications during a production. They were asked to do so gesturally; and we provided them with one example of a gesture they might use to elicit more information (a repeated circular motion of one open-palmed hand). Participants did use and other gestures to ask for more information or clarification, but the use of this varied by participant and by trial.

In general, participants' requests for more information or clarification were minimal (mostly consisting of the "tell me more" gesture we showed them during the Instruction period). In many cases, it seemed as though participants either did not feel confident about asking for more information, or they did not know how to do so. Certainly the lack of a shared system influenced their ability to produce requests for clarification. Interestingly, in pilot work in which we ask native users of American Sign Language to complete the interactive task, we noticed much more back-and-forth between participants, and the semantic content of those clarification interactions was much richer

There were two additional forms of turn-taking built in to the experiment. The first occurred across items: participants switched roles every 8 trials, so one participant acted as the producer for a block of 8 trials, then acted as a receiver for the following 8 trials (etc.). Each block of 16 trials included the same 2 characters and 8 unique events, repeated twice (with each character participating as an agent in each event exactly once). Thus, participants each had the opportunity to describe and comprehend a semi-overlapping set of events with the same characters.

The second form of turn-taking occurred at the item-level. Producers were required to indicate whether a receiver's selected picture matched or did not match the event they had described. When a receiver selected an incorrect answer (as indicated by the producer), producers were required to describe the event again, and the receiver required to select a picture again. Producers were able to see the full comprehension array, and could therefore calculate what the receiver had misunderstood, and modify their descriptions accordingly. We are currently in the process of analyzing differences between first and second productions.

These results suggest that this particular language structure cannot emerge solely in the interactive context provided here. Although we simplified the language genesis task facing participants—giving them a focused task and a restricted set of things to describe in an interactive, turn-taking paradigm—participants were unable to generate a spatial agreement system within a single generation. This accords with other observations that participating in an interactive group setting can reduce the complexity of linguistic structures (e.g., (Coppola & So, 2005 on the consistency of spatial layouts in NSL v. Homesign). However, it may also be the case that the interactive context we provided was insufficient to encourage the genesis of a spatial agreement system. Work pairing naturalistic data with modeling data has shown that the structure of interactions among individuals influences the speed and degree of lexical conventionalization (Richie et al., 2014). Future work will examine the ways in which different conditions of interaction (horizontal versus vertical; community size, network structure, age of learners) affect the nature of language emergence.

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