



Original Articles

The emergence of temporal language in Nicaraguan Sign Language

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ABSTRACT

Understanding what uniquely human properties account for the creation and transmission of language has been a central goal of cognitive science. Recently, the study of emerging sign languages, such as Nicaraguan Sign Language (NSL), has offered the opportunity to better understand how languages are created and the roles of the individual learner and the community of users. Here, we examined the emergence of two types of temporal language in NSL, comparing the linguistic devices for conveying temporal information among three sequential age cohorts of signers. Experiment 1 showed that while all three cohorts of signers could communicate about linearly ordered discrete events, only the second and third generations of signers successfully communicated information about events with more complex temporal structure. Experiment 2 showed that signers could discriminate between the types of temporal events in a nonverbal task. Finally, Experiment 3 investigated the ordinal use of numbers (e.g., *first*, *second*) in NSL signers, indicating that one strategy younger signers might have for accurately describing events in time might be to use ordinal numbers to mark each event. While the capacity for representing temporal concepts appears to be present in the human mind from the onset of language creation, the linguistic devices to convey temporality do not appear immediately. Evidently, temporal language emerges over generations of language transmission, as a product of individual minds interacting within a community of users.

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1. Introduction

Human languages are complex symbolic systems, found in all human societies. No other animal has a communication system that has the scope and complexity of human languages, and no other animal can acquire such a system as readily as humans can. Thus there must be something unique about being human that allows for the creation and transmission of language. Identifying this property has been a central goal of cognitive science. Two broad classes of answers have been proposed. The first possibility is that language is a direct consequence of our mental architecture, and thus the capacity to create language is present in every human mind. For instance, perhaps the language faculty itself is a part of our genetic endowment (e.g., Chomsky, 1968, 2000; Pinker, 1994) or perhaps language is a product of more general changes in our conceptual resources and computational abilities (e.g., Christiansen & Chater, 2008). On this view, language is a window into the mind, and its properties and organization reflect the struc-

ture of human cognition (Chomsky, 1975; Pinker, 2007). The second broad possibility is that language developed gradually over historical time, rather than phylogenetic time, through a process of “cumulative cultural evolution” (Tomasello, 2011; Tomasello, Kruger, & Ratner, 1993). From this perspective, language is a side effect of the human capacity for social learning and cultural transmission (e.g., Tomasello, 2008). Since direct evidence on the origins of language is difficult to come by, arguments for these two alternatives tend to rest heavily on the theorist’s prior assumptions about what kinds of learning and evolutionary change are or are not plausible.

Recently, however, a new tool has appeared for exploring this question. By studying emerging sign languages, such as Nicaraguan Sign Language (NSL), we can gain new insights into the time scale of language creation, which provide hard constraints on the role of historical processes and cognitive predispositions. This research program has painted a more nuanced picture of how historical and cognitive processes interact, suggesting that the answer varies depending on the phenomenon of interest (e.g., Flaherty & Senghas, 2011; Pyers, Shusterman, Senghas, Spelke, & Emmorey, 2010; Senghas, 2003). We suggest that many features of language do not emerge in one step from a single human mind acting in

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isolation, nor do they require long periods of historical evolution. Instead these elements emerge over the span of a few generations, suggesting that convergence on these forms does not require prolonged historical evolution, but may require a community of users, a process of transmission, and in some domains, sequential age cohorts of child learners.

NSL is a new language created by a deaf community in Managua, Nicaragua over the past four decades. Before the 1970s, there were few opportunities for deaf people to gather together and interact, and consequently Nicaragua had no standardized sign language. But in the mid-1970s and early 1980s, the government opened a new primary school for special education, followed by a vocational program for adolescents, and for the first time, deaf Nicaraguan children and adolescents were able to gather together in large numbers (Polich, 2005). Lessons were in spoken Spanish and instruction focused primarily on lip-reading and speaking Spanish, but were met with limited success. The children, however, like deaf students everywhere, began communicating with each other through gestures, and a new sign language emerged (Kegl & Iwata, 1989) that continues to develop to this day. Each successive group of children who enters the community introduces linguistic complexity into the language that adults evidently do not acquire (Senghas, 1995; Senghas & Coppola, 2001). This situation gives rise to a distinctive pattern in the language community, where the older signers, the initial creators of the language, represent earlier stages of the language relative to younger signers (Senghas, Kita, & Özyürek, 2004). To capture the changes in the language over time, researchers initially compared the language of the first cohort of children who entered the community in the late 1970s and early 1980s, to a second cohort of children who entered the community in the late 1980s. Today, NSL has multiple co-existing age cohorts of users, from the creators of the language to the young children now learning and changing the language.

Previous work on NSL has found that different properties of the language have emerged over time and across these cohorts. Taken together, the findings suggest, first, that language is not solely an individual achievement—some properties emerge only over time within a social context—and second, that language, or at least these properties of language, are also not the product of slow process of cultural evolution—the time scale is one of decades rather than millennia (cf. Tomasello, 1999).

The seeds of language are present in individuals, as evidenced by the creation of gestural communication systems by deaf children who are not exposed to a manual language they can acquire. These *homesign* systems possess some key properties of language, such as vocabulary, grammatical categories, and word order (e.g., Goldin-Meadow, 1979; Goldin-Meadow, Butcher, Mylander, & Dodge, 1994; Goldin-Meadow & Feldman, 1975; Goldin-Meadow & Mylander, 1983). The first cohort of NSL signers, drawing on their gestures and homesign (Coppola, 2002; Coppola & Newport, 2005), created an ordered system with a stable lexicon that enabled them to express abstract thoughts beyond their immediate surroundings (Richie, Yang, & Coppola, 2013; Senghas, 1995; Senghas & Coppola, 2001). Other early-emerging elements of the language used by the first cohort of signers include words for cardinal numbers, a distinction between the syntactic categories for nouns and verbs, and devices for indicating argument structure (Flaherty & Senghas, 2011; Flaherty & Goldin-Meadow, personal communication; Senghas, Coppola, Newport, & Supalla, 1997). With the appearance of the second cohort there emerged systematic ways of describing spatial relations (*to the right of*, *to the left of*), using spatial morphological marking to indicate the roles of the patient and recipient in an event, and language to express mental states (Pyers & Senghas, 2009; Pyers et al., 2010; Senghas, 2003).

This body of work, along with work in other domains (e.g., Goldin-Meadow, 2003), demonstrates that some features of

language, those reflecting properties of individual minds (as seen in homesign systems) are immediately or very quickly available at the onset of the creation of a new language (e.g., Flaherty & Senghas, 2011; Richie et al., 2013; Senghas & Coppola, 2001), while other aspects, perhaps those requiring reiterated learning, take longer to emerge (e.g., Pyers et al., 2010; Senghas, 2003).¹ NSL contains many features that have been observed in other languages that are thought to be universal, including a stable lexicon, the grammatical categories noun and verb, and words for abstract concepts. Additional features that are observed in mature sign languages, such as a grammatical use of space, have emerged within two generations. Accordingly, the language of each age cohort of signers differs from the language of the cohort that preceded it, indicating a role for social interaction and learning.

The present study explores a new domain – temporal language – to continue the exploration of which concepts and devices emerge rapidly, and which appear over a few generational transitions. This work provides evidence regarding aspects of grammar that may depend heavily on intergenerational processes. Time is a rich area of study because temporal language encodes basic features of experience that all animals must be able to represent, such as order and simultaneity, but it does so in a highly abstract way, allowing these concepts to be generalized across time scales and over a variety of events. Temporal relations are critical for social communication: they provide structure to a narrative, they anchor causal explanations, and they are central in providing useable instructions. Accordingly, every language needs means to express temporal relationships, though the specifics of how they do it varies.

There are several reasons to expect that the expression of time might emerge early in a language. Primitive representations of time, fundamental to learning and survival, are available to all living creatures (Carr & Wilkie, 1997; Gallistel, 1990; Wilkie, 1995). Making sense of the world requires segmenting a stream of perceptual input into events. All events, from hearing human speech to tracking an object in motion, are perceived over time. Engaging in spatial and causal reasoning requires an understanding of temporal structure (Nelson, 1996), and understanding the behavior of agents and objects requires temporal concepts such as *before* and *after* (e.g., understanding that the window was in pieces *after* the ball hit it). Unsurprisingly, the ability to perceive temporal relations has been detected in early infancy (e.g., Bahrick, 1988; Chang & Trehub, 1977; Demany, McKenzie, & Vurpillot, 1977; Gardner, Lewkowicz, Rose, & Karmel, 1986; Lewkowicz, 2000). Given the cognitive importance of time, the early development of temporal perception, and the critical role of time in communication, one might predict that temporal language would emerge early in the creation of a new language.

However, there are also strong reasons to expect that the emergence of temporal language might depend on social and cultural processes that extend across generations. First, many temporal terms refer to time scales and relations that are quite different from the simple temporal relations that are needed for basic event perception and causal analysis. Language encodes abstract notions of time that cannot be directly mapped onto anything in our moment-to-moment experience, like *yesterday*, *tomorrow*, and *forever*. Furthermore, languages differ in how they describe time. This is true not only for temporal concepts that are clearly cultural

¹ It is useful to distinguish between two kinds of changes in a language. The first is directional change, or the growth of a new language and the creation of new resources over historical time, which is the focus of this paper. The second is historical change, or changes in a language that do not necessarily increase its level of complexity but instead reflect a constant flux due to contact, cultural shifts, and infidelity in the learning process. The point at which directional change ends and historical change begins is a question not addressed here.

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