The Developmental Trajectory of Combinatorial Patterning in Nicaraguan Sign Language

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Abstract

This paper explores the claim that combinatorial patterning developed in Nicaraguan Sign Language (NSL) through segmentation and sequencing of holistic gestures accompanying speech (Senghas, Kita, & Özyürek, 2004). I suggest an alternative interpretation of the NSL data and argue that segmentation alone, while a prerequisite for combinatorial patterning, does not constitute evidence for combinatorial structure. I additionally point out the discrepancy that arises when attempting to reconcile the changes in NSL with existing evidence on sign language morphology more generally. The omnipresence of simultaneous morphology in the world's sign languages (Aronoff, Meir, & Sandler, 2005) suggests empirical inadequacies with the original account of the NSL data, in which the development of sequencing was attributed to a universal bias for linearization (Senghas et al., 2004). I propose that sequencing in early NSL actually reflects an intermediate stage in the language's development from simultaneous-holistic to simultaneous-combinatorial representation. Drawing from linguistic analyses of simultaneous morphology in American Sign Language (Supalla, 1982), I show how simultaneous-combinatorial patterning might be expected to manifest in NSL and outline a set of specific predictions for its emergence. These predictions find empirical support in evidence from sign languages' historical development (Aronoff et al., 2005) and their acquisition by children (Newport, 1988). The paper concludes by showing how my account, but not the original, captures the modest differences between second- and third-cohort NSL signers' representation of motion events, suggesting that the change to simultaneous-combinatorial patterning may already be underway.

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Introduction

All human languages share certain structural properties that are independent of the modality in which they are transmitted. One such property is combinatorial patterning: in all natural spoken and signed languages, sets of elementary units or components (e.g. morphemes) combine with one another to form higher-level representations (e.g. words). Combinatorial or componential representations are fundamental to human language yet unattested in the communication systems of other animals. As such, an issue of great interest is whether this property is so fundamental as to emerge spontaneously in a new language. Evidence bearing directly on this debate is scarce, however, because new languages are typically created by speakers with access to languages that already display this structural property.

In certain situations, however, children lack access to the language of their environment, as in the case of deaf children born to hearing parents who choose not to sign to them (Coppola & Newport, 2005). In order to communicate with their families, these children often develop structured gestural communication systems, known as homesign. Although these systems display an impressive degree of linguistic complexity – including abstract grammatical categories (Coppola & Newport, 2005) and systematic word order (Feldman, Goldin-Meadow, & Gleitman, 1982; Goldin-Meadow & Mylander, 1998) – hearing family members typically do not treat these gestural systems as linguistic and rarely adopt these structural innovations. Homesign systems thus remain relatively primitive systems of communication, quite different in formal character from full-fledged spoken and signed languages.

Full-fledged languages do emerge whenever previously isolated deaf individuals come together to form a community, bringing with them their individual homesign systems. These

circumstances create the unique opportunity for researchers to observe the process of language creation with minimal influence from existing languages. Language emergence under these conditions has now been documented across the globe in Nicaragua, Israel, Thailand, Ghana, and many other geographic areas (Meir, Sandler, Padden, & Aronoff, 2010).

One particularly interesting claim from this body of work is that a new language develops combinatorial patterning by separating and sequencing representations that were previously expressed within a single unit (Senghas et al., 2004; Senghas, Ozyurek, & Kita, 2000). Ann Senghas and colleagues have argued for this claim based on their evidence from Nicaraguan Sign Language (NSL), a language that emerged in the early 1980's in Managua following the government's creation of education programs for deaf children and adolescents. Here I will consider this claim in more depth by exploring what it means for a representational system to be combinatorial and how such patterning might be expected to develop in a language. In doing so I hope to show that segmentation of representations is necessary but insufficient as a marker of combinatorial patterning. Contra assertions that learners universally prefer languages with sequential and linear combinatorial patterning (Senghas et al., 2004) – an idea which is called into question by the widespread use of simultaneous morphology in sign languages worldwide (Aronoff et al., 2005) – I suggest that NSL's sequenced representations may be only transient, to be supplanted by simultaneously inflected, morphologically complex forms as NSL matures into fully combinatorial structure. Existing work on the structure of ASL (Supalla, 1982, 1986, 1990) provides a model for understanding how simultaneous-combinatorial forms might be structured in NSL and illuminates the evidence that would tell us whether they are. This account, supported by data from the historical development of sign languages (Aronoff et al., 2005) as well as their acquisition by children (Newport, 1982, 1988; Supalla, 1982), turns out to provide substantial

explanatory coverage for a broad range of phenomena in historical linguistics, sign language typology, and language acquisition.

Linguistic Innovations in Nicaraguan Sign Language

Segmentation and sequencing in Nicaraguan signers' motion-event reference

The argument that combinatorial patterning has developed in NSL was argued for based on evidence concerning the representation of events of motion. Ann Senghas and colleagues (2004, 2000) compared the descriptions of such events by deaf users of NSL to the gestures produced by hearing, Nicaraguan speakers of Spanish while orally describing the events (hereafter termed "co-speech gesture"). The deaf signers joined the Nicaraguan signing community in early childhood (before age 6). Three groups of 10 deaf signers represented three different "cohorts" of students whose entry into the signing community came at varying points in NSL's development: before 1984 (in the earliest stages of the language), between 1984 and 1993, and after 1993. Because students' only exposure to NSL came from other students of the school, the language input for each cohort is assumed to consist solely of the signs produced by the students already there. Comparison of these successive cohorts of signers therefore enabled researchers to identify new linguistic constructions that, missing from the prior cohort's signs, must constitute contributions of the child learners to the language's structure.

Motion events were investigated for two reasons. First, these were represented in the co-speech gestures of the surrounding hearing community, hence accessible to the deaf children and available for incorporation into NSL. Second, the researchers realized that motion events were likely candidates for transformation into segmented representations. These events involve multiple conceptual features such as manner, direction, and path of motion, and these features are typically represented by spoken and signed languages using distinct segments. These

segments are furthermore typically combined linearly (sequentially) in spoken languages, despite the nature of movement in the real world, i.e. the fact that moving entities experience manner, direction, and path of motion simultaneously. In English, for example, motion events are typically represented with a verb-preposition sequence in which the verb form represents manner of motion ("rolling") while the preposition encodes the motion's path ("down"). Senghas and colleagues therefore asked whether the gestures of NSL reflected these same patterns, reasoning that "signing that dissects motion events into separate manner and path elements, and assembles them into a sequence, would exhibit the segmentation and linearization typical of developed languages and unlike the experience of motion itself" (Senghas et al., 2004, p. 1780).

Descriptions of motion events were elicited using a technique originally developed to elicit the same kind of representation in ASL (Supalla, 1982). Subjects viewed animated cartoons depicting motion events designed to incorporate both manner and path elements, such as a cat wobbling down a street after having swallowed a bowling ball. Deaf participants' signs and hearing participants' co-speech gestures during subsequent narration of the cartoons' storylines were analyzed to determine the proportion of expressions that represented motion manner and path simultaneously as compared with the proportion of expressions that represented these elements sequentially (in separate gestures).

This analysis revealed substantial group differences in how manner and path were represented when the gestural description encoded both of these elements (henceforth "manner-path expressions"). Hearing subjects overwhelmingly represented manner and path within a single co-speech gesture, directly mimicking the simultaneity of the motion event itself. The first cohort of signers (NSL 1) used these combined manner-path gestures somewhat less, in only 70% of manner-path expressions; the remaining 30% of manner-path expressions consisted of

sequentially articulated manner-only and path-only representations. The second-cohort signers (NSL 2) used even fewer combined manner-path gestures (30% of manner-path expressions), sequentially producing separate manner-only and path-only gestures the majority of the time. The third-cohort signers (NSL 3) similarly produced mostly separate, sequenced manner-only and path-only signs, with combined manner-path signs making up only 35% of all manner-path expressions.

To summarize: the signed representation of motion events in NSL 2 and 3, and to some extent even NSL 1, is strikingly different from the representation of these same events in co-speech gesture. Hearing subjects iconically represent manner and path of motion simultaneously within a single holistic gesture, while the later cohorts of Nicaraguan signers represent these features with sequentially articulated manner-only and path-only segments. This change from holistic to segmented representation is interpreted by the authors as a shift to combinatorial patterning (Senghas et al., 2004).

Remaining questions about NSL

The discovery that motion-event representation in NSL is becoming increasingly segmented engenders many more questions. One set of questions pertains to the formal linguistic properties of these representations. Are forms used consistently to represent particular meanings within and/or between signers? Does the two-segment sequence function as a higher-level unit, such as a compound word or verb phrase? Do individual segments recur in many contexts, or are they limited in their use? Answers to these and similar questions would clarify a fundamental issue concerning the linguistic structure of these forms: whether they represent lexical items or grammatical components. Although lexical items might be considered to be combinatorial in a broad sense (in that words can combine to form phrases), the term ‘combinatorial’ in the

linguistics literature denotes something more precise: consisting of grammatical components that combine in rule-governed ways to form higher-level units. The introduction of segmentation into NSL is quite interesting in its own right, but questions about whether and how segmentation might develop into combinatorial patterning remain unaddressed pending further specification of the linguistic properties of these representations.

Second, what is the source of these changes? Senghas et al. (2004) suggest that these changes reflect biases at play during child language acquisition, in particular children's natural tendency to 'decompose' complex representations into smaller segments. A wide range of theories of language acquisition make predictions that are consistent with this account. For example, segmentation might result from innate, detailed knowledge about the structure of natural language (e.g. Lightfoot, 2006), including its universally combinatorial nature (Hauser, Chomsky, & Fitch, 2002). Segmentation into smaller units might also be a natural result of children's limited processing capacities (Newport, 1990). Although situations of language emergence are crucial sources of data for this debate, the current evidence on NSL does not help narrow the field of viable hypotheses regarding the nature of the child's contribution to language structure. Such clarification will be achieved only when follow-up work yields a more precise linguistic analysis of the structural properties of NSL, which will in turn provide language acquisition theorists with a more precise description of what the child learner brings to the task of language acquisition.

A third class of follow-up questions concerns the trajectory of this change. Why, for example, did the proportion of separate manner and path representations increase so drastically between NSL 1 and NSL 2, only to stabilize or even decline slightly between NSL 2 and NSL 3? If child learners are sufficiently biased to introduce segmentation where none existed in their

input, why do over a third of NSL 3's representations remain simultaneous, apparently resistant to this bias? Will these sequenced representations be an enduring property of NSL, or are they merely transient properties of a still-maturing language?

Yet a fourth set of questions concerns how to integrate these results into the decades-old literature on sign language linguistics and typology. One generalization from this body of work is that although sequential assembly, or linear concatenation, is a common feature of spoken languages, sign languages are free to represent multiple meaningful components of an event simultaneously and in fact do just this, making extensive use of complex combinatory, *simultaneous* morphology (Aronoff et al., 2005; Supalla, 1982, 1986). In simultaneously inflected forms, components are superimposed 'on top of' each other rather than concatenated sequentially as prefixes or suffixes. This possibility is available because sequential concatenation is only one mechanism for combining units; simultaneous (non-concatenative) assembly is an equally valid alternative, one that as noted by Supalla (1982) and Newport (1982) is attested in spoken languages as well in the form of infixation and process morphemes such as reduplication. Interestingly, motion events are a common nexus of simultaneous morphology in sign languages worldwide (Aronoff et al., 2005). In other words, the sequential representation of manner and path in NSL, while different in quite interesting ways from the corresponding representations in co-speech gesture, *also* differs starkly from the analogous representations in mature sign languages worldwide. Why does NSL exhibit representational structure that is inconsistent both with the gestural input to its creators and with the structure of other signed languages? At present we lack a satisfying answer to this question and those outlined above.

A source of answers: beyond the simultaneous/sequential distinction

The possibility of simultaneous combinatorial patterning. In the remainder of this paper I will explore an account that, if correct, has the potential to answer many of these questions. It rests on clarifying and further exploring the distinction between *simultaneous* and *combinatorial*. Analysis of the NSL data along the simultaneous/sequential dimension revealed evidence for a fundamental prerequisite to combinatorial structure: segmentation. Having established this crucial property, analyses are now called for that move beyond the simultaneous/sequential distinction into the holistic/combinatorial one. There are in principle at least two classes of simultaneous representation: simultaneous-holistic, epitomized by co-speech gesture, and simultaneous-combinatorial. The omnipresence of the latter class of representation in the world's mature sign languages leads me to the following empirically testable prediction: NSL, too, will eventually develop combinatorial simultaneous representations. In other words, we should expect that as NSL matures, the trend of increasing sequential and decreasing simultaneous representations should at some point reverse, as the proportion of simultaneous forms begins to increase. These future simultaneous representations would be of a very different character, however, from the simultaneous forms of co-speech gesture. The forms that I predict will develop in NSL will be simultaneous-combinatorial in nature, differing both from the simultaneous-holistic forms of co-speech gesture and from the sequenced-segmented forms of the earliest NSL cohorts.

Clues from a newly described 'transitional' form. A recent reanalysis of the NSL data gives strong support to the hypothesis I have just proposed. In a study of motion-event representation in Turkish homesigners, Ozyürek, Furman, and Goldin-Meadow (2015) report a kind of representation that appears to incorporate at once simultaneous and sequential representation. This "mixed" form consists of a "conflated" (simultaneous) form expressing both

manner and path features, followed immediately in sequence by a manner-only or path-only segment. These semi-sequenced forms are far more prevalent in the gestures of homesigners than of their hearing mothers or those of similarly aged hearing children. Based on this finding, Senghas, Ozyürek and Goldin-Meadow (2013) conducted a similar analysis of the original NSL data. Their results indicated that the simultaneous forms of NSL 1 were in fact primarily of the 'mixed' type, i.e., consisting of a simultaneous form followed in sequenced by a manner-only or path-only segment. These contrasted with the simultaneous forms of co-speech gesture, most of which were not followed by a single-feature segment.

The semi-sequenced 'mixed' forms produced by Turkish homesigners and NSL 1 signers – who of course started out as homesigners – were argued to reflect a transitional stage between the simultaneous (N.B.: simultaneous-holistic) forms of co-speech gesture and the fully sequenced forms of NSL 2 and 3 (Ozyürek et al., 2015; Senghas et al., 2013). I would like to further argue that the fully sequenced forms of NSL 2 and 3 reflect a second transitional stage, from the semi-sequenced forms of homesign to the simultaneous-combinatorial forms of mature sign languages like ASL. Such a change would bring NSL in line with the universal typological characteristics of the world's mature sign languages.

The transition from holistic to combinatorial structure in language (re-)creation

The possibility explored in this paper is that the sequenced-segmented forms in NSL 2 and 3 will eventually develop into simultaneous-combinatorial representations. The question that now arises is: What differentiates conflated-combinatorial from conflated-holistic forms? In other words, how will we know whether future cohorts' simultaneous manner-path expressions are combinatorial (as I predict them to become) or holistic (as in co-speech gesture)?

In the following section, I attempt to answer these questions by providing a detailed description of the fundamental structural differences between simultaneous-combinatorial and simultaneous-holistic representations, emphasizing the precise kind of linguistic data that would lead a linguist to characterize a novel NSL form as one or the other type. The discussion is made possible by and rests on Ted Supalla's detailed descriptive work on ASL verbs of motion, which provides a comprehensive illustration of the evidence and arguments that support an analysis of visual-gestural linguistic representations as simultaneous-combinatorial. Supalla's (1982, 1986, 1990) convincing demonstrations that ASL verbs of motion are generated by a complex system of inflectional morphology refuted the belief (widespread at the time) that these forms were holistic, 'mimetic' representations of real-world events. The discussion below takes full advantage of this existing body of work, showing how the methodology and argumentation of linguistic analysis as applied to ASL verbs of motion by Supalla can illuminate the crucial empirical questions we must ask about NSL in order to address questions about combinatorial patterning in this language. As will become clear, the existing evidence on NSL is silent on many of these questions, leaving them unanswered for now. My hope is that the clear articulation of these questions will nevertheless move us toward accruing the right kind of evidence, the kind that will meaningfully advance our understanding of linguistic universals and the human minds that shape new languages in accordance with them.

Having described the kind of evidence that would support my predictions concerning the future structure of NSL, I will turn toward explaining the trajectory of these changes. The central phenomenon requiring explanation is the existence of a 'sequencing' stage in the transition from simultaneous-holistic to simultaneous-combinatorial representation. If sign languages tend to represent the features of motion events simultaneously, and if simultaneous representations are

present in the gestures observed by deaf children, why would a new sign language first depart from this simultaneity in favor of sequenced representations, only to return to simultaneity at a later stage? The reasons for this counterintuitive developmental trajectory are clarified, I will argue, by findings from two related areas of research. One is the apparently paradoxical finding, brought to my attention by Aronoff, Meir, and Sandler (2005), that unrelated sign languages worldwide each incorporate complex simultaneous inflectional morphology alongside simple, sequential, concatenative morphology. The within-language juxtaposition of these properties is unattested in spoken languages and thus poses a typological paradox. The illuminating explanation of this phenomenon offered by Aronoff and colleagues is fully consistent with the NSL predictions I have offered. The second finding of particular relevance comes from what is known about children's acquisition of simultaneous-combinatorial representations. Child learners of ASL pass through a stage during which they sign the morphemes of a simultaneous-combinatorial representation in sequence, rather than simultaneously as called for by the adult grammar (Newport, 1982, 1988; Supalla, 1982).

Both sets of empirical results are natural outcomes of a developmental process that works in the following way. As combinatorial systems are built, whether at the level of the language as in NSL or within the mind of the child language learner, a crucial and inevitable preliminary step is identifying the individual components that combine with each other to form complex representations. That is, evidence of rules governing how segments combine with each other should be expected to emerge no earlier than, and perhaps even subsequent to, evidence for the existence of segments themselves. Under this account, the sequenced manner-only and path-only representations in NSL may be transient artifacts of the process by which a system changes from simultaneous-holistic to simultaneous-combinatorial representation. Just as children's errors in

producing simultaneous-combinatorial representations in ASL reflect accurate identification of individual morphemes prior to mastery of the rules according to which they combine, the sequenced forms in NSL may be evidence of an intermediate stage in this language's development, a stage at which the signing community is converging on a set of meaningful components but has not yet created complex grammatical rules for their combination.

A number of specific, testable predictions follow from this proposal, and in the final section of this paper I will show that these predictions are entirely compatible with the existing NSL data, particularly as analyzed most recently by Senghas and colleagues (2013).

Simultaneous Combinatorial Patterning in Mature Sign Languages

Characteristics of simultaneous combinatorial patterning

In order to evaluate future NSL data against the predictions of my account, we must first address this question: How will we know whether new simultaneous forms are best analyzed as simultaneous-combinatorial or simultaneous-holistic? Here I will point out the analyses that can distinguish between these classes of representation by describing the evidence Supalla used to argue for this distinction in ASL verbs of motion and location. All facts of ASL structure described here are due to Supalla (1982) except where otherwise indicated.

Consistent with the understanding of this term in the linguistics literature, I consider a representation to be *combinatorial* if and only if it meets the criteria in (1):

(1) Minimal criteria for combinatorial (componential) representation of meaning

i. Representations built from a finite inventory of recurring components

ii. Components consistently serve a specific representational function

iii. Grammatical rules govern how components may combine

As discussed, the segments identified by Senghas and colleagues (2004) certainly warrant consideration as candidate linguistic components but are not themselves evidence for combinatorial patterning as defined in (1). Only a distributional analysis can determine whether these segments recur in different contexts, are consistently related to a particular semantic feature or set of features, and combine in rule-governed ways with other units of the language. I have predicted that combinatorial patterning as defined in (1) will develop in NSL. It is therefore of interest to identify the evidence that would confirm or refute this prediction.

(i) Finite inventory of recurring components. The fundamental characteristic of combinatorial/componential systems is that complex forms are decomposable into a finite set of individual components (criteria (i)). A system of meaning representation is considered to be combinatorial when its semantic distinctions are grammaticized, i.e., when there is a limited number of possible values along each semantic parameter, each corresponding to a component of form. As such, the first step in demonstrating combinatorial patterning is to identify the semantic parameters that are grammaticized, the possible values along each of these parameters, and components of form representing those values.

In ASL verbs of motion and location, the grammaticized semantic parameters concern various characteristics of movement, location, or existence. Verbs fall into three predicate types, each of which corresponds to a distinct movement root: existence (these take the *stative* movement root), location (*contact* root), and movement (*active* root). The form of these movement roots may be altered through changes in their location, orientation, and shape (the universal phonological parameters of the signed modality[1]) to represent semantic variations on

[1] In ASL, most morphemes take the form of a single phonetic feature, i.e. a change in location, orientation, or shape. This contrasts with the form that morphemes take in spoken languages, where they are usually (but not always) realized as sets of phonemes rather than individual phonetic features (Supalla, 1982, p. 10).

the basic predicate. The set of meaningful movement changes – morphemes – is limited to the following.

Roots take on features in the location parameter such that they surface in either *displaced* or in *anchored* form, representing movement in space or existence/location (depending on the root's predicate type). A finite set of variations is available to each form. The *anchored* forms of the *stative* and *contact* movement roots have only one possible value (*hold* and *contact* respectively, as dictated by the predicate type they represent). The *anchored* form of the *active* root may optionally incorporate one of two possible orientation affixes (*end pivot* and *midpivot*, representing swinging and rotating, respectively) or one of four form affixes (*spread*, *bend flat*, *bend round* and *change diameter*, representing changes to the entity undergoing movement). The *displaced* forms incorporate *tracing*, *stamping*, or *changes of location* depending on the predicate type and may also incorporate one of three variants in shape (*linear*, *arc*, or *circular*, representing the path of motion).

The inflected movement root is visible as the movement of a handshape through space. The handshape, representing the external noun argument, has its own internal componential structure and is built from a set of 'articulator morphemes' (arrangements of the hand and body articulators, as contrasted with the arrangement and position of these articulators in space). Again, there is a limited number of possible combinations of articulator morphemes, which together function as a set of classifiers representing selected semantic features of the argument, analogous to classifiers in spoken language (Supalla, 1986). The movement root, its inflectional movement affixes, and the obligatory noun argument are all articulated simultaneously, as individual components of a single morphologically complex sign.

Returning briefly to NSL, we now have an idea of what kind of evidence would meet the first criterion for combinatorial patterning (1). Taking manner and path as candidate semantic parameters, the next step is to take an inventory of the possible values along each parameter. Can segments referring to any kind of physically possible path be represented in the same way, or is the set of path features restricted to a finite set as in ASL? A semantic distinction with a limited number of possibilities will meet criterion (i) for combinatorial patterning as defined in (1).

(ii) Consistency and specificity in representational function. The components in a combinatorial system, in addition to belonging to a finite set, must also serve a consistent function within the larger representation. Whether the presence of a component correlates with a specific meaning determines whether its representation is phonemic or morphemic, like the inflectional affixes of ASL verbs of motion. While non-meaningful segments may be componential at other levels (e.g. phonological), here I am concerned with morphemic status because it has already been established that the NSL segments have semantic value (Senghas et al., 2004). Components qualify as morphemes if they are consistently used by individuals and, in a fully mature language, by the community to confer specific meanings.

From the requirements that components be (i) limited to a finite set and (ii) consistently associated with a specific representational function, it follows that any linguistic forms generated by a combinatorial system can represent only those semantic distinctions that the morphological paradigm makes available. That is, if the finite set of 'path' values includes only *linear* and *circular* with the meanings 'move straight' and 'move in a circle' respectively (these are the meanings of the corresponding ASL affixes) but no value representing 'move in a figure 8 pattern', and if the rest of the morphological paradigm provides no further means of representing such a distinction, then communicating that a motion happened along a figure-8 path must be

done outside the componential system (e.g. through a modifier or through non-linguistic mimetic depiction). In other words, combinatorial forms differ from one another only in the components they comprise; other differences are not possible when generated by a fully regular system.

We have now identified two further empirical questions that must be asked of the NSL constructions in order to determine whether they can be accurately characterized as componential. First, are the 'manner' and 'path' elements observed by Senghas et al. (2004) used relatively consistently (within individual signers and eventually the community in general) to refer to specific semantic features or categories of motion? Second, are the possible representations of motion events in the language structured such that they differ from one another only in the specific components that they consist of?

Consistency and specificity of representational function could be established by eliciting descriptions of sets of motion events that share a single feature along a semantic parameter hypothesized to be grammaticized. For example, if 'path' is hypothesized to be represented componentially in NSL as it is for ASL, one might elicit descriptions of movements that differ in manner (e.g. bouncing, rolling) but share a path (e.g. circular). A componential analysis of path would be supported if a certain form is used to represent a circular path in many different motion events, thus demonstrating a consistent representational function. Similarly, a distributional analysis of signers' spontaneous productions would generate evidence concerning representational specificity. A componential analysis would again be supported if a particular form appears in representations with a specific semantic feature or set of features (e.g. circular path) and fails to appear in signs lacking that particular semantic feature.[2]

[2] This conclusion stands under the assumption that the morphological paradigm in question is fully regular. Of course, very few languages exhibit such absolute regularity in the relationship of components of form to specific meanings: irregular verbs in English, for example, incorporate the [+PLURAL] feature without the –s affix, and the

Regarding the possibilities for altering representations to create distinctions in meaning, this question is best answered by eliciting descriptions of motion events that are identical except along a targeted semantic dimension. Forms that are truly componential can be altered in meaning only by adding, deleting, or substituting affixes from the finite set of components. The componential structure of a form is confirmed by (i) the existence of forms with these minimal alterations, that is, minimal pairs, and (ii) the absence or unacceptability (as confirmed by grammaticality judgments) of forms with other kinds of alterations. Taking the hypothetical 'figure 8 path' example already introduced, suppose a subject produces a figure 8 path within a simultaneous sign where only linear and circular paths had previously been attested. Maintaining a componential analysis would require arguing that a 'figure 8 path' has been newly introduced to the language (and the inventory of components had recently expanded to include this one additional element). The more plausible interpretation would be that this representation is simultaneous-holistic rather than simultaneous-combinatorial. In contrast, if movement along a figure 8 path is represented differently from movement along linear and circular paths, through a modifier or mimetic depiction, a combinatorial analysis of motion-event representation would be supported. Eliciting descriptions of motion along entirely novel paths (which could not possibly be represented in the language's existing inventory of components) would provide decisive evidence one way or the other.

(iii) Components combine in systematic, rule-governed ways. The third criterion for combinatorial patterning is that components combine in systematic, rule-governed ways. These combinatory rules determine where components may occur and how combination takes place, including any ordering constraints on the application of different combinatory processes.

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phoneme [s] certainly does not always confer plural status. I would argue that an assumption of full regularity is not particularly problematic in the case of NSL since any morphology in young languages tends to be quite regular.

In ASL, movement affixes combine with a set of basic verbal predicates, hence this system is one of inflectional verbal morphology. Certain of these affixes are obligatory (e.g. the noun argument) while others are optional. Affixes are furthermore limited with regard to which other affixes they may appear alongside. These contextual constraints can be described with a hierarchical morphological paradigm in which the values chosen for lower-level distinctions constrain the possibilities available at higher levels in the hierarchy. For example, the affixes *end pivot* and *midpivot* are available only to the *anchored* but not the *displaced* form of the *active* root, as described above.

The general combinatory process is, as is now familiar, simultaneous: signs are 'changed internally' such that the noun argument (handshape) and movement affixes (variations in the location, orientation, and form of the movement root) are *part of* the movement root as it is signed. This is just one example of the rule-governed nature of ASL motion-verb inflection. There are also rules governing the processes by which affixes are incorporated into the root. Depending on how an inflectional affix is incorporated, the resulting sign represents movement that is *minimal* or *maximal* (in terms of the degree to which the root is altered by the affix); *unidirectional*, *bidirectional*, or *contradirectional;* and *single* or *repeated*. Noun argument placement relative to the movement root is also rule-governed. In ASL, these combinatory processes actually form part of the inflectional morphological paradigm since there is a finite set of possibilities for each combinatory process and each corresponds to a specific meaning, in this case characteristics of movement manner.

The crucial point of this discussion is to show that only those complex forms made available by a finite inventory of components and generated through the application of systematic combinatory processes are acceptable forms in a combinatorial system. In ASL,

representations that cannot be generated by the system described above "are either ungrammatical or are not distinguished semantically or phonologically from the [acceptable] forms" (Supalla, 1982, p. 23). The best evidence for systematicity of this type is obtained using the standard tools of linguistic analysis: grammaticality judgments and tests of productivity.

Note that a language need not display structural complexity on a level with ASL verbs of motion in order to qualify as combinatorial. As a well-established and relatively old sign language, ASL has had many generations to develop these intricacies. There are yet more grammatical constraints on ASL motion verb morphology that I have not described, concerning the ordering of inflectional processes, priority hierarchies for the representation of different classes of affixes, and the use of sequentialized serial verb constructions in certain cases. To discuss these phenomena in detail would be to stray too far from the primary goal of this paper, which is to argue that combinatorial patterning will develop in NSL, but has not yet; and to highlight the linguistic evidence that would support my predictions. Having done this, I leave the complexities of ASL structure here and direct readers to Supalla's body of work for more information. See Supalla (1986) for details of the ASL classifier system, in particular constraints on affixation order and on the co-occurrence of different affix types; and see Supalla (1990) for discussion of constraints on simultaneity and the serial verb constructions that result.

Explanations for a Counterintuitive Developmental Trajectory

I have reviewed evidence for simultaneous-combinatorial patterning in an established sign language, ASL, and showed how we might distinguish such patterning in NSL from the simultaneous-holistic representations of co-speech gesture. Simultaneous-combinatorial representations like those in ASL have in fact been attested in signed languages worldwide, and may even be a universal property of languages in this modality (Aronoff et al., 2005).

Furthermore, simultaneous-combinatorial patterning is used for similar functions cross-linguistically, including to represent motion events. These typological facts are the primary motivation for my argument that simultaneous-combinatorial structure should be expected to develop in NSL.

Viewed from this perspective, however, the sequential patterning observed in the early stages of NSL is rather mystifying. Surely we would expect that whatever mechanism is responsible for the development of simultaneous morphology in sign languages worldwide should be at work in NSL as well. The puzzle grows deeper if one assumes that NSL developed out of the co-speech gestures of the surrounding hearing community, in which 'manner' and 'path' features were overwhelmingly produced concurrently. Why, then, have we observed sequential rather than simultaneous patterning in the early stages of this language's development? An explanatory account of NSL's historical trajectory, as I attempt to provide here, will only be satisfactory insofar as it provides a convincing answer to this question.

What I suggest is that the sequenced forms in NSL represent an inevitable transition stage between holistic, non-grammaticized gesture and fully grammaticized simultaneous morphology. Recall criterion (i) for combinatorial structure as defined in (1): the existence of a finite set of recurring components. It is a logical impossibility for a system to meet criterion (iii), existence of grammatical rules for combining components, until the components themselves have been identified as required by criterion (i). A developing language must pass through a point at which form-meaning pairings – future morphemes – have been isolated, but complex rules do not yet exist for combining them. At such a point, components might be expected to be articulated one after the other in sequence, as if they were separate words.

Crucially, the logic of this argument applies to language development on two quite different scales. This trajectory should manifest on a historical scale, as a sign language develops in a community over time. It might also be expected to manifest at the level of the individual, within each child, as she identifies the morphological paradigm from which the complex forms of her language were generated. In the following sections, I discuss evidence suggesting that sign language development on both of these scales is indeed characterized by this trajectory.

The typological puzzle of sequential and simultaneous sign morphology

The striking difference in how motion events are represented in NSL and ASL – with simple and sequentially assembled signs in the former, and complex, simultaneously inflected signs in the latter – is reminiscent of the apparent paradox noted by Aronoff, Meir, and Sandler (2005) concerning the existence of both simultaneous and sequential morphology in sign languages worldwide. Those authors point out that worldwide, mature sign languages exhibit quite complex, minimally variable, and highly productive simultaneous morphology – such as that identified in ASL verbs of motion – while also incorporating limited amounts of simple, minimally productive, and highly variable 'concatenative' (sequential) morphology.[3] This simultaneous/sequential dichotomy appears to hold universally of sign languages, yet is unattested in spoken languages. In this sense, "sign languages seem to present the impossible combination of Navajo-like and Tok-Pisin-like languages, a typological puzzle" (p. 303).

Aronoff et al. (2005) arrive at an explanation for this apparent paradox by exploring two observations about language in the signed modality. The first is that most sign languages are relatively young, and none are known to be older than 300 years. This fact, perhaps due to the social circumstances in which sign languages typically arise, can account for sign languages' use

[3] An example of a sequential affix in ASL is the agentive suffix (analogous to English –er).

of simple concatenative (and usually derivational) morphology, a hallmark of the world's creole (i.e., young) languages. Sequential morphology of this kind is argued to result from a mechanism of language change that is also available for spoken languages: the grammaticization of existing content words, which as distinct lexical items would have originally have been signed in sequence.

The second observation accounts for the distinctly un-creole-like property of widespread complex, simultaneous inflectional morphology in the same languages. The rapid development of this kind of morphology, the *absence* of which has been identified as a defining feature of creole languages (McWhorter, 1998), results from the possibilities for iconic representation made available by the signed modality. That is, a modality that allows for non-arbitrary representations facilitates the development of syntactic categories and inflectional affixes to represent them, in turn accelerating the development of complex inflectional morphology.

The explanation provided for the sign language typological puzzle relies on basically the same reasoning as that which I have used to motivate a search for simultaneous morphology in NSL. The idea is that a community can more easily converge on a set of forms with specific representational functions – thus meeting criterion (ii) for combinatorial patterning as defined in (1) above – if representational function is transparently related to form. Indeed, it was likely the iconicity of NSL that allowed Senghas and her colleagues (2004), who are not NSL signers, to identify 'manner' and 'path' segments in the first place. This iconicity enables sign languages to develop complex inflectional systems quite rapidly – within "a few generations" (Aronoff et al., 2005, p. 326) – so long as the representational function of the morphemes is non-arbitrary.

A revised analysis of NSL motion-event representation is now possible. The sequenced forms reported by Senghas et al. (2004) appear to fit quite neatly into the category of simple,

concatenative morphology identified by Aronoff et al. (2005): they appear to have derived from related free "content words" (the iconic motion representations in co-speech gesture); their use appears to vary substantially within and perhaps between individuals, since even third-cohort signers use non-sequenced forms a substantial minority of the time (35%); and they are language-specific, in that other signed languages (notably ASL and Israeli Sign Language) represent manner and path quite differently, as already described. No evidence exists concerning the productivity of NSL's concatenative patterning – but if this phenomenon belongs to the class of nonproductive sequential morphology identified by Aronoff and colleagues, then any search for productivity in NSL would be expected to produce null results.

Importantly, although sequential concatenative morphology has been attested in all sign languages studied so far, it is quite limited relative to morphology of the complex, simultaneous type. Given that transparent inflectional morphology can develop quite rapidly in sign languages, the prediction that simultaneous morphology is soon to come in NSL now appears quite reasonable. The prerequisites for this kind of structure may be only to meet criteria (i) and (ii) – to establish a finite set of components with consistent representational function – and, provided that components' meanings are transparently derived from their form, complex simultaneous rules may soon follow.

In sum, the identification of representational components is an inevitable step in the development of complex morphology. The iconicity available in the signed modality facilitates the identification of these components, with the result that inflectional morphology can develop quite rapidly in young sign languages (Aronoff et al., 2005). Under this account, sequenced forms are an artifact of a 'contingency' constraint in language creation: the existence of complex morphological processes is contingent on the existence of a set of morphemes. Sequenced forms

are therefore the reflection of a language in the process of transitioning from simultaneous-holistic to simultaneous-combinatorial representation: they are what happens when a language is assembling a morphological paradigm but has not yet established grammatical operations for combining the elements in it. In the following section, I will show that the "re-creation" of a language within the mind of a child learner may well be subject to the same kind of constraint.

Insights from children's acquisition of simultaneous sign morphology

Just as a new language may be created when a new community forms, a language must be 're-created' in the mind of each individual who learns it. That is, lacking direct access to a description of the morphological paradigms and grammatical rules that generated the language of the environment, the child language learner must induce this underlying organizational structure. Language acquisition is successful when the learner has 're-created' mental representations of the relevant grammatical paradigms and rules. In the framing of the generative linguistics tradition, this 're-creation' process amounts to forming an individual/internal language (I-language) on the basis of exposure to external language (E-language) (Lightfoot, 2006).

Whether framed in terms of learning a grammar or 'growing' an I-language, the steps involved in re-creating morphological representations in a child's mind mirror the steps involved in the creation of a new morphological paradigm in language creation. In order to learn a language with complex inflectional morphology, a child must identify the semantic parameters that are grammaticized; identify the set of possible values for each parameter; identify the units of speech or sign that correspond to those values; and induce the grammatical rules governing how those units combine to produce the complex forms of the input. In other words, in language acquisition just as in language creation, evidence for complex morphological processes should be

attested no sooner than, and most likely subsequent to, evidence for (the beginnings of) a morphological paradigm.

Strong support for this prediction comes from work on children's acquisition of ASL verbs of motion, which has revealed a developmental trajectory that is strikingly similar to the historical trajectory predicted for NSL (Newport, 1982, 1988). At the earliest stage of acquisition, children's productions consist mainly of monomorphemic signs along with limited numbers of adultlike complex forms. The latter forms are unanalyzed lexical chunks, analogous to the formulaic chunks attested in early spoken language. Children subsequently move to producing partially complex forms, characterized by the omission of one or more morphemes that are obligatory for the adult. In a third developmental stage, children produce all the obligatory morphemes of a complex form, but arrange them in a nonadultlike way: rather than combining them simultaneously as called for by the adult grammar, children at this stage sign the morphemes sequentially, producing concatenated forms unattested in their input. Only at the relatively old age of 4 or 5 years old do ASL learners produce adultlike, simultaneously inflected verbs of motion. This developmental trajectory suggests that children learn complex simultaneous morphological representations piecemeal, by identifying the individual form-meaning mappings that constitute the morphological components of a complex form. Only after the morphological paradigm has been 'filled out' do children combine morphemes according to the rules of the adult grammar.[4]

[4] To clarify, I am not arguing that a child must learn an entire morphological paradigm in order to correctly combine any of the morphemes within it. In principle a learner might identify two or three morphemes and proceed to combine them correctly while continuing to fill out the rest of the paradigm. In this case the contingency nevertheless holds: *some portion* of the morphological paradigm must be filled out in order to apply the combinatory rule. Perhaps only a minimal contrast between two values along a given parameter is sufficient for rule application in some cases (although not, apparently, for ASL).

This trajectory of error patterns in the acquisition of ASL verbs of motion is directly predicted by the contingent account of morphological development that I have provided in this paper. That is, evidence for the application of complex morphological operations in ASL child data emerges apparently only after evidence that the child has assembled a morphological paradigm. A parallel contingency thus characterizes language development at multiple scales: whether in language creation by a community or in language 're-creation' by an individual learner, the application of rules for assembling morphemic components is contingent on the establishment of a morphological paradigm.

The child learner of ASL has a relatively straightforward task, needing only to discover the morphological paradigm and grammatical rules that generated the complex forms of her input. Though this is no trivial job, she at least has a 'head start' over the creators of NSL, whose input contained no evidence for such organization. Even under pressure to develop simultaneous inflectional morphology – pressure stemming from whatever mechanism is responsible for the apparently universal presence of this kind of morphology in unrelated sign languages worldwide – these signers cannot do so without first establishing a morphological paradigm.

I suggest that the 'sequencing' stage in NSL is analogous to the sequencing stage in the acquisition of ASL verbs of motion. Sequencing may be the default method of assembly when components have been identified, evidence of the development of a morphological paradigm. Until some consensus has been reached within the community (or within the child's mind) regarding which components of form, paired with which meanings, comprise this morphological paradigm, no evidence is expected for complex morphological processes. Once this paradigm has stabilized, or perhaps even once minimally contrastive values along particular parameters have

been established, simultaneous combinatorial patterning may emerge. This prediction follows both from the account I have proposed and from the related account of Aronoff et al. (2005).

Summary

In this section I have attempted to answer the question raised by evidence from sign language typology: why have the children creating NSL developed a pattern that is relatively uncommon in other sign languages and unattested in their gestured input? My suggestion is that historical change, like language acquisition, is contingent: a language can incorporate complex morphological processes only once it has morphemes to apply them to. This suggestion parallels that made by Aronoff et al. (2005) to account for the apparently paradoxical observation that sign languages universally display properties of both young (creole) and mature (non-creole) languages. My argument finds strong support in the error patterns of child learners of ASL motion-verb morphology (Newport, 1982, 1988) and, if correct, provides a coherent explanation for the discrepancy between NSL representations and those of mature sign languages. A further strength of this proposal is that a number of testable predictions follow from it. I turn now to these predictions.

Specific Predictions for NSL's Developmental Trajectory

The contingent account of morphological development predicts that once some consensus is reached on the linguistic components of a language (as reflected by consistency and specificity in the components' representational function, i.e. criterion (ii) for combinatorial structure), nothing prevents a sign language from developing simultaneous morphology. Because of the widespread existence of complex simultaneous morphology in the world's sign languages, I suggest that NSL, too, may be expected to develop this kind of representation. If this is right, we should observe a progressive increase in the proportion of combinatorial to holistic

representations in the NSL data as the language is transmitted through subsequent cohorts of students. The proportion of simultaneous to sequential representations should vary as a function of the proportion of combinatorial representations, but crucially, not monotonically: the proportion of simultaneous representations should first decrease, as conflated-holistic forms become segmented and sequential; after which it should increase, as the segmented-sequenced forms transition into conflated-combinatorial representations.

In Figure 1 I have re-graphed the reanalyzed NSL data as reported in Senghas et al. (2013), in order to highlight the consistency of the existing data with the predictions of my account. My explanation for this developmental trajectory is the following. The transition from simultaneous-holistic to simultaneous-combinatorial representation begins with the 'mixed' form introduced by NSL 1, in which a 'conflated' (and presumably holistic) form is immediately followed by a redundant sign representing one element (either manner or path) from the preceding 'conflated' sign. These 'mixed' forms begin their transition into sequenced forms in NSL 1. This transition is accelerated by NSL 2, where 'conflated' forms are nearly entirely absent, with signers producing primarily sequenced forms along with a substantial minority of 'mixed' forms.

With Senghas, Ozyürek, and colleagues (Ozyürek et al., 2015; Senghas et al., 2013), who consider the 'mixed' forms of homesigners representative of a transition stage between 'conflated'[-holistic] and sequenced, I suggest that the sequenced forms of NSL cohorts 2 and 3 developed *from* the 'mixed' forms of the immediately preceding cohorts. I would therefore predict an item analysis to show that the particular semantic features represented in 'sequenced' representations by cohort 2 are at least in part the same as those semantic features represented in

'mixed' form by cohort 1. Whether this is so remains an open empirical question at present, pending further investigation of the existing NSL data.

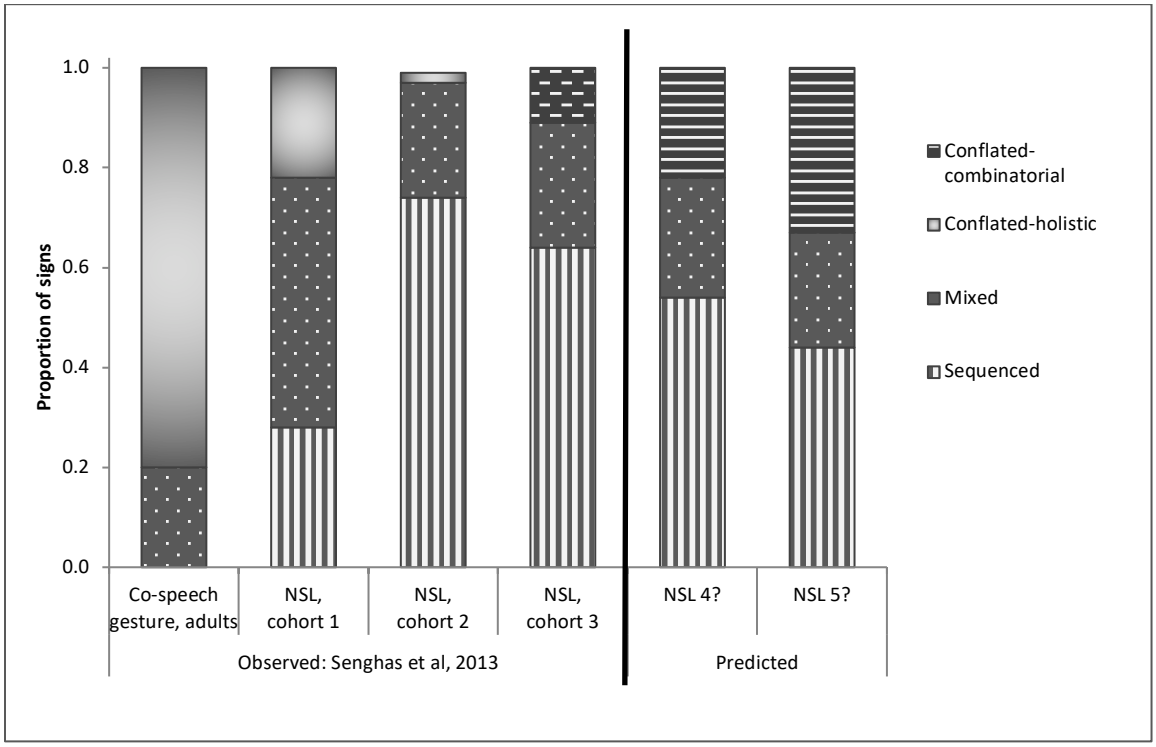

Figure 1. Proposed developmental trajectory of simultaneous-combinatorial representation. The first four columns contain data estimated from Senghas et al. (2013), Figure 4.5; the last two columns depict my predictions for the future structure of these representations. Sequenced forms are coded with vertical lines to invoke the 'one after the other' articulation of manner and path segments in these forms. Conflated-combinatorial forms are coded with horizontal lines to reflect the assembly of manner and path affixes 'on top of' one another. The conflated forms of NSL cohort 3 are coded with dashed horizontal lines to suggest the possibility, at present unconfirmed, that their structure is conflated-combinatorial rather than conflated-holistic.

Distribution of form types is roughly similar for the second and third cohorts except for a slight increase in the proportion of fully conflated (not mixed) forms in cohort 3. Because Senghas et al (2013) do not report the results of any statistical tests, it is not clear whether this slight numerical increase is a significant one. For the sake of exploring the predictions of my account in a more concrete way, let us assume for the moment that it is. An increase in 'conflated' forms for cohort 3 is entirely unexpected under an account that language learners are naturally biased toward sequential over simultaneous representations (as originally proposed by

Senghas et al. (2004)). If any simultaneous forms are expected at this point, they should be exclusively of the mixed type, as in NSL 2. On my account, however, an increase in simultaneous (but not mixed) forms in later cohorts is explicitly predicted. Once the simultaneous-holistic forms have been fully segmented, as appears to be the case in NSL 2, the stage has been set for the development of complex grammatical rules for the combination of these segments – provided, of course, that they (i) are part of a finite set and (ii) consistently represent a specific meaning. If grammatical rules are developed that call for simultaneous assembly of segments, the resulting complex forms will be categorized as 'conflated' according to the coding scheme used by Senghas et al. (2013). I would predict, however, that their internal structure would be quite different in character from the 'conflated' forms of co-speech gesture and NSL 1. This prediction is depicted in the last two columns of Figure 1.

In summary, my predictions for the developmental trajectory of NSL will be confirmed if (a) the proportion of simultaneous to sequential motion-event representations *increases* in future cohorts, reversing course from its initial decline in cohorts 1 and 2; and (b) these simultaneous forms are structured combinatorially according to the three minimal criteria described in (1). These results would support my characterization of the 'sequenced' forms as transitory, representing a language in the process of developing from simultaneous-holistic to simultaneous-combinatorial representation.

Conclusion

I have argued that findings from sign language typology motivate further exploration of the internal structure of motion-event descriptions in NSL. In view of the apparently universal tendency of sign languages to incorporate complex simultaneous morphology, I have suggested an analysis of the sequenced manner-path expressions observed by Senghas et al.(2004) as

transitory forms, soon to be supplanted by simultaneous but combinatorial representations that more closely resemble the analogous representations in mature sign languages. An intermediate 'sequencing' stage, I have argued, results from inherent contingencies in the creation of a morphological system: simultaneous rules for combining segments can only exist once segments have been established in the first place. This contingency also explains the analogous intermediate 'sequencing' stage observed in children learning the simultaneous morphology of ASL (Newport, 1982, 1988; Supalla, 1982). As NSL matures, typological evidence suggests that simultaneous-combinatorial patterning will develop eventually. As such, any new 'conflated' forms merit a careful linguistic analysis, for they may represent the emergence of the simultaneous combinatorial patterning that characterizes the world's mature sign languages.

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