Subregular Complexity Across Speech and Sign

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Keywords: formal language theory, complexity, phonology, sign languages, modality

Overview Do the computational properties of phonology hold independently of modality? Many phonologists claim that the characteristics of the phonological system are inextricably dependent on the physical articulators which externalize it (Hayes et al., 2004). However, others (Sandler and Lillo-Martin 2006, Berent et al 2016) use sign language phonology as evidence for an "algebraic" phonology of computational rules that hold regardless of the system of articulation used, i.e. independent of modality. Here I use properties of formal language theory to argue that signed processes are of the same complexity class as their spoken equivalents, and thus point to a unified independent phonology.

In this paper I review thee sign processes (metathesis, final syllable reduplication, compound reduction) using the framework of Heinz (2016) and Rogers et al. (2013). They propose that the complexity of spoken phonology is heavily restricted, falling in the sub-classes of the Chomskyan Regular class of string patterns. These "subregular" classes are crucially independent of any grammatical formalisms. For example, a Strictly Local string transducer rewrites segments in terms of *banned substrings*, and a Tier-Based Strictly Local string acceptor projects certain segments onto a *separate tier* and then checks them against a strictly local grammar. I show that in sign languages, metathesis and final syllable reduplication are Strictly Local transducers just like the parallel spoken language processes (Chandlee 2014), as is compound reduction, a phenomenon unique to sign.

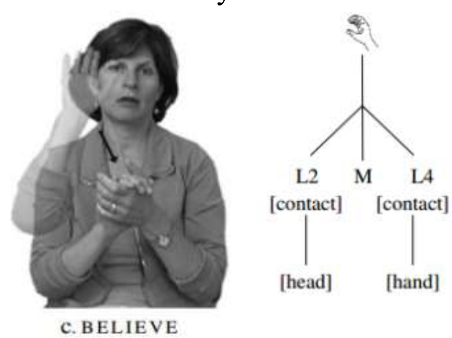

Figure 1. LML representation of ASL 'BELIEVE' (reprinted from SLM 2006)

The Structure of Signed Syllables Signs exhibit a strong tendency towards monosyllables and contain both linear and nonlinear structure. Sandler (1989) demonstrates that a sign's linear structure alternates between static location holds (L) and movements (M). Each hold is also assigned a place and manner feature, and each sign has a handshape configuration (HC), which may also exhibit some movement, though this is usually separated from M. For example, the sign for 'BELIEVE' (Fig. 1) involves a movement from the dominant hand contacting the head to contacting the non-dominant hand.

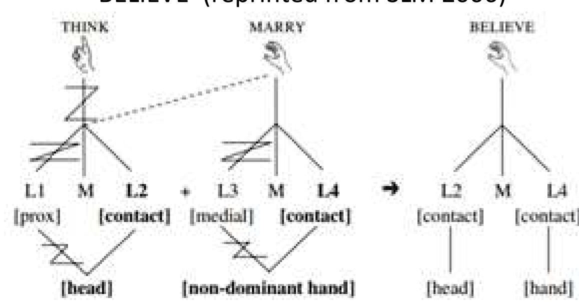

Figure 2. ASL compound reduction (SLM 2006)

Compound Reduction Many signs are reduced lexicalized compounds of two other lexical signs. For example, ASL 'BELIEVE'=THINK^MARRY (Fig.2). In compounds, sequential segments of both members of the compound delete, the first HC deletes, and the second HC spreads to the whole compound. The manner of articulation undergoes agreement as well. Using the autosegmental character of the LML model, we may characterize this process with an SL_4 transducer, where the locality domain window of length 4 rewrites the segments it has seen thus far to obey structural restraints.

Proceedings of the Society for Computation in Linguistics (SCiL) 2018, pages 225-226.
Salt Lake City, Utah, January 4-7, 2018

Final Syllable Reduplication When ASL verbs are reduplicated for aspectual inflection, the reduplication rule copies only the final syllable (1a-c) (Sandler, 1989). This process is identical to Marshallese partial reduplication, so I apply Chandlee's (2014) treatment of partial reduplication as a Strictly Local process to sign, captured via the transducer in Figure 3.

(1) a. $L_1M_1L_2$ + RED → $L_1M_1L_2$. $\underline{L_1M_1L_2}$

b. $L_1M_1L_2M_2L_3$+RED → L_1M_1.$L_2M_2L_3$.$\underline{L_2M_2L_3}$

c. $L_1M_1L_2$.<L_3>+RED → $L_1M_1L_2$.L_3.$\underline{L_3}$

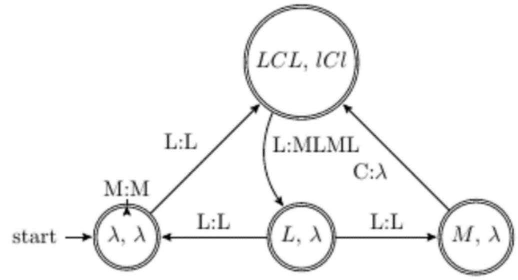

Figure 3. Minimized T_{SL} for ASL partial reduplication, $k = 4$, $\Sigma = \{L, M\}$

Metathesis: The sign 'DEAF' includes a downward movement to the chin in isolation or when following a sign that ends above the chin (Fig. 4a). Following a sign that ends at the chin, such as 'MOTHER', the start/end spoints metathesize, resulting in an upward movement (Fig 4b). Such bounded long-distance metathesis is identical to Cuzco Quechua, which Chandlee (2014) shows is a Strictly Local Process. I use her method to create an SL transducer for ASL, using 'aBc' in place of "LML'. Where *a* and *c* are locations and *B* a movement (Fig 4c)

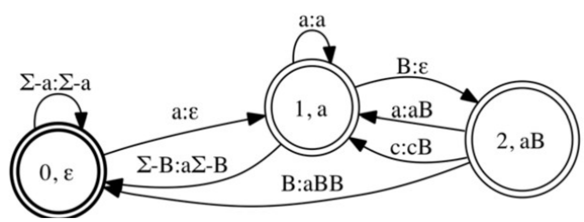

Figure 4. (a) Location metathesis in ASL 'DEAF'. (b) Subsequential FST to describe the bounded long-distance metathesis pattern for (a), where a and c are Ls and B is a movement

Conclusion I claimed that phonological patterns in sign language can be captured using the same finite-state machines as their counterparts in spoken language, as exemplified by the three processes shown above. This supports the view that the Subregular classification of phonology holds regardless of modality. Further research in this direction has particularly interesting consequences: if phonology is truly independent of modality, then any phonological process will fit into this subregular characterization regardless of modality. If not, then either (1) the subregular hierarchy is not expressive enough, (2) the signed modality imposes a different complexity than the oral modality, or (3) the "algebraic" view is wrong. In any event, formal language theory is well-suited to answer questions about modality and representation in phonological systems.

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