Articulatory Degrees of Freedom and Sign Language Lexicons

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A common observation about sign languages is that monosyllabicity is the predominant form of lexical items, and that this is "a clear modality effect" that differentiates signed from spoken languages [1: 332]. Van der Kooij [2] and Morgan [3] both observe that sign languages have large numbers of degrees of freedom within their simultaneously produced phonological parameters and suggest that this is tied to the monosyllabicity effect. Here, we illustrate the viability of this suggestion by quantifying the degrees of freedom available for building monosyllabic forms in sign languages and comparing them to spoken languages. We show that the viable articulatory space for monosyllables is much greater in signed than in spoken languages, bolstering the idea of a true 'modality' effect, but also relate this to larger claims that phonological patterns in *either* modality are a result of competing forces within an efficient communication system [4, 5, 6].

A sign is generally considered to be monosyllabic if it has one movement (a 'light' syllable) or one set of simultaneous movements (a 'heavy' syllable) [7]. Descriptively, a canonical sign syllable can be thought of as in Figure 1 (though see e.g. [2, 8, 9] for debate on the formal representation). The initial cluster of co-occurring characteristics are changed by some movement(s) into a second set of co-occurring characteristics that is entirely predictable from the combination of the first set and the movement. Each of these four characteristics (hand configuration, location, orientation, and movement) can be used contrastively in sign languages to distinguish minimal pairs, and each sign language has its own inventory of phonologically distinctive elements in each category.

We take both a feature-based and an inventory-based approach to determining the number of possible monosyllables in sign languages. With the feature-based approach, using the especially conservative phonological feature hierarchy proposed by van der Kooij [2], we find a lower limit of ~97,440 unique light monosyllables. This hierarchy is based primarily on Sign Language of the Netherlands, but does take other languages into consideration. Other proposed feature hierarchies (e.g. [8, 9], both based primarily on American Sign Language) contain significantly more feature possibilities and hence would result in a far higher number of possible monosyllables. With the inventory-based approach, using the specific phonologically contrastive elements in the inventory of Kenyan Sign Language as described by Morgan [3], which is arguably the most complete phonological analysis of any sign language to date, we arrive at 374,440 possible light monosyllables (44 phonologically distinctive handshapes * 37 phonemic locations * 5 phonemic orientations * 23 phonemic core articulatory movements * 2 number-of-hands-used options). When heavy monosyllables are also allowed, we arrive at between 481,440 (feature-based) and 8,937,320 (inventory-based) possible monosyllables, still just using well-established phonologically contrastive elements. By comparison, the spoken language with the largest and most evenly spread distribution of consonants, vowels, and tones in Phoible [10] is Dan, which with its 44 consonants, 40 vowels, and 8 tones would have 14,080 possible CV^{Tone} syllables, and with its actual allowable syllable types and the phonotactic restrictions thereon has 17,317 theoretically possible syllables [11: 28]. Even English, with a smaller segmental inventory, but a larger number of allowable *complex* syllable types, has only ~100,000 possible syllables [12].

The details of such calculations and ranges of variability will be explored in this presentation, but the key point is that the number of *possible* monosyllables in sign languages is vastly greater than the number in spoken languages. Hence, it is possible for sign language lexicons to have a monosyllabic tendency without straining their phonological resources, and this is directly tied to their modality, i.e., the different phonetic substance of the phonological characteristics in signed vs. spoken languages. At the same time, Nettle [13] and Fenk-Oczlon & Pilz [14] show that spoken languages with larger segmental inventories tend to have shorter word lengths / more monosyllabic words, in line with a principle of efficient communication: by investing more resources into a larger inventory size, a language can minimize the amount of articulatory effort needed by keeping words as short as possible while still producing enough unique lexical items for communication. Here, we illustrate that this same principle of efficiency applies *across* modalities, while the difference in modality itself allows signed languages to take this principle to a further extreme than spoken languages, giving rise to the 'monosyllabicity' modality effect.

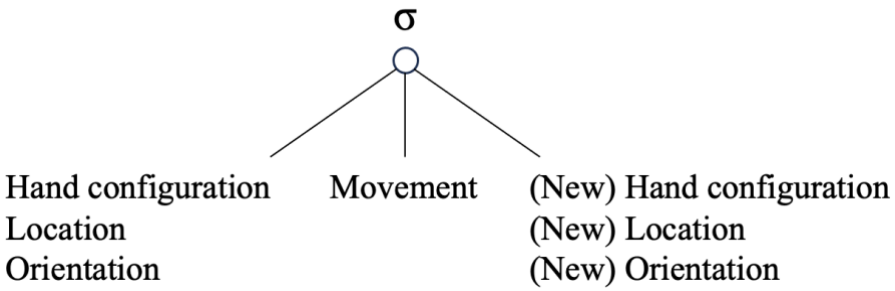

Fig. 1. Descriptive canonical form of a syllable in signed languages

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