Typological and Historical relations across sign languages
The view from articulatory features

Natasha Abner
University of Michigan

Justine Mertz
Paris Diderot University

Jessica Lettieri
University of Turin

Shi Yu
École Normal Supérieure, Institut Jean-Nicod, EHESS

Carlo Geraci
École Normal Supérieure, Institut Jean-Nicod, CNRS

Goals. The aim of this paper is twofold. First, we use articulatory/phonetic features to describe the properties of sign language (SL) lexical items; second, we use these features to classify SLs into macro- and micro-families. The paper provides proof of concept that quantitative methods can be used to probe typological and historical classifications of SLs, along the lines of what has been done in spoken language phylogenetics (Nichols 1992, Dunn et al. 2005) and the genetics of speech communities (Verdu et al. 2017).

Background. SLs are natural languages that are perceived visually (vs. acoustically) and produced gesturally (vs. vocally). The perception-production systems of SL give rise to two macroscopic modality effects. One, SLs allow simultaneous production of a significant amount of contrastive phonemic material (Brentari 1998). Two, SLs display a degree of iconicity at the lexical level, understood here as a conceptually motivated mapping between sign form and sign meaning (Taub 2001 i.a.). Thus, SLs may exhibit a higher degree of cross-linguistic similarity (Wilbur 2010) and signers without a shared language may experience relative ease in converging on a shared communication system (Zeshan 2015). Nevertheless, SLs share many of the structural and functional phenomena of spoken languages. SLs may be classified into language families according to their historical relationships (Anderson & Peterson 1979, Wittman 1991), though additional reliable and verified documentation remains necessary. SLs may also be grouped typologically according to their linguistic properties (Brentari et al. 2015, Zeshan 2006). For example, pairwise comparisons of SLs based on global resemblance of handshape, movement, location and hand-orientation showed that it is possible to detect the degree of similarity/distance between SLs (Woodward 2000; McKee and Kennedy 2000). Here, we assess the efficacy of established statistical models in the typological classification of SLs based on linguistic features. Because typology and history exhibit patterns of convergence and divergence, we also evaluate the typological groupings statistically inferred relative to what is known about historical relatedness among SLs.

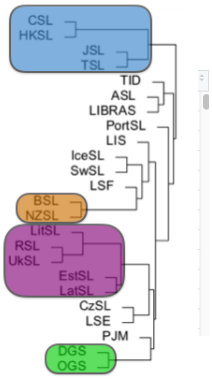
Methodology. To have the same baseline for cross-linguistic comparison, we used Woodward's SL adaptation of the Swadesh list. Following lexicostatistics practice (Rea 1990), this list identifies 100 items that represent some of the core concepts of human life/experience (e.g., *mother,*

live, fire, etc.). Data from 24 SLs (4 Asian, 7 Eastern European, 9 Western European, plus ASL, LIBRAS, NZSL and TiD) were sourced from an on-line dictionary (www.spreadthesign.com). Articulatory (phonetic) features were manually coded for items on the SL-adapted list for all nine languages (all items were not available for all languages). The set of articulatory features coded (55 handshapes, 36 locations, 11 movements) were modeled after Brentari (1998) but are common across SL phonological models (Sandler and Lillo-Martin 2006, Van der Kooij 2002). The features fall into four major classes (Handshape, Place of Articulation, Hand-orientation and Movement) and distinguish the possible configurations and actions of the hand during sign production. For instance, the feature $[\pm spread]$ distinguishes adjacent vs. non-adjacent fingers in handshapes like  and . Coding was done using ad-hoc web-based software for annotation (Author 2, Author 1 and Author 3, 2017). Figure (1) offers an overview of the dataset. Historical information about the SLs in our sample has been retrieved via the Ethnologue of World's languages and the available literature on each language. A graphical representation of the reconstructed historical relations is given in Figure (3).

Analyses. Two types of cluster analyses have been performed on the data: One analysis focuses on major similarities between pairs of signs between pairs of languages. It extends on a large scale the original Woodward's method and it has been successfully applied to spoken languages (Lynch et al. 2002). The results of this method are illustrated in Figure (2). The other analysis focuses on the distribution of articulatory features within the 100 sign sample for each language. It is an adaptation of Dunn et al (2005) method. The adaptation consists in the fact that i) we only considered articulatory features, ii) our data are not in binary form but are counts of each feature. The results of this method are illustrated in Figure (4). Both analyses cluster together i) the group of Asian languages (blue), ii) British and New Zealand SL (orange), iii) Most of the countries of former Soviet Union (purple). The **item analysis** also highlights a relation between Austrian and German SL (green), while the **feature analysis** groups together Austrian, Czech, Lithuanian and Polish SL (green).

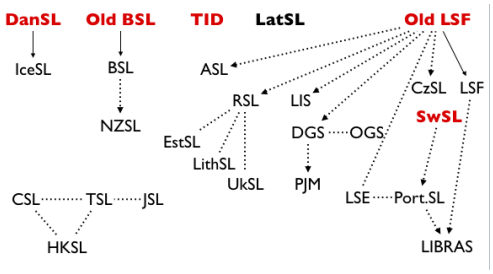
1. FIGURE: Overview of the annotated files

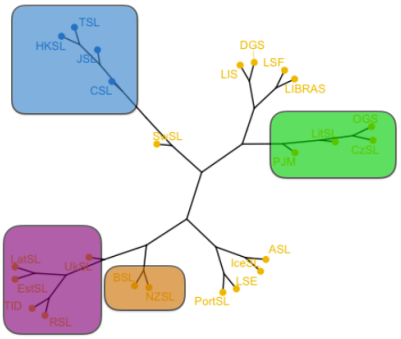
	language	english	handshape	twohands	handpart	TwoH	PoA	PoA2
1	English	all	5	true	palm	1	Lateral	Lateral
2	English	animal	5	true	palm	1	Horizontal	Horizontal
3	English	bad	I	false	ulnar_side	0	Vertical	Vertical
4	English	because	1	false	radial_side	0	Torso_top	torso
5	English	bird	L	false	heel	0	mouth	head
6	English	black	S_b	false	finger_fronts	0	cheek	head
7	English	blood	1	false	tip	0	chin	head
8	English	boring	E	false	finger_fronts	0	chin	head
9	English	brother	S_b	true	heel	1	Lateral	Lateral
11	English	bug	1	false	UNDEF	0	back_of_fingers	hand
12	English	cat	5	true	tip	1	mouth	head
13	English	child	E	false	palm	0	Horizontal	Horizontal



2. FIGURE: Cluster Analysis for items

3. FIGURE: Reconstructed Historical relations





4. FIGURE: Cluster Analysis for features

Discussion. Both analyses partially confirm the reconstructed historical relations. The Asian group can also lead towards an areal interpretation. Under this view, the two cluster analyses witness the fact that Asian SL phonology has features that make it intrinsically different from the other groups. As for the influence of OldLSF, the reason why we do not observe a large cluster with LSF could be due at least to two possible reasons: i) the various languages originated from OldLSF diverged too much over the last two centuries; ii) OldLSF had a similar influence on almost all the remaining SL, which in turns make clusters harder to shape. Evidence of this second hypothesis will be provided during the talk. The green cluster in Figure (4) is somewhat surprising as there is no documentation about it. However, a plausible explanation is available if we look at macrohistory: those countries were formerly part of the Austro-Hungarian Empire. The Empire vanished after World War 1. What our **feature analysis** literally shows are then the fingerprints of human history in the history of these sign languages.

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