Phonetic annotation of signed languages as a tool in cognitive linguistics[1]

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ABSTRACT. In this paper, I argue that a conventionalized system of phonetic transcription will meet both the theoretical and practical needs of signed language researchers in the usage-based/cognitive linguistics field. I give a working definition of a cognitive linguistics framework of phonetics and phonology for signed language, and evaluate Sign Language Phonetic Annotation (SLPA), proposed in Johnson and Liddell (2010, 2011a, 2011b, 2012) under this definition. I assert that phonetic notation of signs in general is appropriate within and necessary for a usage-based understanding of signed language form. I advocate for the need for a gestural approach to language form transcendent of modality and assert that SLPA can facilitate such an approach. Characteristics of SLPA deemed incompatible with usage-based theory include binary feature specification and possibly the proposed sequential segments within signs.

1. INTRODUCTION: NOTATION AND THEORY. The field of signed language (henceforth SL) linguistics is replete with proposed notation systems. This profusion itself has direct negative consequences for researchers, such as the inaccessibility of transcription to those outside one's research team (Garcia & Sallandre 2012:1124). At the root of this diversity, however, lies a deep theoretical issue. Not only transcription but development of notation systems are inseparable from theory, as discussed, for example, by Miller (2001). Liddell and Johnson (1989:207) capture this dual nature of notation by stating that a system must represent both "the 'facts' of a language" and "the organization of the facts." Whether a system allows one to characterize this organization will first depend upon its descriptive adequacy according to the assumptions of one's theory. Among the most salient differences between the myriad of SL notation systems is the grain of detail they capture, thus revealing a lack of consensus regarding the mental representation of phonetic and phonological form and its relationship to produced form. In other words, assumptions regarding the relevance of various production phenomena to the cognitive structure of language will lead to either inclusion or omission of tools to transcribe these phenomena in notation systems.

I would like to reframe the problem of the lack of conventionalized SL notation as an opportunity for the field of USAGE-BASED LINGUISTICS and, more specifically, COGNITIVE LINGUISTICS (henceforth CL). Unfortunately, it seems the aforementioned theoretical disagreement is often overlooked, and researchers make no appeal to a particular stance in defense of adopting one system over another. This silence may reveal a failure to acknowledge notation's origin in theory. We must first acknowledge the inseparability of description and theory. Only then can we explore how to address each in SL linguistics, which is the goal of the present discussion. Thus we may set in motion a cycle of advancement: identifying usage-based

assumptions about produced form and mental representation allows us to develop appropriate notation for description within this framework, employment of this notation allows us to describe that which is relevant to the questions raised within this theory, the theory develops, notation can be refined, and so on.

Before presenting an overview of the present discussion, I will address a possible challenge to my point that a notation system may not exist independently of theory: that the International Phonetic Alphabet is used by spoken language linguists of diverse theoretical bents. My rebuttal stems from my advocacy for a phonetically based notation system for SL, which I address in Section 3. An understanding of various methods of measuring the phonetic detail of speech underlies the IPA. Thus even when linguists disagree, they have the tools to discuss both production and questions of phonetic detail in mental representation. Like when spoken language linguists use broad transcription, we of course may sometimes employ more language-specific phonemic notation. By building a notation system from the bottom up, however, (that is, by examining phonetic detail and allowing it to inform our understanding of higher-level units) we can gain a better understanding of phonemic categories within a given language, how categories differ cross-linguistically, etc.

In pursuit of descriptive and theoretical advancement, then, I make two proposals. The first is that both description and theory of SL within a CL framework necessitate phonetically detailed – as opposed to strictly phonemic – transcription. The second is that a notation system which describes signs in terms of their gestural basis facilitates an analysis of language form which unifies our understanding of the signed and spoken modalities and, thus, a deeper understanding of the human language capacity. In building my argument, I use Sign Language Phonetic Annotation (SLPA[2]) as an example of such a tool. This model is a development of the

earlier Movement-Hold Model in Liddell and Johnson (1984, 1989) and is described in Johnson and Liddell (2010, 2011a, 2011b, 2012). Hochgesang (2014a, 2014b, 2014c) are lecture slides providing unpublished details of SLPA developed largely by Johnson and disseminated to his students (including Hochgesang). These slides contain both Hochgesang's explanations of the system and illustrations and descriptions taken from Johnson's own slides. I begin with a description of SLPA based upon both sources. I then address the issue of description generally by providing evidence of the need for a phonetically based notation system in areas which may be of interest to researchers of diverse theoretical leanings.[3]

Turning to the particular question of description within CL, I then address the role of phonetic detail in usage-based theories of mental representation and, therefore, the necessity of phonetic transcription within this framework. This portion of my discussion begins with a working definition of phonetics and phonology based upon Bybee (2001) and Langacker's (2008) tenets of Cognitive Grammar, providing criteria for evaluating a notation system's compatibility with usage-based claims.

Finally, following Bybee (2001), Wilcox (2012), Wilcox and Xavier (2013) and Armstrong et al. (1995), I adopt the assertion that an articulatory gesture view of language is the view most amenable to a usage-based framework and one which allows us to unify our understanding of language form independent of modality. I conclude that, in allowing for description of SL in terms of articulatory gestures to a much greater extent than phonemically focused systems, SLPA (or a similar system) is therefore beneficial to inquiries under this assumption and a necessary tool for the next step in understanding and describing human language in a way that transcends modality.

2. SIGN LANGUAGE PHONETIC ANNOTATION. SLPA is a featural, phonetic approach to both understanding the (proposed) segmental structure of signs and transcribing signs through notation (Johnson & Liddell 2010). Thus, like the IPA, SLPA assumes both a simultaneous (featural) and sequential (segmental) level of organization within signs. This distinguishes SLPA from other systems, which analogize hand configuration, movement, orientation, and nonmanual gestures to spoken language phonemes (e.g. Brentari 1998). This parameters-as-phonemes approach has led to an understanding of signs as essentially unanalyzable in terms of sequentially unfolding units. In section 3.2, I review Liddell and Johnson's (1989) justification for describing a sign sequentially, concluding that, regardless the grammatical status of syntagmatic units, sequential description is useful. In the next section, I provide the details of SLPA relevant to the present discussion. I do not provide the depth of description needed to apply the system but, rather, an outline of those characteristics representative of phonetic SL description generally.

Two points must be kept in mind throughout my discussion of SLPA. The first is that Johnson and Liddell claim not to present a finished product but a foundation for phonetic description of SL. The second is that my goal is not to argue for the adoption of SLPA *per se*. I argue, rather, for phonetic transcription of SL generally, given the assumptions of a usage-based approach, and to my knowledge, SLPA is the most phonetic, rather than phonological, notation system developed for SL. I thus employ it as a representative for this kind of notation, keeping in mind the larger goal of advancing usage-based analysis of SL form.

2.1. ARTICULATORY DESCRIPTION OF FEATURES. As I mentioned in section 2, most theories, and therefore notation systems, understand hand configuration, orientation, movement, location, and nonmanual gestures as phonemic units specified only once or twice per sign. In other words, the

hand configuration pictured in Figure 1, for example, is considered a phoneme or, in production, an allophone of ASL.

FIGURE 1. Production of an ASL allophonic handshape[4]

In Stokoe Notation (Stokoe 1960) and similar systems, the arrangement of the fingers and thumb shown above is labeled a '5 handshape'. Such a label is typically the most precise detail given systematically; should further detail be relevant, such as the degree of spreading between two specific fingers, it must be given in prose. The other parameters are similarly holistically described.

SLPA, on the other hand, proposes binary [+/-] features specifying muscle and joint activity, describing production rather than perception. Johnson and Liddell (2010, 2011a, 2011b, 2012) and Hochgesang (2014a, 2014b, 2014c) present the full inventory of features identified by Johnson and Liddell as descriptively adequate. A comprehensive list is beyond the scope of this paper, and Johnson and Liddell concede that additional evidence may call for increased detail. Instead, I will provide an overview of SLPA's articulatory descriptions of hand configuration, placement, facing, primary contact, and nonmanual grammatical gestures (NMG).

HAND CONFIGURATION. SLPA describes hand configuration in terms of degree of extension and flexion of each thumb and finger joint. Abduction and adduction at the metacarpophalangeal

joint (where the fingers connect to the palm) account for degree of spreading of the fingers and thumb. Contact between the thumb and a finger or fingers and where this contact occurs also contribute to hand configuration.

PLACEMENT. Placement describes the spatial relationship between the hands, hands and body, or hands and space. Changes in these relationships account for the movement parameter of other approaches, and path features produce the movement's shape. Defining a sign's placement requires identification of a focal site, a determinate (stable) spot in signing space or on the weak hand or body with respect to which the active articulator (usually the hand) is positioned. Hochgesang (2014a, 2014b, 2014c) presents the various points on the body and in space relative to the body which have thus far been determined as important for phonetic description.

FACING. Facing is a reconceptualization of orientation, described as a result of rotation, extension, and flexion of the wrist, elbow, and shoulder joints.

PRIMARY CONTACT. Primary contact describes contact between the hands and body, the values for which are defined similarly to possible focal sites. The point on the hand with which contact is made also constitutes primary contact.

NONMANUAL GRAMMATICAL SIGNALS. NMG include movements and configurations of the head, eyes, eyebrows, mouth, and body which contribute to a sign's form. Description of NMG is a forthcoming component of SLPA (Hochgesang 2014b) and is requisite to any complete phonetic notation for SL.

TIMING UNITS. Further departing from other approaches, SLPA theorizes that the features specifying SL articulation bundle horizontally to produce sequentially unfolding segments called TIMING UNITS within individual signs. These segments divide into the two major categories of TRANS-FORMING and POSTURAL segments. Trans-forming segments are characterized by a changing specification of one or more features. Postural segments are defined as (brief) points in the signing stream in which all features are aligned, that is, unchanging. A feature [+/- dynamic] is proposed to distinguish these two types of segments. The two categories are divided further based upon the manner of production (e.g. controlled vs. ballistic muscular activity).

Figures 2 and 3, reproduced with permission from Johnson and Liddell (2011), show an instance of the sign CHICAGO (plus several frames before and after the sign) and an illustration of its segmentation under SLPA, respectively. A frame's duration simply represents the finest grain of detail observable through the technology available to the authors (therefore holding no theoretical significance), and frame letters and numbers correspond to the boxes along the top of the image in Figure 3. The horizontally stacked boxes on the left signify hand configuration, placement, facing, and NMG. The solid gray boxes labeled 'changing' extend through frames during which the features defining these parameters are in transition, and the patterned boxes containing numbers stretch across frames during which the given feature remains static. The numbers in the patterned regions demonstrate the sequence of feature specifications: a change in number represents a change in specification between the current and previous postural segment. Frames during which at least one parameter is changing capture trans-forming segments (frames 2-6 and 8-11). Frames throughout which none of the four parameters exhibit changing featural specifications are identified as postural segments (frames 1, 7, and 12-15).
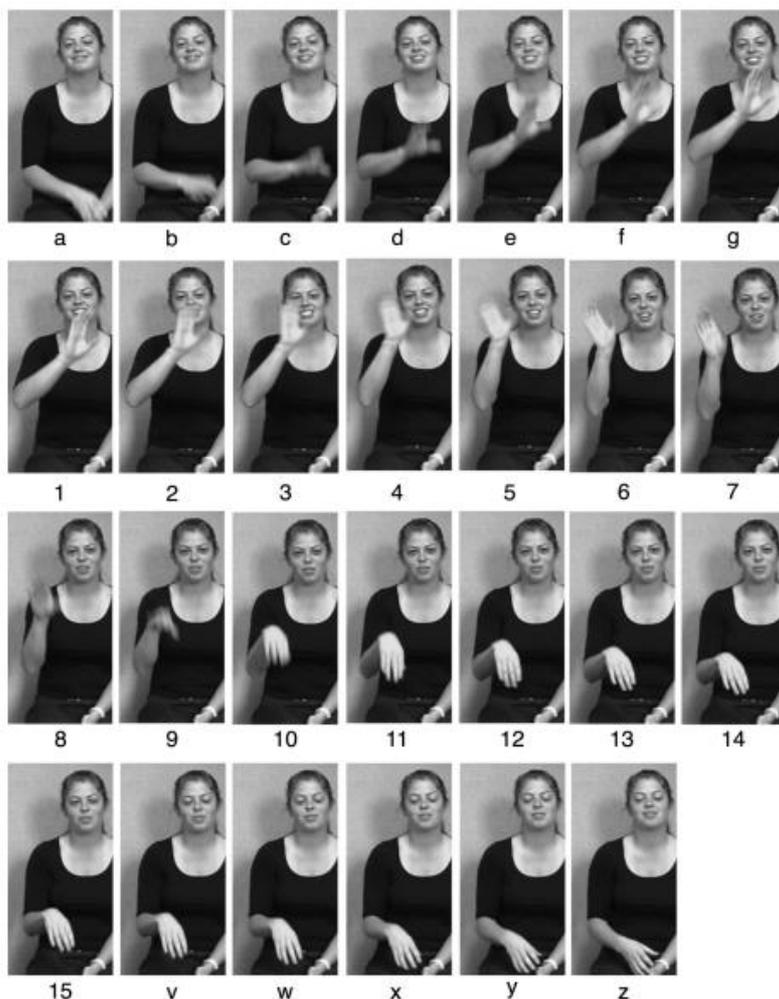
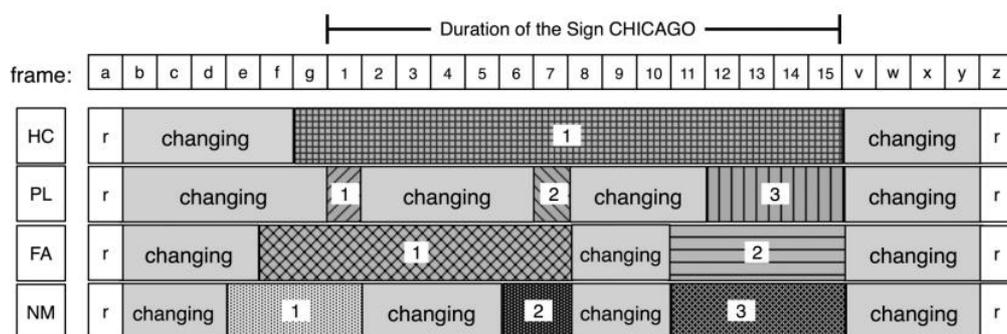FIGURE 2. Frames capturing a demonstration of the sign CHICAGO

FIGURE 3. Segmentation of timing units in CHICAGO based upon feature alignment

Thus, rather than merely a configuration of handshape, location, orientation, and movement, the sign CHICAGO is transcribed in SLPA as containing five sequential segments. In section 3.2, I discuss this segmentation approach in light of usage-based theory. Table 1 offers a summary of the articulatory description of parameters in SLPA and, for comparison, rough equivalents under traditional phonemic approaches. NMG are omitted since their description is not yet provided in SLPA.

	Articulatory description, SLPA	Traditional equivalent
Hand configuration	extension, flexion, abduction, and adduction of finger and thumb joints thumb-finger contact	holistic handshape labels, such as 'claw' or 'bent 5'
Placement	spatial relationship between the hands and focal site on the weak hand, body, or signing space	location, defined as regions identified in traditionally defined minimal pairs
Facing	rotation, extension, and flexion of wrist, elbow, and shoulder joints	orientation, described as direction faced by palm or extended fingers
Primary Contact	location and presence or absence of hand-body contact	location, defined as regions identified in traditionally defined minimal pairs, and presence or absence of hand-body contact
Timing Units	alignment of all features or changing of one or more features	-------

TABLE 1. Parameter definition in SLPA and traditional phonemic systems

SLPA exemplifies the characteristics of a phonetic notation system for SL. Its difference from traditional phonemic notation lies most saliently in its emphasis on the gestures producing configurations of the articulators and its description of signs as temporally structured units. Section 3 deals with the necessity of this type of notation.

3. NEED FOR PHONETIC NOTATION. I have followed others (e.g. Miller 2001) in asserting that our field requires a common system of notation. Some have argued against the need for SL

transcription at all, however, such as Armstrong and colleagues (1995), appealing to advancing technology and increasing video data access. However, photographs remain the primary means by which SL researchers display raw data, and these can never stand alone. As in spoken language research, not every property of an instance of SL will be relevant to a single research question (Miller 2001), and many aspects of signed production are not captured in photographs. Even if raw video data is presented, the researcher must still identify which characteristics they are examining, especially for audiences unfamiliar with SL.

In the absence of notation, prose accounts of data reveal something about our descriptive needs. The following example reveals what I believe to be true throughout the body of research: our analyses require a system, like SLPA, which describes signs articulatorily. Stokoe's (2001:436) description of the sign YES is strikingly similar to what is proposed by SLPA:

> L]ooked at from the physiological basis…[the sign] yes is the result of **flexing** the fingers, and…of **abducting** and **rotating** the upper arm outward at the shoulder, and of fully **pronating** the forearm, and of **flexing** the arm at the elbow (emphasis added).

We see here that configuration of the articulators and the gestures that produce it are central to an adequate description of a sign's form, even in prose. This description and the phonetic transcription made possible by SLPA differ only in systematicity. By providing a more succinct and standardizable approach, SLPA, or a similar system, will facilitate advancement in our field.

4. TRANSCRIPTION AND USAGE-BASED THEORY. As mentioned in Section 1, transcription, and even notation, cannot be theory-neutral. What notation captures must follow from at least broad assumptions of the nature of the linguistic system. In Section 4.1, I discuss ways usage-based and

CL theory will impact decisions made in the development of SL notation. Section 4.2 concludes that SLPA, as a tool for phonetic description, is precisely the kind of notation system this theory's understanding of language form demands.

4.1. USAGE-BASED PHONOLOGY. To evaluate the appropriateness of phonetic notation for SL within usage-based linguistics, we must first define our model of phonetics and phonology within this framework. For this purpose, I employ Bybee's (2001) usage-based understanding of form and principles laid out in Langacker (2008).

The major consequence of Bybee's (2001) model for a notation system is the significance of the phonetic rather than phonemic level only. Her work has emphasized the role of phonetic detail in reception and storage (Bybee 2010) and called for a 'model of phonetic categorization' (Bybee 2001:53). This model assumes 'that storage units are categorized tokens of use' and that 'mental representations contain considerable detail about phonetic variants…not just those [features] that determine phonemic contrast' (49, 52). As yet, we have no evidence to believe that this importance of phonetic distinctions for mental representation of spoken language differs for the perception and production of SL. To pursue a usage-based understanding of SL form, then, at least as Bybee (2001) conceives of this theory, we must describe phonetic detail.

Langacker's CONTENT REQUIREMENT also serves as a useful guide for what may constitute linguistic mental representation. Within his approach, linguistic 'units are limited to structures that arise from usage events through…schematization and categorization' (2008:220). With regard to language form specifically, 'phonological units [are abstracted] from apprehension of their phonetic properties' (220). Again, we find in the very definition of usage-

based and cognitive linguistics an emphasis upon phonetic detail as the foundation for phonemic categorization and, as such, essential to our understanding of mental representation.

4.2. SLPA AND USAGE-BASED THEORY. With this broad understanding of a usage-based theory of language form, we can now ask whether SLPA suits this perspective. A review of Section 2.1 reveals both characteristics which adhere to the stated goals of usage-based linguistics and characteristics which, adhering to a generative framework, are in conflict. I will first address the latter, namely SLPA's binary feature specification, which conflicts with the usage-based assumption of gradience and detail in mental representation. According to Bybee (2001), storage is not limited to phonemic contrast. Since identification of timing units within SLPA depends largely upon such binary specifications, their compatibility with CL is also questionable. I do not argue against a simultaneous level of representation in the SL grammar but assert, rather, that descriptive adequacy also requires understanding of signs as temporally unfolding articulations. Even for spoken language, however, considering segments as emerging from use requires us to rethink the nature of their stored representations. Thus, we should consider trans-forming and postural segments as a starting point for exploring the sequential nature of signs. Their status as psychologically real units requires further empirical (including experimental) evidence.[5]

On the other hand, the level of phonetic detail SLPA captures is precisely the level at which we must analyze form to develop a usage-based model of SL form. Moving beyond holistically perceived units, SLPA is a tool which allows us to explore SL production within the CL view of language use and its relationship to mental representation. Some have criticized the system's level of detail, however, and even Johnson and Liddell view it as a shortcoming. This

criticism is in fact an accusation of redundancy (or predictability), which is not a flaw from a usage-based perspective.

PREDICTABILITY. Johnson and Liddell (2011b:409) express their attempted avoidance of predictable features as follows: "The search for potential phonetic distinctions provides a means for determining which aspects of the sign are linguistically important and which are accidental or simply the result of how our bodies work." They concede that, as yet, SLPA fails to accomplish this goal. As a demonstration, we can discuss how SLPA would treat the ASL sign WORK, pictured in Figure 4, in which the palms are oriented toward the ground the front of the active hand wrist contacts the back of the passive hand wrist.

FIGURE 4. Demonstration of a form of the ASL sign WORK

As is clear from Section 2.1, SLPA would capture both the location of contact between the two hands and their facing produced by rotation at the elbow. Such notation, however, involves redundancy. It would be physically impossible for the point of contact to be, for example, the sides of the hands if the palms were oriented toward the ground. But if our goal is to capture aspects of production of significance to the grammar, and if our theory of representation follows a usage-based perspective, this redundancy is acceptable. Consequences of 'how our bodies work' are legitimate observations within a model of language wherein language use plays a

crucial role in the developing the grammar. Bybee (2001), citing Ohala and Ohala (1995), explains that predictable features are a meaningful part of our linguistic perception and that redundancy of mental storage is not only not a problem within a usage-based framework but is in fact a major assumption of how language works.

5. THE GESTURAL VIEW OF LANGUAGE FORM. Thus far, I have attempted to demonstrate that phonetic notation, exemplified here by SLPA, is required for adequate description of SL data. I have argued that this is especially true if we are concerned with description that is informative to usage-based and CL theory. I now turn to my second and broader argument for developing phonetic notation for SL: that a unified analysis of signed and spoken language production follows necessarily from CL theory, that a gestural analysis allows for this unification, and that a tool of phonetic description is necessary for carrying out gestural analysis.

The notion that gesture, in the sense I have thus far applied the term, constitutes both the physical and cognitive substance of language emerged as the articulatory phonology theory of spoken language (Browman & Goldstein 1989). Browman and Goldstein write that "the basic 'atoms' out of which phonological structures are formed…are assumed to be primitive actions of the vocal tract articulators," or "articulatory gestures" (1989:201), also described as articulatory goals or targets. This articulatory approach provides a framework within which the measurement of gestures is considered linguistically relevant. In other words, this theory assumes that such measurements, including observations of overlap and interactions of gestures in use, are informative regarding mental representation. Thus, articulatory phonology facilitates exploration of the bridge between phonetic substance and phonological structure with which usage-based phonetics and phonology are, by definition, concerned.

Wilcox (2012) and Bybee (2001) assert that usage-based theory mandates this view of language. Wilcox (2012:129) characterizes the divergence of CL from other theories as follows: "[F]ormalist or abstractionist theories…sever language and our conceptual system from movement and perception." He also quotes Langacker's assertion that grammar "reflects our basic experience as moving, perceiving, and acting on the world" (2008:4). In this way, Wilcox juxtaposes the CL view of the relationship between the cognitive and physical substance of language with the generative competence-performance dichotomy. Similarly, Bybee rejects the exclusion of performance data in usage-based research on the grounds that "grammar is directly based on linguistic experience" (2010:20). Thus we find in articulatory gesture analysis the marriage of grammar and use which is central to usage-based inquiry.

5.1. UNIFIED ANALYSIS OF SIGN AND SPEECH. With a premium placed upon not only linguistic but world experience by CL, it follows that all human communication should exhibit deep and fundamental commonalities. Indeed, analysis of language form as gesture allows us to achieve an understanding of language that transcends modality. An alternative view of the modality distinction holds that, while theories of higher levels of the grammar easily apply to both speech and sign, the use of different articulators and receptive organs means that theories of form, and therefore tools for measuring it, must be distinct. Brentari articulates this view in her "hypothesis…that the closer our analyses are to the phonetics, the more apparent the differences are between sign language and spoken language, and that the closer our analyses are to grammatical function, the more apparent the similarities become" (1998:3). This perspective depends not only upon the dichotomous understanding of competence and performance addressed in Section 5, but also upon the assumption of linguistic modularity. In order to see a

modality distinction as more pronounced in some fundamental way at the phonetic and phonological levels than at the higher levels such as syntax and discourse, we must assume that these levels of the grammar exist in isolation from one another and operate according to different mechanisms.

The view Brentari expresses also contradicts a foundational tenet of CL, which is that these levels are gradiently and schematically distinguished, not modularly isolated (Langacker 2008). If we take this schematic model of the grammar as our foundation, we must also theorize that the phonetic substance of the two modalities, while using different articulators, is at a basic level amenable to a single analysis. Wilcox argues that "language is best understood as articulatory gestures" and that this approach "sees language in all of its modalities and channels – speech, sign, words, grammatical markers, intonation – and gesture within a unified framework," reconciling our understanding of the human communicative capacity as a whole (2012:128). Wilcox and Xavier also address the implication of CL that SL, spoken language, and gesture (in the sense of non-linguistic communicative symbols) can be understood within a unified framework in which all three are understood as "manifestations of the same embodied conceptual system" (2013:90). With this perspective, the difference between the use of the hands, arms, and face as articulators versus the use of the vocal tract as an even trivial distinction.

5.2. NOTATION FOR A GESTURAL ANALYSIS. It should be clear from the description of SLPA in Section 2.1 that, just as this system is suited for usage-based linguistics in its capturing of phonetic detail, it is appropriate for this articulatory gesture approach in its focus upon the processes of articulation. Researchers have already recognized the advantage of analyzing sign

production in terms of articulatory gestures (e.g. Tyrone et al. 2010). Given the descriptive

requirements of such pursuits, it is no longer adequate to limit our notation to broadly defined

perceptual units such as '5 handshape'. Our field requires not only description of more phonetic

detail but also an attention to the physical processes of production, such as that provided in

SLPA. Without such a tool, empirical testing of the theoretical assertion that embodied cognition

and experience are central to the human language capacity remains out of reach.

6. CONCLUSION. After stating the problem in Section 1 that the field of SL linguistics has no

conventionalized notation system, I posit that the root of the problem is a lack of theoretical

consensus regarding SL form. I then propose, however, that this problem may also be viewed as

an opportunity: the intimate link between notation and theory means that our pursuit of a

notation system for SL can drive an effort for a more clearly defined theory of SL form within

usage-based linguistics. This endeavor is crucial since, although usage-based and CL theories

have contributed vast depth to our understanding of many aspects of SL, we continue to confine

study of SL form within a generative framework.

The present discussion has taken as a model Johnson and Liddell's (2010, 2011a, 2011b,

2012) SLPA. This system's departure from traditional SL notation lies in its status as both an

articulatory and a phonetic approach. Evaluation under usage-based assumptions reveals that its

inclusion of phonetic detail is compatible with and necessary within this theory. Likewise, its

focus upon the motor activity leading to various configurations of the articulators make it

suitable for investigating articulatory gestures. Most important is this second advantage of SLPA

or a similar system; in facilitating research which adopts a gestural view of language, such a

notation system allows for exploration of language in a way which transcends modality. In this

way, a descriptive tool is relevant to our achievement of the highest goal of linguistic theory,

particularly within CL: an understanding of the human communicative capacity.

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[2] The name Sign Language Phonetic Annotation was coined by Hochgesang (2013) in her dissertation, which compares the success of several transcription systems in describing hand configuration errors in child language acquisition.

[3] Unless otherwise specified, the signs referred to in this paper are from the lexicon of American Sign Language (ASL), and SLPA's development has been based largely upon analyses of ASL. However, the system is intended for transcription of any SL, with room for improvement following application to other languages. Likewise, I intend my discussion to apply to SL research generally, and I will occasionally reference both the known and less explored characteristics of other SLs in my argument for phonetic transcription.

[4] I am extremely grateful to Dr. Julie Hochgesang, a native signer of ASL, whose image appears in Figures 1, 4, 6, and 7.

[5] Although not part of SLPA per se, it is worth noting that Johnson and Liddell's discussion of rule-governed phonological alternations is also outside the bounds of CL, conflicting with the assertion that the linguistic system is composed only of representations of actual language use and their categorical relationships.