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An Introduction to Embodied Cognitive Phonology: Claw-5 Handshape Distribution in ASL and Libras

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Abstract. While the arbitrariness of the sign has occupied a central space in linguistic theory for a century, counter-evidence to this basic tenet has been mounting. Recent findings from cross-linguistic studies on spoken languages have suggested that, contrary to purely arbitrary distributions of phonological content, languages often exhibit systematic and regular phonological and sub-phonological patterns of form-meaning mappings. To date, studies of distributional tendencies of this kind have not been conducted for signed languages.

In an investigation of phoneme distribution in American Sign Language (ASL) and Língua Brasileira de Sinais (Libras), tokens of the claw-5 handshape were extracted and analyzed for whether the handshape contributed to the overall meaning of the sign. The data suggests that distribution of the claw-5 handshape is not randomly distributed across the lexicon, but clusters around six form-meaning patterns: convex-concave, Unitary-elements, non-compact matter, hand-as-hand, touch, and interlocking. Interestingly, feature-level motivations were uncovered as the source of the mappings

These findings are considered within a new cognitive framework to better understand how and why sub-morphemic units develop and maintain motivated form-meaning mappings. The model proposed here, Embodied Cognitive Phonology, builds on cognitive and usage-based approaches but incorporates theories of embodiment to address the source of the claw-5 mappings. Embodied Cognitive Phonology provides a unifying framework for understanding the perceived differences in phonological patterning and organization across the modalities. Both language-internal and language-external sources of motivation contribute to the emergence of form-meaning mappings. Arbitrariness is argued to be but one possible outcome from the process of emergence and schematization of phonological content, and exists alongside motivation as a legitimate state of linguistic units of all sizes of complexity. Importantly, because language is dynamic, these states are not fixed, but are in continuous flux, as language users reinvent and reinterpret form and meaning over time.
Keywords: Cognitive Phonology, Cognitive Semantics, Embodiment, ASL, Libras.

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1. Introduction

Over the past decade, an explosion of iconicity research has brought about a renewed interest in the organization and distribution of motivated mappings at the phonological level. Systematic phonological motivation is, in fact, prevalent both within individual languages, and across typologically distinct sets of languages (Blasi et al. 2016; Dingemanse et al. 2015; Nobile 2015; Perlman, Dale and Lupyan 2015). Robust evidence of phonological level form-meaning pairings has provided fodder for recent challenges to the necessity of duality of patterning and the arbitrariness of the sign. Some have claimed that duality of patterning and arbitrariness of the sign are not linguistic 'pre-requisites' but are merely statistical tendencies (Blevins 2012). They argue that languages do not need duality of patterning to be real and productive (Blevins 2012; de Boer, Sandler and Kirby 2012; Ladd 2012; Givón 2015); suggesting phonological material is not by default arbitrary. Languages can, and do, associate meaning with phonological and, even featural, level content.

Since the first publication on ASL linguistics (Stokoe 1960), researchers have recognized a high degree of phonological motivation, often referred to merely as "iconicity" (Friedman 1977; Mandel 1977), in the formational units of signed languages. The earliest linguistic studies of signed languages documented the "two-faces" of the sign (Klima & Bellugi 1979), which seemed at once to exhibit both phonological and highly iconic properties. During these early years, linguists struggled to legitimize the study of signed languages. Their research sought to prove that signed languages were real, natural, human languages, on par with spoken languages in terms of complexity, structure, and expressive power. Early influential papers argued that iconicity was inversely related to phonological and or grammatical complexity (Frishberg 1975; Klima & Bellugi 1979). Iconic mappings became viewed an inconsequential outgrowth of the visual modality, peripheral to organization or structure of the language. In this view, phonological units, like those in spoken language, were considered meaningless combinations of distinctive features organized by well-formedness rules (Brentari & Goldsmith 1993; Corina & Sandler 1993).

Though some researchers during this time continued to investigate motivated mappings in signed languages, especially in metaphorical signs (Brennan 1990; P. Wilcox 2000; S. Wilcox 2004) these authors' works have remained largely overlooked within the broader field of signed language research. This is perhaps due to the more formalist tradition of signed language linguistics in which structure is investigated without appealing to meaning. Thus, research on metaphor and other semantically related phenomena are not considered central to the architecture of the language. Only recently, with the acceptance of iconicity research in spoken language linguistics, has the study of iconicity become a mainstream research topic within signed language linguistics. In Deutsche Gebärdensprache (DGS) (Grote and Linz 2003) and American Sign Language (ASL) (Thompson, Vinson and

Vigliocco 2009), motivated phonological mappings have been shown to impact lexical organization. In British Sign Language (BSL) (Thompson, Vinson and Vigliocco 2010), motivated phonological forms have been found to increase response times and reduce accuracy in phonological decision tasks. And in the realm of second language acquisition, motivated phonological mappings have been shown to aid in the acquisition of meaning, but hinder the acquisition of distinct phonological properties, in non-native BSL users (Ortega 2013, 2017). This research shows that motivation and iconicity influence both the organization and processing of signed languages.

Given the recent findings of systematic form-meaning mappings in the distributions of phonological content in spoken language, and the growing acceptance of iconicity research in signed languages, the time has come for investigations into the systematicity of such phenomena in signed languages. The hypothesis investigated here concerns whether signed languages exhibit distributional tendencies for systematic form-meaning mappings at the phonological level. If, for example, current models of phonology are correct, and signed language phonemes are entirely arbitrary, one should not expect to see formal properties of handshape clustering around meaning. If, however, phonological parameters are not by necessity arbitrary, handshape may indeed cluster around semantic categories.

A usage-based study of handshape in American Sign Language (ASL) and Língua Brasileira de Sinais (Libras) examined all tokens of the claw-5 handshape which were analyzed for whether the handshape contributed to the overall meaning of the sign. The distribution of the claw-5 handshape in both ASL and Libras was found to cluster around six schematic form-meaning patterns. Importantly, six individual feature-level articulatory properties of the handshape were identified as the source for each of the schemas: convex-concave, Unitary-elements, hand-as-hand, non-compact matter, interlocking, and touch. This data supports the hypothesis that signed languages, like spoken languages, exhibit phoneme and feature level from-meaning patterning.

While traditional phonological models struggle to account for the existence of motivation at the phonological and sub-phonemic level, usage-based and cognitive models are entirely compatible with this phenomenon. Gradience is recognized as a defining feature of language and classical categories are not part of these models and instead exemplar or prototype based representations are normative. Thus, these models provide an excellent framework for investigations into how and why non-arbitrary phonological mappings might arise, how they relate to and interact with arbitrariness, and why signed and spoken languages have seemingly differing degrees of phonological motivation. Linguistic content is considered emergent, arising from the schematization and categorization of usage-events, and dynamic, changing over time as usage affects the representation and storage of linguistic content.

Importantly, usage-events themselves, are produced by the body. Linguistic articulations are coordinated motor-routines (Browman & Goldstein 1989; Bybee 2001), not unlike other entrenched motor routines related to moving bodies (Fowler 1996; 2010). Articulations are produced by articulators that have multiple functional roles in addition to their language production. These physical forms of language are also *interpreted* by the body. In a non-Cartesian view, the domain-general cognitive processes of categorization, analogization, entrenchment, rou-

tinization, and memorization, all depend on our experiences in the world, our sensory motor abilities, and our movement (or lack thereof) in our physical environment. Far from disembodied, language is crucially tied to our existence in our bodies.

The view presented here is that phonology should be considered on par with other emergent linguistic structure, i.e., subject to the same processes and cognitive pressures that drive the rest of language organization. Like other conceptually contentful fields of linguistics, the role of meaning, broadly construed, is involved in the organization of phonemic and sub-phonemic units of languages. Moreover, incorporation of a theory of embodiment into a cognitive model of phonology can account for the ways in which multi-modal, multi-sensory, multi-dimensional events become integrated into language structure. In other words, an 'embodied' cognitive phonology explains the emergence and maintenance of motivated form-meaning mappings, which seem to be frequent and commonly attested cross-linguistically.

2. Background

2.1. Concerns of a Cognitive Phonologist

The idea of a 'cognitive phonology' is not new. During the late nineteen eighties and early nineties, linguists began to recognize the need for revamped phonological models that better incorporated emerging research from fields such as cognitive science, artificial intelligence, and computational linguistics. Nathan (1986, 1996, 2006; 2008), an early pioneer of cognitive approaches to phonology, proposed that phonemes are real entities in the minds of language users. He has argued that (for spoken language) phonemes are auditory/motor images of sounds as they are perceived, not abstract specifications for sounds (Nathan 2006). Nathan has also advocated for the role of prototypicality in phoneme inventories, showing that not all members of natural categories necessarily share the same defining feature, e.g. some phonemes may be better exemplars of a given category than others.

Building on this research, Mompean too has addressed issues of prototypicality and its relationship to the conceptual structure of phonological categories (Mompean 2001; 2004). Mompean & Mompean-Guillamón (2009) have argued for blurring the distinction between phonetics and phonology, suggesting that phonological categories have phonetic motivations and that phonemes enjoy basic-level category status (Mompean 2006). Mompean has also advocated for the role of general cognitive processes but also for considering the role of phonetic, usage-based, and sociocultural factors as sources of motivation of the phonological pole of linguistic units (Mompean 2014; Mompean & Mompean-Guillamón 2012).

Other advances in cognitive approaches to phonology have focused on individual pieces of the phonological puzzle. Nesset (2008) has worked within a Cognitive Grammar framework to discuss the morphology-phonology interface, suggesting that morpho-phonological alternations have meaning. Kristiansen (2006) has investigated these issues from within a sociophonetics framework, suggesting that phoneme exemplars include phonetic details such as sociological indicators related to speaker identify, such as gender and geographic dialect. Kristiansen has also

shown that receptive and productive lectal varieties play different roles in phoneme categorization and inventory building. In this sense, phonemes carry meaningful content relating to the speaker, including inferences made by the hearer regarding the speaker's relative social status.

While neither Cognitive Grammar (Langacker 1987a, 2008) nor Usage-based Phonology (Bybee 2001, 2006, 2010) explicitly investigates 'cognitive phonology,' the basic tenets of these approaches align with the attempts of cognitive phonologists to develop models of the phoneme which better characterize the way in which language users produce, perceive, and organize form. Though Cognitive Grammar focuses primarily on meaning and symbolic units, and does not define the emergence of phonemic content in detail, Langacker insists that the process of abstraction of linguistic form and meaning is the same regardless of level of complexity. He emphasizes that usage-events provide raw, untagged material from which users perceive, categorize, and schematize events into smaller and smaller chunks.

Indeed, theorists working on various aspects of cognitive phonology have pulled from these well-established, well-developed theories to motivate their own research. The Embodied Cognitive Phonology model developed in this article also draws on the theoretical bases of Usage-based Phonology and Cognitive Grammar. As a guiding principle, these models assume that, "the only elements ascribable to a linguistic system are (i) semantic, phonological, and symbolic structures that actually occur as parts of expressions; (ii) schematizations of permitted structures; and (iii) categorizing relationships between permitted structures" (Langacker 2008: 25). This tenet, called *the content requirement,* restricts theorists to dealing with the actual utterances, i.e., what is spoken or signed by the language user. Under this approach, there is no separation between underlying forms and surface forms, and the former are not used to derive the latter.

Form, from a cognitive perspective, consists of all the gestural (articulatory) material of an utterance, in other words the substance. For both auditory and visual modalities, this includes the content produced by the vocal tract, the hands, the face, the body, and any other perceptible part of our meaning-producing machine. Articulatory gestures exist in a physical medium, transmitted by light or acoustic waves—this is the physical content of language—the signal we perceive. These multi-channel, multi-modal mappings are rich in their semiotic potential, combining in complex, dynamic ways to convey meaning.

M*eaning*, from a cognitive perspective is the conceptual material of language—our encyclopedic knowledge of the world. Meaning includes detailed knowledge of how bodies move, how objects interact, and how things and processes, in the Langackarian sense, are related (or not). Meaning is subjective knowledge of the world. *Construal*, in its technical sense, is our ability to conceptualize and interpret situations in more than one way. Construal of perceptual properties of things and processes is central to how humans, and perhaps other animals, map formal articulations to meanings.

Finally, a cognitive perspective includes the association between form and meaning, i.e., the *symbolic unit*. Symbolic units can be simple e.g., *think* or can combine in complex ways e.g., "for that was *an unthinkable thought*" (Davies 2008). These simple or complex units can vary in their degree of schematicity or specificity, being comprised of combinations of wholly schematic, wholly specific,

or variations of schematic and specific form-meaning mappings. In such a view, differences between the grammar and the lexicon are a matter of degrees of schematicity (or specificity), with the more schematic content associated with 'grammar' and the more specific content associated with 'the lexicon'.

A cognitive approach to phonology utilizes these three, usage-based units, for the description of language structure: form, meaning, and symbolic units. Additionally, language can be described in terms of schematizations of usage-events and the categorizing relationships between those schemas. *Schemas* arise from abstractions of form and meaning, or more precisely abstractions *from* and relationships *across* form and meaning. When a language user encounters a usage-event, that utterance is immediately compared and contrasted with other previously experienced usage-events. The user recognizes commonalities across the events and updates their existing schema, or creates a new schema, to account for the new usage-event. But these are not abstractions in the sense of *extractions*. One does not simply extract commonalities and dispose of the redundancies which allowed for the categorization in the first place. In other words, one does not throw the baby out with the bathwater.

In a usage-based approach to language learning, one keeps the baby *and* the bathwater. Linguistic units have the same properties as other stored conceptual content (Ohala & Ohala 1995; Langacker 1987; 2000). Redundant predictable material is stored alongside unpredictable material, allowing for future schema updating. In other words, all of the instances of all of the tokens experienced are added to our exemplars, which are in turn continuously updated (Ellis, O'Donnell & Römer 2014). Prototypical usage-events are strengthened each time a new token which fits the prototype is encountered. Less prototypical instantiations expand the fuzzy boundaries of these schematic categories.

Taking the research themes of cognitive phonology in hand with basic tenets of Usage-based Phonology and Cognitive Grammar, one arrives at the following theoretical bases from which to approach investigations of the phonological content of language:

a) Phonemes and other sub-lexical units are conceptual phenomena, not just lists of abstractions and rules.
b) Phonemic representations are gestural motor routines, shaped by articulatory and perceptual factors such as routinization, frequency, saliency, and prominence.
c) Phonemic organization is subject to constraints from general cognitive mechanisms such as analogical reasoning, categorization, learning algorithms, and memory.
d) Phonemic content is affected by social-interactional factors such as prestige, identity markers, and pragmatic inference.

Overall, a usage-based, cognitive account of phonology should incorporate these tenets and use them to make predictions about the state of phonological organization, phonological change, and other linguistic concerns of the phonological sort.

Unfortunately, these views have not been extended to signed language phonology, which remains largely formal. The following section provides background on the basic phonological structures of signed languages and raises concerns related to

formal divisions between phonological and morphological content, as it relates to handshape.

2.2. Signed Language Phonology

The three major phonetic parameters in signed languages—*handshape*, *movement*, and *location*—refer to the configuration of the hand, the movement of the sign in space, and the location (or place) of the articulation respectively.[2] Signed language phonology overwhelmingly focuses on the *handshape* parameter, which describes the shape of the hand/s during the articulation of a sign. This is likely because it is both easier to isolate (compared to location and movement) and because it is more amenable to concerns of contrastiveness. In the same way that phonologists use voicing, place, and manner of articulation to describe the phonemes in spoken languages, these primary parameters of handshape, location, and movement are used to describe the basic units of signs. Much as *pat* /pæt/ and *cat* /kæt/ are minimal pairs in English, differing only in the place of articulation of their word-initial segments, two signs can be minimal pairs, similarly varying in handshape, location, or movement. Stokoe (1960) was the first to notice that signs like MOTHER and FATHER feature the same 5-handshape produced with the same articulatory movement (a double tap), but differ in the place of articulation. The ASL sign MOTHER is articulated by tapping the extended thumb on the chin, while FATHER is articulated by tapping the extended thumb on the forehead. Stokoe thus demonstrated that signs, like words, are could be seen as compositional rather than holistic and analyzable (1960).

With these parallels drawn between signed and spoken language phonology, it is crucial to recognize that unlike spoken language, the clear majority of articulations produced in signed languages are fully visible to the naked eye. Signed languages are articulatorily transparent in the sense that the entire articulation can be seen without instrumental techniques (e.g. ultrasound or other imaging techniques). While a place of articulation change between bilabial and velar voiceless stops /p/ and /k/ has some visual saliency (pursed lips verses slightly open lips) place of articulation changes, such as the one discussed above in FATHER and MOTHER (articulated at the forehead and chin respectively), have a high degree of visual saliency. Similarly, because signs are articulated using multiple large articulators, including the head, torso, arms, and hands, the articulatory space employed by signers is much larger than the articulatory space of the vocal tract and take more time to articulate (Klima, Bellugi, Fischer & Newkirk 1979).

Whereas the tongue is the major active articulator for spoken language, the hands are the primary active articulators in signed languages. Unlike spoken languages, which have relatively clear divisions between active and passive articulators (e.g. the tongue moves to meet the alveolar ridge, but the alveolar ridge does

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[2] These three parameters exist alongside other minor parameters such as *palm-orientation*, the orientation of the palms relative to each other or relative to another articulatory part of the body and *non-manual markers*, including facial articulations of eye aperture, brow raise/furrow, lip/mouth movements, as the primary contrastive properties of signed languages.

not move), signed language articulators can be active or passive (e.g. the non-dominant hand can be articulated on, or can move as an active articulator). This introduces many more degrees of freedom to the phonetic description in signed languages, as the articulatory role that a given articulator plays is not always predictable.

In the same way that the tongue does most of the dynamic articulatory work for spoken language, signers' *dominant hand* (often though not always their preferred writing hand) is responsible for much of the dynamic articulatory movement. Though some signers are ambidextrous and distribute the articulatory load relatively equally between right and left hands, most signers exhibit some *hand dominance*. The dominant hand is the least restricted articulator and is free to take a wide variety of handshapes, movements, and contacts with different parts of the body. The *non-dominant hand* is generally more restricted in possible movements and handshapes. In addition, signs vary according to how many hands are required for their articulation. *One-handed signs* consist of a single (usually the dominant) hand only, while *two-handed signs* require both hands for articulation and vary in terms of whether the two hands are *symmetrical*, having the same handshape and motor routine articulated by both hands, or *asymmetrical*, each hand articulating a different handshape and movement. The terms *hand-configuration* or *handedness* are often used to refer to the relationship between the two hands with respect to one another within a given sign (Battison 1978).

Phonemes are considered meaningless building-blocks that combine to create meaningful units (Brentari 1998; Sandler 1986; Sandler & Lillo-Martin 2006); however, like in spoken languages, this dichotomy is often not cut and dried. For many signs in ASL, and indeed in other signed languages, the articulatory parameters seem to imbue some sense of meaning to the sign. This is especially apparent in so-called *classifier constructions*, also called polymorphemic verbs (Engberg-Pederson 1993) or polycomponential verbs (Schembri 2003), which are morphologically complex and very productive. Thus, classifier constructions, while still considered part of the core components of signed languages, are given a separate status and put in their own category of 'non-lexicalized signs'. The primary reasons for this dichotomy are that classifier constructions do not behave predictably in terms of prescribed phonological rules; and handshape (as well as movement and location) seems to function like morphemes in these constructions (Brentari & Padden 2001). Diachronically, these signs can become fully 'lexicalized' at which point handshape and the other parameters are said to function phonemically, no longer retaining their original compositional meaning (Frishberg 1975; Brentari 1998; Sandler & Lillo-Martin 2006). By labeling these handshapes as phonemic, signed linguists reject the idea that the form of the sign, in lexical signs, are meaningful.

2.3. Setting the Stage

Though morphology and phonology are intuitively pleasing separate categories for the linguist, and have functional diagnostic weight, Embodied Cognitive Phonology challenges the need for a strict categorical divide, following both Langacker (1987, 1991, 2001) and Bybee (2001, 2010). Structures of varying degrees of schematicity and specificity litter the field of linguistics, and while we may look to

phonological or morphological prototypes, much of the content of the languages of the world fall somewhere on the continuum between. If does not seem promising that after years of linguistic research and gallons of ink have been spilled in trying to defined and redefined units such as phoneme and morphemes, we seem no closer to an objective "truth" regarding these constructs. Basic assumptions such as "what is a word" or "what is a phoneme" still require special issues and workshops, to discuss the necessary and sufficient conditions of these categories.

Undoubtedly, the lack of cohesive definitions for these categories rests on the inherent gradience of language. As Bybee has stated, "we find variation and gradience commonplace in empirical studies, and we find phonological phenomena intimately bound up with lexicon and morphology, syntax, discourse, and social context" (2001: 2-3). On the morphemic side, 'defective morphs' such as -cep and -cieve, as in deception/deceive and conception/conceive, as well as the infamous cran-morphs as in *cranberry* or *cranapple juice*, fail the meaningfulness criteria of traditional morphemes. Bolinger has pointed out that even unrelated nucleus + coda strings, such as English -ob as seen in *blob, cob, gob, and nob* form a constellation or words that imply 'compactness' (1965). Likewise, phonaesthemes like sn- and gl- as in *sniff* and *glisten* are bigger than a segment and smaller than a 'morpheme', yet tend to cluster around meaningful associations.

At the phonemic level, recent work by Winter (2016) has shown that /r/ disproportionately represents 'rough' things in English. He argues one possibility for this disproportionate mapping is that historically, /r/ has been a trill, which has the properties of repetitive airflow obstruction over a relatively lengthy duration. He suggests "the repeated interruption of the airstream might be thought of as analogous to the gaps between the elements of a rough surface suggesting a cross-modal association with the articulatory features of the air-flow and the tactile concept of rough" (2016: 121). These types of meaningful mappings are not restricted to the phoneme level. They are also observed in systematic patterns at the feature level. Anderson (1990) found that English-speaking American children backed their vowels when imitating important men, while Hamano (1994, 1998) showed that palatalization in Japanese alveolars was correlated with being childlike and immature and by extension unreliable, uncoordinated, and noisy.

What these studies share is the finding that phoneme level, and even feature-level content, is able to encode meaning. Motivations can arise from embodied, cross-modal mappings where the articulation is construed as having properties that make it well suited to represent a construal of semantic content. In the case of /r/ the unevenness of the articulation makes it well suited to represent the unevenness of rough surfaces. In the case of Japanese alveolars, the construal that palatalized articulations are well suited to represent the lack of articulatory control exhibited by children, who have not yet learned to specify place of articulation, also arises from a type of embodied knowledge of language use. Likewise, in the backing and lowering of vowels in English-speaking children, to mimic authority figures, the association of lower and more backed vowels with bigger and more powerful adult males reveals a complex interplay of socio-cultural and articulatory-based knowledge that results in a motivated phonological mapping.

The idea that phonemes are meaningless, contrastive units is based in the Structuralist tradition, which valued arbitrariness and duality of patterning as central components of language. This tradition has been handed down and adopted in var-

ious manifestations by most, if not all, theoretical branches of linguistics. If we begin with the claim that phonemes are contrastive minimal units used as building-blocks, devoid of meaning, we tacitly accept several theoretical assumptions. Usage-based and cognitive linguists explicitly reject building-block notions of language in favor of the view that language emerges from user experience and that units of language are discovered through usage.

Regarding duality of patterning, Blevins (2012) has explicitly stated that natural language data seem to suggest, that like many linguistic universals, duality of patterning is but a statistical tendency and that duality need not be a central component of all grammars. She goes on to astutely observe that, "while meaningless segments are the norm, and clearly facilitate generative capacity, yielding, in particular, lexicons of unlimited size, a relatively large segment-inventory with relatively free phonotactics can yield similar generative capacity, even if segments are meaningful. There seems no reason, at present, to rule out grammars of this kind". Before gaining access to large data sets, which allow for large comparisons within and across languages, the Structuralist assumption that segments in the classic sense were meaningless went largely unquestioned. Blevins (2012) has suggested that the advent of probabilistic modeling and large data sets has now allowed for the testing of these assumptions. The result of these tests is that numerous publications have now shown the distributional tendencies of motivated submorphemic units at the level of syllable, segment, and feature (Hamano 1998; Hinton et al. 1994, Dingemanse 2011; Winter 2016).

Following other cognitive descriptions of linguistic phenomena such as grammar and lexicon, there exists a continuum from prototypically morphemic to prototypically phonemic content, and that many linguistic forms smaller than the word exist somewhere in the middle. That is, what makes a phoneme 'a phoneme' is very high degrees of abstraction over multiple usage-events, in which the gestural unit occurs in a wide array of phonotactic positions, across a wide variety of constructional types. This rapid accumulation of tokens across a variety of marginally related constructions contributes to the rapid schematization of meaning (Occhino 2016). Thus, as the form becomes schematized, meaning too, can pattern in clusters. What makes a morpheme 'a morpheme' is a comparatively restricted distribution of form and meaning across multiple usage events. Thus, as the form and meaning are extracted and stored, reinforcement of the overlap allows for a lower-level schema wherein a stronger bond is retained between meaning and form.

To better understand the interplay between schematization and specificity, let us now briefly review Langacker's notion of thing (1987). A prototypical noun like *cat* has a very specific phonological pole /kæt/ and a fairly specific semantic pole including aspects, i.e., the semantic frame (Fillmore 1982) of 'catness'. We know that *cat* is a noun and that nouns refer to things. In other words, we can recognize that there are schematic properties that we recognize belong to all nouns, and a semantic pole of thing-ness arises from usage-events which are manifested through the formal, gestural articulations which instantiate these nouns. In the same way that we can conceive of semantic properties shared across nouns, so too can we schematize the formal (articulatory) properties of 'things'.

Phonological schemas arise from language-specific distributional properties of phonetic segments which occur across the given distribution of thing. Thus, just as the semantic content across a large and diverse category can be schematized, we

schematize the form as well. This includes the distributional properties of where noun-like-things occur in phrases, but also the phonological properties of what all instances of thing entails. Hollmann (2013) has shown that when speakers are given nonce words whose forms are possible but not occurring words in English, they have a sense based on the form alone as to whether a given nonce word is a nouny-thing or a verby-thing. This intuition is possible only because speakers are sensitive to the distribution of formal properties. These symbolic units have become highly schematized at both the phonological and semantic pole, but this does not mean they do not exist in the mind of the language user. Within a cognitive framework, such highly schematic units are generally considered to be grammatical.

In the same way that we can conceive of a highly abstract formal schema across such a varied semantic category as 'noun,' so too, are we capable of conceiving of a highly schematic semantic schema, across a varied distribution of a given formal property. Like the high degree of schematicity for the formal pole of thing, the high degree of *semantic* schematicity for phonetic content occurs as the result of a high degree of variation in the distribution of a given form. For example, one of the things that English speakers "know" about /p^h/ is that, distributionally, it tends to occur syllable initially. Of course, this is not explicit, but rather implicit, knowledge of the language (Ellis 1994; 2002). An English speaker will also have knowledge of what meanings are associated with the words in which /p^h/ occurs. More importantly, we have associations across those contexts which relate to physical, articulatory, kinesthetic, audio-visual perceptual properties associated with /p^h/. Additionally, phoneme inventory size is limited by motor automation, which forces articulatory units, be they sounds or handshapes, to be repeatedly recycled across numerous lexical constructions. Consequently, because phonemic level content is used and reused across a wide array of form-meaning contexts (and with generally little impact of language-external motivations), it is possible for these mappings to schematize quickly, so much so that the semantic pole is no longer readily accessible (Occhino 2016).

I have argued that low-level, less variable form-meaning mappings make better morphemes, while high-level, many-to-one form-meaning mappings make better phonemes. Therefore, units that seem to function as morphemes do so simply because of a regularity of mapping between form and meaning which is comparatively restrained in terms of variability across forms and contexts, while units which function as phonemes are perceived as such because the form-meaning mappings are *not* restricted and, are therefore, not consistent across multiple instantiations. What follows in sections 3.0 and 4.0 is the brief summary of part of a larger study which focused on a number of both *static handshapes* (i.e., those that do not change during the articulation of the sign) and *dynamic handshapes* (i.e., those that do) ([Occhino 2016]). By focusing on the details of just one static handshape, I hope that the reader will gain an in-depth appreciation of the complexity and interconnected nature of these distributions.

The following examination of the distribution of the claw-5 handshape, across two signed languages, will show systematic motivated form-meaning mappings appear throughout the lexicon, not just within classifier constructions. I will show that when one compares individual phonemes within the entire system, not just in isolation within a single lexical item, the same types of distributional tendencies

found in spoken language phonology (Abelin 1999; Bergen 2004; Magnus 2001; Winter 2016) are seen in the phoneme inventory of ASL and Libras.

3. Method

3.1. The Claw-5 Handshape

The ASL handshape on which the following discussion centers on the claw-5 handshape. Articulated by making a 5-handshape, extending all fingers and thumb, and then flexing the metacarpal and phalangeal joints into a loosely held 'clawed handshape.' This handshape is considered a phoneme, and is listed as such, in the "lexicalized" portion of the ASL lexicon. The claw-5 handshape can be found in many signed languages of the world and is often considered
to be an allophone of the 5-handshape, which is articulated in a similar way but with fully extended fingers (no flexion). This handshape occurs widely in both ASL and Libras and as such provides an excellent opportunity to track the distribution of the handshape across languages.

The claw-5 handshape is considered to be part of the structure of the "native vocabulary" (Brentari & Padden 2001) which includes "core signs" and "classifier constructions". This division in the lexicon is made to separate the "foreign vocabulary" which includes handshapes which are primarily associated with the fingerspelling system. The native vocabulary part of the lexicon is further divided into "non-lexicalized" e.g., classifier constructions and a "lexicalized", signs. The claw-5 handshape occurs in both sub-parts of this native lexicon. However, in the classifier constructions, the handshape is given morphological status as a c*lassifier handshape,* a term used to denote handshapes which reference properties of the referent, including but not limited to groups of people, profiling object shapes, handling objects, etc. (Valli, Lucas and Mulrooney 2005). In the core portion of the native lexicon, i.e., in fully lexicalized signs, handshape is considered purely phonological i.e., arbitrary.[3]

3.2. ASL and Libras Data

ASL is the signed language used by the signing community in the US and non-Francophone parts of Canada. Libras, alternately referred to as Brazilian Signed Language, is used by large numbers of the signing community across Brazil. ASL and Libras are sister languages and share Old French Sign Language as a mother language, along with modern French Sign Language. Because not all handshapes occur in every signed language, comparing these two languages provided an op-

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[3] This claim is problematic in many ways, the least of which is that in a diachronic perspective of language, at what point does a given handshape "become" phonemic. Usage-based views of phonology of course recognize that constructional frequency plays a central role in language change, and that phonological changes are not monolithic events, but instead occur gradually as more frequent constructions lead the way, and less frequent constructions lag behind.

portunity to investigate the distribution of the same sets of handshapes across two historically related but mutually unintelligible signed languages. The comparison between handshapes in ASL and Libras was made possible by two existing data sets, coded for phonological properties of signs in each of the languages.

The Morford and MacFarlane Corpus of ASL is a small corpus of 4,111 signs, collected from videotaped conversations and narratives, ranging from formal to casual registers, produced by signers from across the United States (Morford & MacFarlane 2003). Importantly, this corpus is representative of real usage and was coded for all sign types used in the discourse context, including core lexical signs, which can be found in a dictionary of ASL, as well as classifier signs, deictics, fingerspelling, inflected numerical signs, and proper-name signs of places or individuals, which are often not included in dictionaries. The Libras database (Xavier 2006) is a lexical database of 2,274 signs compiled from the *Dicionário Enciclopédico Ilustrado Trilíngüe da língua de sinais Brasileira* (Capovilla & Raphael 2001) with extensive phonological coding using Liddell and Johnson's (1989a) coding system. While not a corpus in the usage-based sense, the detailed coding of these lexicalized Libras signs made for a more conservative estimate of the degree of sub-lexical patterns because the morphological properties of handshape associated with classifier constructions were not included in the data set. The Libras database contained 81 signs with static claw-5 handshape, while the ASL corpus contained 66 tokens, which were reduced to a type frequency in make the conversational data comparable to the dictionary type-count of the Libras database. This resulted in 37 unique types of the claw-5 handshape for ASL. Due to the low type-frequency data, the ASL corpus was supplemented by extracting all examples of the claw-5 signs from a dictionary of ASL lexical signs, which were not represented in the corpus (Tennant and Gluzsak-Brown 1998), which brought the sign-type total, to 73 ASL signs.

The initial research question was instigated by the claim that parameters, once in the lexicon, are phonologically organized, meaning their distribution and organization is governed by phonologically determined rules such as principles of well-formedness, and production constraints. If it is the case that the handshape parameter in the core lexicon is meaningless, and the distribution of handshape is dictated by proposed phonological principles, then one should not expect to find form-meaning patterns based on identifiable properties of the handshape. If, however, form-meaning patterns are found, then we cannot reject the hypothesis that phonological content in ASL and Libras might have distributional skewing related to robust form-meaning mappings.

The claw-5 handshape tokens were coded for their distributional properties, frequency in the database, and frequency relative to other handshapes. Tokens were then coded by the ASL and Libras consultants as to whether the handshape parameter contributed to the meaning of the sign. Signers were asked, "Does the handshape contribute any meaning to the sign?" If signs were coded as "yes" these signs were then compiled for further coding for type of semantic information contributed by the handshape. Surprisingly, only five signs were coded as either *not* having semantic contribution from the handshape, or there was no clear consensus which emerged as to the possible mappings associated with the sign. For the remaining 68 signs, labeling of the semantic contribution of the handshape was an open-ended task. Consultants were not given pre-determined labels. Therefore, the

second round of coding contained open-ended, often phrasal descriptions of the meaning an individual handshape was contributing to a given sign. Signs were categorized by the author based on similarities across the 'semantic labels' assigned by the consultants. For example, when coding the semantic contribution of the claw-5 handshape in the sign AUDIENCE (Figure 1), descriptions included phrases such as "the fingers represent people in a row," or "individual chairs," or "rows of chairs," while description of the same handshape in the sign RAIN included "individual raindrops," and "streaks of rain".

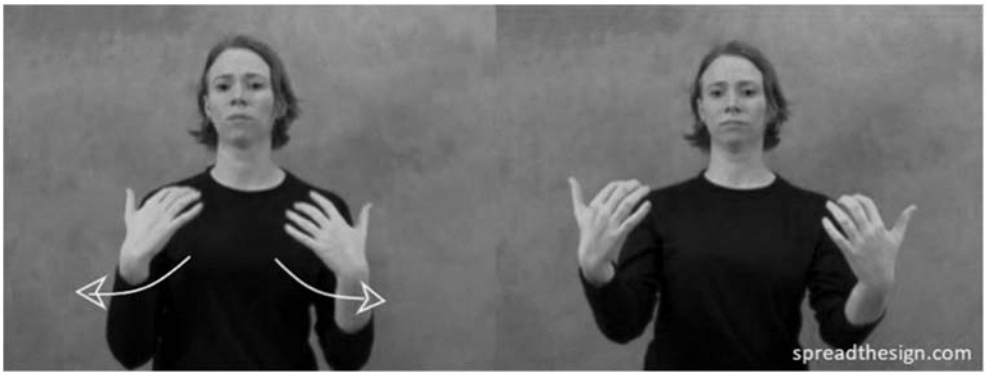

Figure 1. ASL: Audience

4. Analysis

Once the groupings of semantic categories emerged, organization of these groupings was completed following *basic-level categorization* (Rosch 1978) including factors related to gestalt perception, motor activation, mental images, and cultural importance, noting that "basic level objects constitute the center of such schemas while radial categories arise from conceptual metonymies, image schema transformations and conventional mental images" (1990: 110). In exploring these synchronic relationships and considering the basic and peripheral members of these schemas, the role of both individual members of categories as well as the roles of all category members was central to organization. As Geeraerts has pointed out in his analysis of the Dutch verb *kruipen* 'to crawl', the historical sense of 'to go by means of hands and knees' took on a manner related meaning, 'to go slowly.' That later extension, can be seen as directly related to a new 'central meaning' of slow (Geeraerts 1997).

Geeraerts advocates for keeping both synchronic organization and diachronic change in mind when thinking about the knowledge of systematic schematization in the minds of language users. As can be seen below, several basic level schemas are extended through metonymic and metaphorical means to strong sub-groupings of form-meaning mappings, pulling some forms closer together in conceptual space than others, despite the surface appearance that they might be related—or unrelated—due to a mere overlap in handshape.

Analysis of the semantic labels for the claw-5 handshape revealed patterns consistent with at least six schematic form-meaning mappings. Each of these six identified mappings are outlined below, detailing the profiled formal component, as well as the profiled semantic component. These mappings represent separate, unrelated construals of formal properties, though each mapping has several semantic extensions unique to that construal.

1) Curved Palm = Concave: the palm of the hand is profiled as a concave surface (or similarly, the curved back of hand profiles a convex surface).

2) Fingers = Unitary elements of a whole and/or Straightness: the fingers of the hand are profiled as straight elements which belong to a larger grouping.

3) Gaps between fingers = Non-compact matter: the gaps between the fingers are profiled as not solid, loosely assembled, or fluffy matter or not wholly contained matter.

4) Hand = Hand: in which the entire hand is profiled as a hand, either human or primate.

5) Fingertips = Feeling: the tips of the fingers are metaphorically extended to mean, touching is feeling, where feeling refers to emotional states.

6) Gaps + Fingers = Gap-fit: the fingers interlock, profiling interlocking components of objects, such as gears, and by extension tight fit of adjoined objects.

One of the most interesting findings from the analysis of the claw-5 handshape is that schematic meaning associations are each profiled by different phonetic properties of the handshape. Thus, it seems that no two mappings of the claw-5 handshape arise from the profiling of the same formal properties; instead, individual features of the handshape are exploited to create different schematic form-meaning mappings. Sub-schemas do emerge via metonymic and metaphoric extension, but the basic level construals arise from independent form-meaning profiling. In both Libras and ASL, the claw-5 handshape is construed as a many-to-one mapping of a single handshape to multiple schematic meanings. Likewise, participating in one construal does not preclude a handshape from participating in other construals with overlapping properties. For ease of discussion, I will briefly outline each mapping in turn in the following sections; however, the six mappings are shown together below (figure 2 a-f).

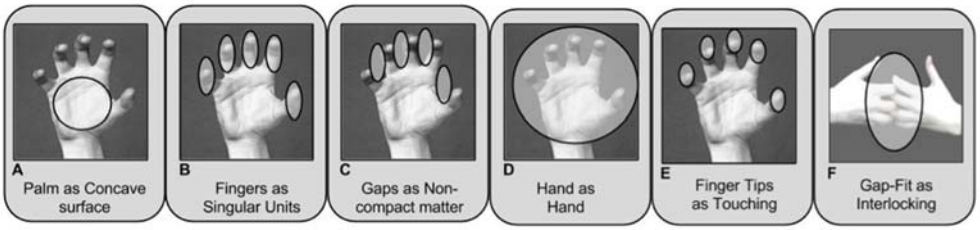

Figure 2 a-f. Six form-meaning schemas of the claw-5 handshape identified in ASL and Libras: Left to Right (2a) Palm as Concave Surface; (2b) Fingers as Singular Units; (2c) Gaps as Non-Compact Matter; (2d) Hand as Hand; (2e) Finger Tips as Touching; and (2f) Gap-Fit as Interlocking.

4.1. The Convex-Concave Schema

Beginning with the concave/convex schema (Figure 2a), which can also be seen as part of the larger handshape as object-shape schema, in which the curvature of the palm of the hand, is the profiled formal feature of the claw-5 handshape. This mapping can be construed as profiling a concave surface, or the negative space contained within the area contained under the surface of the palm. This mapping is based on several of the basic-level organization factors identified by Rosch, including the mental image of such a shape, the motor interactions with curved objects, and even the cultural importance of such objects (bowls or balls). Twelve signs from the ASL data participated in this mapping, including BALL, in which two claw-5 handshapes come together at the fingertips and lightly touch twice, profiling the shape of a ball. SHOCK is also included in this mapping, in which two claw-5 handshapes seem to fall from the location in front of the eyes, bouncing twice, profiling 'eye-balls falling out of one's head' a sign indicating disbelief. Fourteen Libras signs were identified as having this primary mapping, including the signs ALFACE 'head of lettuce' which profiles the round shape of the lettuce and CACHORRO 'dog' which is articulated on the face and profiles the shape of a dog's muzzle (Figure 3).

Figure 3. CONCAVE/CONVEX SCHEMA Libras: CACHORRO 'dog'

4.2. The Unitary-Elements of a Whole Schema

The second form-meaning pattern identified for handshape claw-5 is the unitary elements of a whole schema (Figure 2b). The formal profile in this mapping is two-fold: first, the fingers are individual units which are part of the hand which is itself a whole. Second, the fingers are extended to indicate the extent or linear individuated nature of the entities involved. The semantic profile is multiple individuated elements belonging to a larger grouping, i.e., parts of a whole. In ASL, the signs COMB and SPIDER easily sanction this mapping, where the teeth of the comb and the legs of the spider are construed as individuated parts of a whole. In a more abstract extension of this mapping, we find signs such as ASL RAIN and Libras CHUVA in which individual drops of rain can be construed as part of the event of 'raining.' In the ASL signs RAIN (Figure 4a) and TIGER (Figure 4b), the unitary elements of a whole schema work together with the path movement, as both the straightness of extended fingers but also the straightness and extent of the virtual lines created by the trace of the path movement add to the profiling of streaks or stripes.

Figure 4a. Unitary elements of a whole schema ASL: RAIN

Figure 4b. Unitary elements of a whole schema ASL: TIGER

4.3. The Non-Compact Matter Schema

The third, called the non-compact matter schema (Figure 2c), formally profiles the gaps between the fingers which are then mapped to the construal of 'not wholly contained' or 'not-solid matter' in the sense that the matter is porous or not easily contained within the hand. Both ASL and Libras exhibited evidence of this basic mapping in signs such as CLOUDS and MIX, and ESPUMA 'foam' and TEMPO/CLIMA 'weather'. Other examples include VOMITO 'vomit' and FUMAÇA 'smoke' or 'fumes' in Libras, and ASL LION which profiles the fluffy mane of male lions (Figure 5).

Figure 5. Non-Compact Matter Schema ASL: LION

4.4. The Hand as Hand Schema

The fourth schematic mapping identified for the claw-5 handshape is the hand as hand schema (Figure 2d). This basic schema consists of several sub-schemas which cluster around 'hands performing actions'. In the first case, fingers of the claw-5 wiggle, representing how they would interact with an object in which pressing with individuated fingers is necessary as in the signs TYPE (Figure 6) and DIGITAR, and in the sign PIANO in both ASL and Libras. The construal of hands as instrumental tools, which type on a keyboard, or press on the keys of a piano are metonymically extended where action or motor movement represents object or state (P. Wilcox 2000; Wilcox and Wilcox 2013).

Figure 6. Hand as Hand Schema ASL: TYPE

In another hand as hand sub-schema, the hands articulate a gestural motor routine in which the fingers are stationary, and the static claw-5 profiles grasping of round object such as a doorknob, or a lightbulb. The hand as hand schema thus participates in the sub-schema of hand as handling schema (and is obviously not unrelated to the convex-concave schema discussed in 4.1). Those handshapes, which participate in handling constructions, profile the way in which humans interact with objects, such as how we hold a broom (profiled formally with the S-handshape (closed fist handshape) or the F-handshape (the 'OK gesture' in American English) which profiles how small things are picked up and handled. The hand as handling sub-schema, of the hand as hand schema, is most frequently instantiated by way of metonymic extension and can be seen in the corpus data in the ASL sign CHANNEL which profiles the hand turning a knob, and in ESPREMER 'juice an orange' in Libras. This basic mapping can also be extended to profile the hands of other primates, as in the case of Libras MACACO and ASL MONKEY, and in one classifier construction from the ASL corpus, even the hands of a monster in a stance with hands raised as claws.

Now that we have reviewed the unitary elements schema and the hand as hand schema, we can raise the subject of constructions that can participate in multiple schemas due to overlap in mapping profiles. For example, the ASL sign SALAD was construed by some participants as having dual mappings and was dually identified as representing 'hands tossing a salad' or 'salad-tongs' thus sanctioning simultaneously the hand as hand schema but also the unitary elements schema (Figure 7).

Figure 7. ASL: SALAD, with overlapping unitary elements schema and hand as hand schema

Because construal is rooted in individual experience, it is possible that only one of the mappings be present for a given language user; however, it is also possible, as in these instances, that the user can be aware of both competing construals, reinforcing the mappings: 'fingers of hands' and 'tines on salad servers'.

4.5. The Touch Schema

The touch schema (Figure 2e) was first identified by a Libras consultant who suggested that sometimes the fingertips of the hand might be related to touching, unveiling a possible sub-mapping of the hand-as-hand schema. I have included it as a sixth mapping, rather than as a sub-schema of the hand-as-hand schema because the formal property profiled in the hand-as-hand schema is the entire hand, while

the formal profile of the touch schema is just the fingertips. In Libras, the fingertips of the claw-5 handshape can profile the metaphorical extension of feeling is touching. Most evidently, this mapping occurs in signs such as JEITO, which can be translated as 'his/her way of being' and ANGUSTIAR 'distress' (Figure 8a). A similar semantic extension was also present in ASL but was much less productive and seemed to be restricted to a few negative emotions such as ANGER (Figure 8b), DISGUST, MAD/CRABBY and the verb COMPLAIN.

Figure 8a. TOUCH SCHEMA Libras: ANGUSTIAR 'distress'

Figure 8b. TOUCH SCHEMA Libras: ASL: ANGER

Fingertips, as the most sensitive part of the hand, are especially emblematic in signaling touching as the act of feeling things, physically. This physical reality then is extended metaphorically, as it does in English in phrases like, 'I'm touched' to mean feeling things, emotionally or mentally. This trajectory from physical to emotional and mental extension is a common extension pattern cross-linguistically.

ANGUSTIAR 'distress' (Figure 8a) could also easily be argued to be participating in second metaphorical mapping feelings are objects in which the 5-handshape could represent an object moving inside the body, i.e., the negative feeling is moving around in the chest. In turn, it would be a simple mental operation to relate feelings are objects to the mind-as-body metaphor (Sweetser 1992), which has been described in ASL (P. Wilcox 2000) and Catalan Sign Language (Wilcox & Jarque 2003; Jarque 2005).[4] In this way, it is possible that two mappings are inter-

[4] I would like to thank an anonymous reviewer for pointing out this potential overlap between the proposed mapping and different metaphorical mapping, that was not considered in the original analysis.

acting and reinforcing one another in that fingertips are feeling does not conflict with more schematic object-shape schema as instantiated by the concave/convex schema. The subjective nature of individual construal of any given construction forces the theorist to recognize that these mappings are not absolute, they are not objective, and they are not static. Form-meaning mappings are subjectively construed in the minds of language users, and as such are subject to the social, linguistic, and cultural experiences.

4.6. The Interlocking Schema

The final mapping, is the only two-handed claw-5 mapping, which I call the Interlocking schema (Figure 2f), profiles the interlocking capability of the claw-5 handshape in two-handed signs, and maps the interlocking fingers to schematic properties of objects which exhibit similar interconnected characteristics. By necessity, these signs are all two handed because the construal requires joining of two entities in a tight coupling. Through metonymy, this construal can be extended to represent the whole of a machine, not just the gears, or interlocked parts, as seen in the ASL signs MACHINE or ENGINE (Figure 9). In signs, such as MATCH, the two hands begin apart, and the path movement of the sign brings hands into alignment, ending with the interlocking of fingers. In the antonym, MISMATCH or UNMATCHED begins with the fingers interlocked, and a path movement moves the hands apart from each other, ending with the dominant hand moving down away from the non-dominant hand. In this second form, the separation of the hands is essentially 'breaking the connection' representing an object or idea coming out of alignment. Interestingly, the Libras database did not contain any tokens of the gap-fit schema.

Figure 9. TOUCH SCHEMA. ASL: MACHINE

5. Discussion

5.1. Many-to-one Mappings

The data and analysis provided here reveal patterns in the distribution of the claw-5 handshape in ASL and Libras that suggest that handshape partici-

pates in systematic mappings between form and meaning. Clearly, the claw-5 mappings discussed are not simply one-to-one 'morphemic' mappings. Likewise, they are not simply homophones, in the sense that one morph, has many unrelated meanings, e.g. *seal*/*seal* in English. In any of the given examples, the handshape claw-5 does not 'mean' 'feeling', 'convexness', or any of the other identified patterns. These *many-to-one mappings* only 'mean' when they occur in specific, lexical level constructions.

I have also shown that these many-to-one mappings often profile different construals of the formal properties of a handshape, which in turn map to language-external construals. These form-meaning pairings do not always map to concrete, visible properties, which are objectively observed by the user. Due to the nature of construal, form-meaning mappings make use of a range of semiotic resources, from the socially constructed to the physically grounded, across a range of concrete, metonymic, metaphorical domains. Through repetition of individual instantiations of these signs, schematic similarities emerge across constructions, begin to cluster into sub-schemas, and eventually become more and more abstract with broader generalizations across a wider array of constructional events. This abstraction process is at the heart of understanding a usage-based approach to both the emergence of such mappings. If meaning had no role in the formation and organization formal units, then we would not expect to find the robust form-meaning patterns discovered in the distribution of claw-5 handshape seen here.[5]

A final thought regarding the claw-5 data is that the description of these form-meaning mappings are descriptions of tendencies and robust patterns, but I do not suggest that every sign can be accounted for through this analysis. It is important to keep in mind the role that articulation plays in the development and maintenance of the system. Of course, entrenchment of motor schemas and entrainment of motoric constituents exerts pressure on the formal parameters; however, these do not operate in a vacuum. Clearly, there are several cases where other pressures on the linguistic system 'beat out' the pull of language-internal or language-external form-meaning mappings. This emancipation is not only normal but is the source of new schemas and contributes to phonogenesis (Hopper 1994). Loss of motivation, whether internal or external, is influenced by several factors including: frequency of occurrence in a given collocation, productivity of the pattern, cultural connotations/contemporary relevancy, number of competing mappings, and strength of phonological competitors.

5.2. Language-internal versus Language-external mappings

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[5] I want to caution the reader against interpreting these mapping as simply 'iconic'. This word, while used widely in the literature "iconicity" is frequently used without consistency, and often conflated with transparency. It is easy for one to see visual features and claim 'iconicity' without a deep understanding of the types, sources, or the dynamic relationship between arbitrariness and systematicity that influence motivations in language as a whole.

Though on the surface the analysis seen in section 4 shows many transparent iconic mappings, externally motivated form-meaning symbolism is not the only type of construal which operates within the semantic pole of phonemes. The 'content of the semantic pole of phonemes has origins in two sources, language-internal and language-external motivations. Language-external associations arise from the construal of articulations as they relate to construals of the objects or events in our experiential world, while language-internal mappings arise, or more specifically are strengthened, by perceived similarities between form *and* meaning and between symbolic units within a language. For signed languages, imagistic mappings from sensory-motor routines such as the ASL signs to DRINK or to SMOKE (which look like someone holding a cup to their mouth or holding a cigarette to their mouth between their index and middle fingers) are often considered to be prototypical types of iconicity, in the same way that onomatopoeia such as *buzz* or *meow* are often cited as the prototype of externally motivated iconicity for spoken language.

Though both spoken and signed languages have examples of imagistic kinds of iconicity, like spoken languages, it seems that signed languages make much greater use of these indirect representations, though the visual nature of the modality makes these diagrammatic types of iconicity feel more tangible, or more direct. As Haiman (1980, 1983, 1985) has shown, diagrammatic iconicity often *also* reflects externally motivated states, such as temporal organization of events being represented in a linear representation of clauses. In other words, both imagistic and diagrammatic iconicity can be externally motivated. Likewise, reduplication often iconically signals 'more of something' for both signed and spoken languages be it intensity, number, or repetition of an action. In other words, both imagistic and diagrammatic iconicity can be externally motivated.

Language-external mappings may be grounded in 'concrete' visual or auditory 'one-to-one' mappings within a domain, or they can be based in metonymic, and metaphorical representations (Mandel 1977) and not restricted to transparent one-to-one mappings. A language can use reduplication to signal plurality, while also using repetition of form to signal continuous aspect. In the case of Bikol, a Philippine language, there are five types of productive reduplication, which range in form from partial reduplication to full reduplication. The full reduplication form has a high degree of polysemy, that is, this formal pattern is used for plurality, imitation, attenuation, diminution and more (Mattes 2014: 43). Clearly, this formal repetition serves many purposes of mapping one form to multiple language-external construals of meaning. The status of these reduplication patterns as phonological or morphemic is orthogonal to the point that, like with the claw-5 handshape, we can see a formal pattern in the language that can be used productively across many constructions to convey different motivated mappings, without detriment to the creativity or intelligibility of the language. Importantly, it is not the "real-world" but the construal of the world, which mediates language-external mappings.

Language-internal associations sometimes referred to as *analogy*; arise from connections made between linguistic forms which share similar form, and similar meaning. Language users can use fine-grained statistical information to create expectations about which types of words frequently appear in which type of construction, forming potential prototypes for these dynamic categories (Goldberg 2006;

Ibbotson & Tomasello 2009). These schemas allow humans to make predictions about the function or meaning of novel utterances so that when we experience a new utterance we can analogize on previously experienced forms to discern the function of that new form. While this encompasses traditional morphological associations, which are etymologically related, it also includes construals of language-internal associations, which are only relevant in the mind of an individual speaker. Research has shown that analogy and distributional analysis are central to the formation of abstract schemas or schematic slots within constructions (Tomasello 2003). These mappings can occur at any 'level' of language structure, from the subphonemic to the prosodic, to the clausal level and everything in between.

In ASL, for example, though handshape is considered phonological in the core lexicon, not all handshapes behave the same. Some handshapes seem to be more or less meaningful when compared to other handshapes. The E-handshape, for example, overwhelmingly occurs in signs which map the form to initializations of English translation equivalents, such as in the signs EMERGENCY or ECONOMY. This means that for signers, there is a reinforcement between the occurrences of the articulation of the handshape-E and the mapping to English orthographic 'E'. Contrast this with, for example, the handshape Claw-5 which as we have already seen, has minimally a six-to-one mapping, with many sub-mappings contained within the primary schemas. In signs with a Claw-5 handshape, the distribution of form-meaning mappings is more variable, and therefore does not benefit from the same type of reinforcement of low-level schemas. The Claw-5 therefore feels less restricted and more 'phonemic' due to the multitude of constructional types in which it occurs.

For spoken languages, while we tend to think of morphemes as sequences of sound, individual phonemes can also have morphological properties. For example, in English, the phoneme /ɑɪ/ is one of the most frequent sounds in the language; however, 40% of its occurrences result from a single form-meaning mapping, that of the first-person singular *I* (Mines, Hanson & Shoup 1978). Thus 40% of our exemplars for the phoneme /ɑɪ/ result from a singular morphemic mapping. Notice, this is not to say that the phoneme /ɑɪ/ means *I,* nor does this mean that every instance of /ɑɪ/ references the morpheme *I.* Nevertheless, we can contrast this with, for example, /p/ which while also one of the most frequent sounds in English, but has a distribution across many variable lexical and morphemic constituents. As such, /p/ does not benefit from consistent low-level instantiation of a morphemic schema in the same way that the phoneme /ɑɪ/ might. However, there is still evidence of schematic form-meaning mappings, even in these /p/ type 'true phonemes'.[6]

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[6] More than fifty years ago, Bolinger (1965) had already identified this phenomenon of language-internal form-meaning 'pull'. Applying the label "morphosemantic constellations" Bolinger showed in the context of two or more forms in which the forms, "coincidentally resemble one another in both form and meaning," that the overlap results in the two forms, "drawing closer together and pulling other forms into their orbit" (1965: 59). Bolinger gives examples from English, suggesting that the phonological overlap of *bulge* with *divulge* and *indulge* has acquired a sense of 'expansiveness' where there historically was none.

It could be claimed of course, in a traditional Structuralist analysis, that language-external mappings and language-internal mappings represent a classic dichotomy in linguistics in which Structuralist-like relationships between forms behave differently or independently from factors related to extra-linguistic content (experiential, cognitive, physiological). In such a view, language-internal relations might be argued to be *disembodied* depending only on relationships between structure. Language-external relationships, in such a view, could be excused are peripheral to the linguistic system and therefore *not* linguistic. Indeed, many have treated such distinctions in similar ways. However, *analogy*, as a basic cognitive process, is implicated in both of these sources of linguistic motivation. Analogization is a general cognitive process, the ability or tendency of humans to perceive relationships between one source (an analog), and another source (the target). Within cognitive approaches to psychology and language, analogical thinking applies to a broad range of concepts, largely analogous to conceptual metaphor (Lakoff & Johnson 1989), conceptual blending (Fauconnier 1997; Fauconnier & Turner 2003) and structure mapping theory (Gentner 1983). Analogy is at the center of both language-internal and language-external meaning mappings, as any perceived similarity between construals of form and construals of meaning, regardless of the source, are eligible to be utilized as the basis of making meaning-form connections.

Finally, language-internal motivations interact with language-external patterns. Signers and speakers are likely not to have a strict division between word forms perceived as internally or externally motivated. Internally motivated forms can be construed as having language-external motivation, even when the historical, etymological evidence does not corroborate such intuitions. This is where the role of folk etymology can sometimes become more important than the actual case of diachronic facts, since these are often beyond the realm of speaker knowledge. Likewise, externally motivated constructions can be overridden by language-internal patterning. Thus, rather than being mutually exclusive categories of motivation, language-internal and language-external patterns interact in intimate ways. Unsurprisingly, both language-internal and language-external meanings only arise from the schematization of usage-events. In one instance, language-internal patterning arises from regular form-meaning mappings across linguistic units, in which they imbue the semantic pole of the recurring phonological form with schematized shades of meaning. On the other hand, language-external patterning can arise from regular form-meaning mappings between the construal of the formal properties of articulations and the construal of events or things in the world. These states of motivation are dynamic, and depend on the individual language user and their construal of both form and meaning. While cultural and anthropocentric patterns of similarity may arise, it would be a mistake to assume that there is an objective nature to labeling motivation.

5.3. An Embodied Cognitive Phonology

Allowing for aspects of the phonological system to be grounded in language use and embodied experience does not imply that 'everything is motivated'. This is the most common question people ask upon first encountering Embodied Cognitive Phonology. The fact that 'phonemes' *can* and *do* have motivated and even embodied semantic poles does not preclude 'phonemes' from becoming so highly sche-

matized that these units may seem arbitrary. In the same sense, the model does not preclude 'phonemes' from having semblances of lower level semantic schemas, which according to a traditional model might be labeled as 'morphemic'. The difference between phonemes and morphemes in the model proposed here is a simple matter of degree of abstraction, much like the difference between grammar and the lexicon. What this model considers, that previous phonological models have not, is the role of the body in the making of meaning. In a usage-based approach, we accept that part of what we 'know' about form, regarding its use, including distributional characteristics, collocational frequencies, relative frequencies, and sociolinguistic factors related to use.

In an embodied usage-based model, in addition to these basic usage characteristics, we must also pay attention to production and perception of form itself. Part of what we know about form, includes the proprioceptive characteristics of that form as we produce it, and the audio-visual characteristics of that form as we perceive it. Though articulations and their processing are automated routines, just as we can stop and think about how to 'tie a shoe', or 'play a scale', we have the ability to make procedural knowledge explicit. This gives us the ability to construe articulations, and articulators. It is in this construal that we find answers to questions regarding mappings such as those we saw in the claw-5 handshape data from ASL and Libras. In each of these cases, a feature of the articulator itself was construed as having properties that made it amenable to participation in a constructional mapping, which characterized a semantic construal of said features.

In spoken language, this is also a source of much of the cross-modal (i.e. non-sound based) sound symbolism. The articulation of rhotics includes turbulent intermittent airflow, and thus 'r' can be construed as analogous to 'roughness', meanwhile the articulation of /l/, by contrast, has a metered lateral flow, and lends its articulatory features to construals of 'smoothness' (Winter 2016). In a recent branding study, Abel and Glinert (2008) found that cancer drug manufacturers use a statistically higher concentration of voiceless consonants (associated with smallness, fastness, and lightness by consumers) compared to a regular distribution of a standard American English example. The short buildup of pressure and quickness of the air release in voiceless stops, allows for the construal of quickness, lack of invasiveness, and effectiveness in /p/ /t/ /k/ (Abel & Glinert 2008). Abelin (2015) found similar tendencies across marketing cases for multiple brands in Sweden, but found that fl- clusters, which evoke a sense of speed in Swedish, are also most statistically frequent in medicinal brand names than in standard Swedish. Poets, lyricists, and marketing experts at using these highly schematic sound-meaning associations in phonemes to activate relationships between the sounds and intended meanings. That language users can manipulate, and be manipulated by these mappings makes it clear that these mappings are real, tangible, and not uncommon.

However, because it is very hard to answer the question, "what does the /p/ in *pop* or in the drugs *Procrit* or *Paraplatin* lend to the overall meaning of the word?", spoken language researchers have not generally had to deal with questions regarding motivation at the phonological level. By beginning with signed languages, and expanding our analysis to spoken language (the opposite of the typical direction of linguistic theory building), we gain keen insight into the nature of schematization and emergence of structure, which is obfuscated by the opaqueness of the articulatory mechanism of spoken languages. Thus, exploring the phonolog-

ical pole, without predetermined assumptions about its arbitrary nature, or detachment from meaning, frees us from seriously considering the predictions made by usage-based, emergent approaches to language. Both form and meaning can be abstracted to varying degrees of schematicity and specificity, and in the same way that we can find highly schematic phonological poles, we can also find highly schematic semantic poles.

Fortunately, the long tradition of accepting the separation between meaning-building and meaning-making units of language seems to be fading. Through a usage-based approach, we can begin to understand the nature of phonology as emergent and dynamic (Beckner et al. 2009; Elman 1995; Thelen & Smith 1996). What Embodied Cognitive Phonology adds to well-established frameworks is the inclusion of phonemes in the same echelon as other symbolic units, schematized from usage-events. This model views phonetic content in the same vein as all other usage-events. Usage is usage, articulation is articulation. Linguistic units of all sizes are extracted from the contextually relevant, semantically rich environment. All linguistic form must be discovered from usage-events. When a usage-event occurs, it occurs in a context, and that utterance is a pairing of form and meaning. From this event, we store both predictable, redundant information and unpredictable, contrastive material. This formal representation is tagged for the contextual, pragmatic, semantic, and inferred meaning. Just as a sentential-level construction such as a ditransitive construction arises from schematization across multiple instances of the usage of that form paired with that meaning, uttered in a specific context, so too phonemes, and even feature level patterns arise from the discovery of pieces of larger constructions, which co-occur in specific contexts with specific meanings.

It seems clear that when considering the general cognitive mechanisms at work in usage-based approaches, phonological content should be treated as any other 'level' of linguistic complexity. In addition, if we are clear by what we mean when we discuss conventionalization and meaning, and we are inclusive in our understanding of encyclopedic knowledge, as Fillmore (1982) and others have challenged us to be, then we gain an immense degree of explanatory power in regards to what we might consider phonetic meaning. Experiences that we derive from the world, via the bodies into which we are born, have a marked effect on how we categorize the world.

Regularities in motivated form-meaning mappings, within individual grammars and across languages, reflect our embodied experience with the world. However, it is important to realize that individual grammars imply individual motivations. Though we might share social, cultural, linguistics, and physical experience, what is motivated for one might not be motivated for another. Frequency of exposure, prototype effects, cultural saliency, education levels, multi-lingual environments and perhaps even personality traits, have the possibility to influence the emergence of such schemas. Construal after all occurs in the mind of the construer.

Embodiment is situated cognition; situated cognition implies cognition *in* and *of* the body. A commonly held misconception is that signed languages are *more* embodied than spoken languages because they *use the body* to create the language. While it is true that there may be a greater number of functional motor routines, which can be readily co-opted by signed languages such as 'brushing-ones-teeth', this does not imply that signed languages are *more* embodied. Recognizing that

language is embodied means that we must account for the role of our existence, in these human bodies which locomote through a 3-D world, plays in the emergence, organization, processing of language. Mental simulation studies reveal that spoken language users engage areas of the brain responsible for physical motor routines (without producing the physical action) (Glenberg & Kaschak 2002), and vision (Kosslyn, Ganis & Thompson 2001) when engaging in linguistic tasks. Winter and Bergen (2012) have shown that linguistic processing which references what something sounds like engages perceptual representations of what those relevant objects/events sound like. Work on simulation clearly shows that vision, motor routines, audition, and proprioception are all at work in dynamic construction of meaning. Language is embodied for all language users, but the bodies we have affect our perceptions and interactions with the world and thus impact, most broadly, categorization of events and experiences, and more specifically the categorization of what constitutes linguistic content.

Embodied cognitive perspectives, which takes the interactional importance of humans and their environment into account, can lead to more direct comparisons across modalities. Once production is seen as *gestural articulations* produced by the body, regardless of the part of the body producing them, and perception is realized as a multi-modal incorporation of visual, auditory, tactile, and kinesthetic sensory information, then the links between signed and spoken language will become clearer.

6. Conclusion

The data presented here has shown that distribution of handshape in ASL and Libras exhibits patterned, motivated form-meaning mappings, which cluster around schematic semantic categories. The clear emergence of six schematic semantic categories related to the claw-5 handshape offers a first look at the ways in which sub-morphemic organization in signed languages might be influenced by associations between the form and meaning. The six form-meaning mappings: convex-concave, Unitary-elements, non-compact matter, hand-as-hand, touch, and interlocking, were found to be are motivated by perceived attributes of the articulatory properties of the handshape itself.

To better understand the origins and maintenance of such mappings, I have argued for an Embodied Cognitive Phonology which incorporates the role of embodied cognition into the emergence and categorization of phonological content. As it is the case that usage-events are both produced and perceived via the body, the emergence, schematization, and categorization of phonological content is directly influenced by sensory, motor, and cognitive systems. Bodily movements and interactions with the environment contribute to the ways in which humans perceive and interpret linguistic information.

I have argued that such a model is a general outgrowth of adherence to usage-based, cognitive approaches to phonology, which consider phonology on par with other emergent, dynamic, and gradient features of language. As such, phonology is subject to the same pressures as other parts of the linguistic system. It is unsurprising, given such a view, that phonological level phenomena, e.g., syllables, segments, and features, may in some cases become schematized alongside

meaningful content, across usage-events. Multi-modal usage-events provide rich contextualized medium from which forms are extracted. These forms are compared and contrasted with other usage-events, and evaluated on shared form and meaning overlaps.

I have suggested here that semantic material that is associated with phonological content becomes attenuated due to the high degree of repeated use, across a large variety of constructions. These associations can become so highly attenuated, that they seem to become completely arbitrary. However, this is but one possible outcome of the schematization process. Lower-level schematizations of form-meaning relations can persist if the regularity of occurrence of the form-meaning mappings is consistent enough to warrant the maintenance of the mapping. In these cases, content such as phonaesthemes, syllables, individual phonemes, and features can maintain such associations. As morphemes can be a single segment, or even a feature, the distinction between classical categories of phoneme and morpheme seems to rest on the differences in the degree to which the form-meaning mapping is schematized, and the number of constructions in which the form-meaning mapping occurs.

I have also suggested that motivations in phonological mappings can be sourced to language-internal or language-external associations. These motivation sources are not mutually exclusive and form-meaning mappings can be simultaneously motivated by both. Over time, language-internal motivation may overtake language-external motivations. Language-internal motivations can also be lost due to language change or loss of cultural or social connection with a given mapping. Motivations can also gain new language-internal or language-external mappings based on perceived associations which are not in themselves based on historically accurate accounts, but on new and dynamic connections built by the user.

While this is a preliminary report on one aspect of a larger investigation of handshape distribution, the findings suggest that signed languages, like spoken languages, have probabilistic patterning within the distribution of phonological content which reflects clusters of form-meaning mappings. Future investigations into questions of phonological distribution will be aided by newly available signed language corpora which are becoming available to researchers across the world. Once large corpora are reliably coded for phonological and semantic mappings, larger scale analyses will shed more light on these complicated issues of sub-lexical motivation and systematic patterning in phonological distribution.

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