Introduction:
Phonetics, Phonology, Iconicity and Innateness[1]

1. Overview

This book is the result of the SignTyp conference at the University of Connecticut in 2008, which was made possible through a grant to us from the National Science Foundation. SignTyp brought together an international group of researchers primarily, though not exclusively, interested in the phonetics and phonology of sign languages. While most of the chapters are based on their presentations at SignTyp1, they have been anonymously reviewed and substantially rewritten for this volume.

The book, like the conference, shows certain interesting trends in the field. The stronger role for iconicity in signed languages as opposed to spoken languages is acknowledged, and iconicity is seen as an explanatory force as opposed to something that has to be explained away. Compared to the early days of the field, when ASL and BSL were much more prominent, many more languages are now being studied. In the book, about 17 languages are discussed, including Asian and Middle Eastern languages, and there were many more at the conference. As in other linguistic fields, there is a growing use of experimental data and databases and corpora of signs. One of the purposes of the conference was to introduce the SignTyp database (also made possible by the same NSF grant) which is now available on the web at http://www.ldc.upenn.edu/signtyp/downloads/ and is used extensively in Channon and van der Hulst's chapter here.

The book focuses on the formational units of signs: handshapes, locations, movements, orientations, and non-manual units. At the descriptive level, the question is which units can or have been distinguished, which leads to theoretical questions as to whether and how these units, in addition to having a phonetic status, function phonologically, and how iconicity affects the phonetics and phonology of signs. The chapters included use a variety of observational, experimental and theoretical approaches to understanding these units.

In this introduction, we provide an overview of one perspective on the relationships between phonology, phonetics and iconicity and make some remarks on the possible role of innate factors. The aim here is not to give full arguments for each statement, but to provide a systematic structure for discussion and argument. In what follows, authors mentioned without dates are those included in this volume.

2. Iconicity/systematicity

Two disciplines usually claim to provide explanations of the systematic properties of the form of spoken languages: phonetics and phonology. There is a clear third contender which does not go by a traditional disciplinary name. It is abundantly clear that the form of many signs is 'motivated' or 'explained' by a mental image of the object or action that is the referent of the sign. Signs thus motivated are said to be iconic. Though iconic motivation is not absent in spoken languages, it plays a much more important role in sign languages because, compared to the acoustic material of speech, the visual medium of signing is more suitable to depict aspects of the world which are significant to a visually oriented species.

Before the linguistic study of sign languages began, they were considered to be mimic languages, composed of iconic gestures and borrowings from spoken languages, and therefore non-linguistic, primitive, borrowed, and altogether a less valuable type of language. With their high degree of iconicity, sign languages seemed to contradict the Saussurian 'arbitrariness' of the linguistic sign, i.e. the purely conventional relationship between form and meaning. Early linguists, in their work on sign languages, therefore avoided discussion of iconicity and downplayed its significance. Now that the true linguistic nature of sign languages is no longer in debate, it is allowable to acknowledge that signed and spoken languages, despite deep similarities and communicative equivalence, also display differences due to the fact that they draw on different modalities. Therefore, in contrast with earlier neglect, more attention is now being paid to iconicity.

Iconicity is a kind of imitation based on imagery. The signer's hands and body are substituted for entities and actions which are animate or inanimate, abstract or concrete. The imitation is not exact: it can be altered by additions, deletions, geometric transformations (scaling, skewing or rotating), and substance transformations.

Iconicity remains in some ways the most difficult system to understand. The status of iconicity in sign languages is far more central than it is in spoken languages, so we are less able to depend on basic understandings achieved in spoken languages which could be transferred to the study of sign languages. An additional problem is that unlike phonetics and phonology which have a role in every sign, iconicity is not involved at all in a sizeable number of signs in every language.

Arbitrary signs with historical iconicity only. Almost all signs originate from an iconic gesture, but over time, phonetic and phonological changes make its iconic basis no longer recognizable. Cultural changes can also obscure the

iconicity. An example is the ASL sign GIRL (fist hand strokes the pad of the thumb along the jaw line down toward the chin). Some claim that this sign originated from a representation of the strings of a bonnet. Yet this iconicity has clearly worn away. Frequent use encouraged simplification and ease of articulation over faithfulness to the iconic root, and culturally, the bonnet is no longer a typical female feature. Except as etymology, it is meaningless to offer an explanation of why the sign is made as it is, because the sign now, regardless of any iconic origin, behaves as an arbitrary sign.

Non-productive iconicity. The iconicity of other signs is more difficult to ignore, because the iconic origin is unambiguous and still mentally available. Unlike fully arbitrary signs, an explanation in terms of iconicity is very meaningful, although they could be described without it. For example, signs connected with the written form of the culturally associated spoken language (letter, number or character signs or forms derived from these signs) are often iconic. In ASL, some letter signs resemble the written form of the same letter. Fischer and Gong describe many iconic character signs in Asian sign languages, and Kubuş and Hohenberger show similar iconicity for the letters in the TID (Turkish Sign Language) alphabet. This type of iconicity appears to be a much stronger force in languages where fingerspelling, initialization and characterization (to coin a term) are not as common in everyday signing as in ASL. The reduced usage means that in these languages, systematicity in iconic resemblance overrules the phonetic (articulatory and perceptual) and phonological 'difficulties' that the iconic force causes.

Iconicity may also act to constrain the types of handshapes or other characteristics that can be used in the initial creation or later modification of a sign. For example, the numbers 1 through 5 are usually iconic: the number of digits extended equals the number meaning[2]. It would be very surprising to find a language where the number 1 is signed with two extended fingers, the number 2 with one extended finger, and the number 3 with 4 or 5 extended fingers. Note that iconicity for these signs limits, but does not absolutely predict the choice of possible handshapes: signs for the number 3 are usually limited to some set of three extended fingers, but different languages select different sets of fingers. A similar example of limitation is discussed in Brentari and Eccarius showing that signers don't accept a flattened handshape for signs initialized using the letter O.

Some signs may or may not be iconic but displays a type of systematicity related to other signs. For example, in ASL, signs for women are frequently made on the chin/cheek area, while signs for males are often made on or near the forehead. This is a kind of 'form' symbolism in that aspects of the

form correlate with aspects of meaning without there being a clear semantic motivation for the form as such. In TID, as Kubuş and Hohenberger shows, systematicity within the fingerspelling alphabet produces one handed signs made on the non-dominant hand. While it might be possible to simply specify this for each sign, this misses the generalization that all one handed fingerspelling is made on the non-dominant hand, as well as missing the explanation: this occurs because some letter signs have movements on the dominant hand to show diacritics which then results in the shapes of *all* letters being made on the non-dominant hand. One might consider this a system internal form-symbolic effect.

Nevertheless, while iconicity or related factors like form-symbolism can explain these signs and sign systems, it is not an absolutely necessary part of the analysis, which could be stated using phonetic and phonological structure. The iconic or form-symbolic explanation is like a bonus that could be mentally real, but it might also be an after-the-fact story provided by the linguist. Furthermore, these signs are often less used, and somewhat peripheral in Brentari & Padden's (2001) sense of core and peripheral elements of the language. We might say that the iconic and symbolic motivating factors are (somewhat) *opaque* and as such not necessarily acknowledged by the learner.

Productive and predictive iconicity. However, another set of signs shows that iconicity is absolutely essential to sign languages. These are the signs using verb agreement and classifier predicates, as well as a few apparently lexical signs which allow iconic variations. In these signs, iconicity is needed to describe, to explain and to predict some characteristics (usually related to movement) of the sign. Some examples are the reversing direction signs such as IMPROVE/GET WORSE (the flat unspread hand moves on the arm either up (IMPROVE) or down (GET-WORSE), contacting two or more times), agreeing verbs such as GIVE in most sign languages, and classifier predicates showing a hand grasping an object, tracing an object, or representing a moving object. In these cases the iconic motivation is so overwhelmingly *transparent* and productive that we must assume that the form part of the mental representation of the sign is involved.

Thus iconic effects in signs can range from arbitrary signs with no iconicity to opaquely iconic signs where some characteristics are explained but not fully predicted by iconicity, to transparently iconic signs many of whose characteristics can only be predicted, described and explained on the basis of iconicity. Overall therefore, iconicity must be a part of the knowledge we need to recognize and produce signs.

Innate or learned? The question whether our human knowledge and skills are innate or learned from experience goes back to the days of Plato and Aristotle, but Chomsky (1965) added a new dimension to this question by suggesting that there is a specific innate language acquisition device or module which the child must have in order to acquire a language. This means that when we ask the question whether something is innate or learned, if we claim that it is innate, we must then also ask whether this characteristic is specific to language.

Without some innate ability (or at minimum a bias) to imitate, language and culture could not be passed from one generation to the next. We take it that the ability to represent mental imagery through bodily action and posture is innate. It is not without significance that if people (deaf or hearing) are asked to make up a sign for some object (for which they do not have a basic sign), everyone will come up with a motivated sign. It is much easier to make up a motivated sign than to construct an arbitrary sign, and whatever comes easy to humans is most likely rooted in an innate ability.

However, the specific instances of iconic imitation obviously arise in interaction with the environment and depend on the specific usage that is made of the object or the role of actions. Iconic imitation depends on knowing the world around and in us, including cultural facts such as the shape of written letters and characters.

Iconicity therefore is primarily a learned activity of the mind. In so far as it is innate (the ability to imitate), it cannot be the case that this is specific to language, since imitation occurs in many or all human activities.

3. Phonetics

Our phonetic knowledge can be considered as a system of constraints which supply default information to flesh out the phonological structure[3]. There are three possible types of phonetic constraints: articulatory, perceptual, and cognitive.

Articulatory. Constraints may be absolutely required or a matter of preference. An absolute constraint completely forbids some action; a preference constraint is one where something is possible, but difficult or uncomfortable (or even painful). An absolute articulatory constraint is that we cannot sign further away from our body than we can reach. A preference articulatory constraint controls the extension of the fingers. The ease with which one finger can be extended by itself has a descending order: index, pinky, middle, ring. Eccarius uses this constraint (focusing on the ring finger) in

her chapter. More generally, Ann, Myers and Tsay provide experimental evidence showing that a ranking of handshapes by their articulatory difficulty is predictive of longer response times in an experimental task.

Perceptual. Perceptual constraints are those constraints that benefit the viewer. A simple example is that signs must be made where they can be seen. Pizer, Meier and Points show that mothers are well aware of this constraint and expend considerable energy in making sure that their signs are moved into the child's viewing area. Adam, Orfanidou, McQueen and Morgan show that viewers find it hardest to accurately perceive movements and easiest to perceive locations, with handshapes having intermediate difficulty. The relative difficulty in perceiving movement may be an additional explanation for why Channon and van der Hulst find a relatively small number of pathshapes being used in signs.

Cognitive constraints. Cognitive constraints are those imposed by our limitations on planning and executing certain actions. One such constraint could be stated as "don't do two things at the same time", as in rubbing the stomach and patting the head at the same time. A related constraint is a preference for symmetrical or alternating action. In sign languages, this translates to a strong preference for both hands in a two-handed sign to have the same handshape, and to perform the same action at the same time or in an alternating pattern. There is an even stronger, perhaps close to absolute, limitation against the two hands performing different movements, such as one hand moving in a upward trajectory while the other hand moves up and down. These constraints are much of what is contained in Battison's Symmetry and Dominance Conditions (1978). Van Gijn, Kita and van der Hulst (ms.) have argued that the Symmetry Condition is a general condition found even in the gestures of hearing people, and Channon (2004) has argued that the Dominance Condition, although it appears to be a purely phonological constraint, can be understood as a set of articulatory, perceptual, cognitive and iconic constraints, which in conjunction with weak hand locations, determine the weak hand shape.

The placement of cognitive constraints under phonetics is a choice not everyone would agree with. Others might group such constraints in the phonological domain. But their phonetic character seems reasonable because these limitations are not specifically linguistic limitations. They are limitations of the human mind in all activities, and they generally have the character of overload: the mind can attend to and remember only so many things at the same time, and it can attend more easily to multiple similar activities than to multiple different activities.

An analogy may be helpful here. A desktop computer is limited in two different ways: 1) it has a limited number of abilities and 2) each of its abilities is limited. The first type of limitation means that it can store documents on a storage device but it cannot shovel snow or feel emotions. The second type of limitation means that any given storage device can only store a certain number of documents of a certain limited size. The limitations are not because we don't know how to make a device that can store more or larger documents, but because any particular computer must have a physical instantiation with a specific amount of processing power and memory size. The cognitive limitations that are considered here to be phonetic are similar to this second type of limitation: there are finite limits to our equivalent of processors and memory. (We will not try to answer here whether there are linguistically interesting cognitive limitations of the first type.)

Innate or learned? Knowledge of phonetic constraints is needed to correctly produce signs. Again it would seem that the basis of much of this knowledge is 'built in', although there is no reason to believe that this kind of knowledge is specific to language, because constraints of the relevant sort are apparently used in all human activities to one degree or another.

However, it is likely that the specific forms of constraints arise on the basis of experience. For example, it takes time to understand how far our hands can reach. Furthermore, the knowledge of the constraints of our own body is to some extent dependent on our particular body, yet our bodies change over time. Even artificial body changes are possible. For example, driving a car entails that we become aware of the car as an extension of our body. As we turn and move, we must be aware of the size of the car to avoid impacts, and this awareness seems to be very similar to the body awareness which allows us to walk without collisions. The computer mouse provides a similar artificial extension of the body. Thus, innately we have the ability to form a mental map of our body and its actions, but the specifics of the map are formed while we experience the body and the environment and in this process, even elements of the environment can be mentally analyzed as being part of the body.

4. Phonology

When iconic motivations and phonetic constraints have been taken into account, one point of view is that there remains a residue of linguistic knowledge about a sign that must be phonological. Phonological structure is cognitive, but it does not relate to planning of motoric action. Rather it involves

constraints on mental representation as such. The task for a phonologist is to tease apart the various forces that determine the form of signs, to identify what is phonological, and to create a theoretical model.

The need to postulate a phonological representation, indeed the need to acknowledge phonology as distinct from phonetics is because the phonetic substance (even of a single sign) occurs in infinite variety. This variety of physical signals must be mentally filtered to produce categories or groups of items that count as 'the same'. For example, in English the numerous speech sounds that fall under the umbrella '/t/' are grouped into one category (the phonological concept '/t/'), just like the semantic concept DOG categorizes the infinite variety of hairy and barking animals that we consider to be of 'the same kind'. It is this categorization which gives rise to what we call phonology. We could of course categorize the form of each word holistically rather than in terms of a collection of smaller building blocks (phonemes and features). Here it could be argued that a decomposition into phonemes serves the purpose of allowing a systematic ('alphabetic') arrangement of words according to their form which makes easy and fast retrieval possible. The ability that native speakers have to judge whether a given form belongs to their language (or could belong to it) testifies to the idea that word forms are not stored holistically, or at least not exclusively holistically. As Cruz and Lamprecht show in their chapter, children are aware of the parts of a sign, an awareness that increases with increasing exposure to the language.

4.1   Types of phonological knowledge

Features. Features are the smallest element of form. They are mental concepts or categorizations of phonetic attributes related to the handshape, location, movement, orientation, and nonmanual properties of signs. In this volume, Mak and Tang propose a new feature [return] as a new subcategory of repetition, and Hansen proposes movement phonemes. Just how far non-manual characteristics are a part of the sign is one of the least well-developed aspects of the feature system. Weast's chapter suggests that while eyebrow raising is involved in phrase level prosody, emotional states, and syntax, it is not involved directly in the phonology: there is no phonological feature [eyebrow raise].

Feature relationships – hierarchical structure and dependencies. Features also have hierarchal relationships and dependencies among themselves. For example, if a sign repeats, this repetition can be connected with the hand-shape opening and closing, a change of orientation, or a path change (the

hand moves between different locations). Mak and Tang show that hand-shape change and orientation change must be grouped together under a local movement node, and that repeat features may be dependently related to either path or to local movements.

Segments and Syllables. At least in spoken languages, features form units called segments (or phonemes) which in turn group into larger units like syllables. One of the celebrated issues in comparing signed to spoken languages is the question whether units like segments and syllables occur in sign language structure as well. This issue has led to an exploration into the very nature of these types of units (see for example Channon 2002a and van der Hulst 1995).

Temporal relationships between features and segments. Features and segments may also be related to each other in a temporal sequence. The simplest example of this is that in English (disregarding effects of coarticulation) *cat* and *tack* are minimally different in terms of sequential order. In ASL, IMPROVE and GET-WORSE and similar sign pairs can also be perceived as minimal pairs for temporal order. This temporal order can be expressed in a model as either a series of sequential segments (or syllables, or other elements) which change order, as in [a][b][c] vs. [c][b][a], or as the effect of a change of features from [up] to [down] as argued in Channon (1996, 2002a and 2002b). In this volume Channon and van der Hulst argue that a pathshape feature can also help determine the temporal order of other features.

Phonological constraints. A phonological constraint would be a constraint that encodes a regularity across morphemes, signs or words that cannot be attributed to phonetic or iconic facts. It could be true of all languages, or a type of language such as sign languages, or a particular language or language group.

Phonological constraints in spoken languages arise in two ways. First, they arise when the phonetic substance is categorized as described earlier. An important principle of categorization seems to be to categorize phonetic spaces into binary opposed subcategories (such as voiceless versus voiced). Another phonological constraint might be that these opposing categories are treated asymmetrically, with one being special in one way or another (i.e. having a wider distribution). Whether constraints that result from these principles are specific to phonology or even to language is in question, but it is nonetheless the case that they lead to a systematicity in the phonology

that appears to be distinct from phonetics or iconicity. Second, phonological constraints also deal with universal or language-specific ways in which elements of the phonological structure can be combined. Constraints of this sort encode that whereas *cat, act* and *tack* are grammatical combinations, *kta* and *atk* are not.

Consider the hypothetical phonological constraint for sign languages: "Only the pinky finger may be extended when signing". If this were an actual constraint, it would have to be phonological. It could not be a phonetic constraint or based on iconicity because humans commonly extend different fingers in nonlinguistic situations, and there is no iconic reason for such a constraint. However, a hypothetical example was chosen because it appears that actual phonological constraints in sign languages are few to non-existent, and many apparent constraints appear phonological because of the wording, but when correctly stated they often can be seen to have a phonetic and/or iconic basis. Two examples of apparent phonological constraints are the Symmetry and Dominance Conditions, which as mentioned above are more likely to be based on phonetic and iconic knowledge interacting with phonological features.

Innate or learned? Are features/feature sets innate or learned? The logical possibilities are that 1) only one type of language (sign or speech) has innate features, 2) that there are two innate sets, 3) that there is only one set which applies to both speech and sign, or 4) that features are learned (perhaps using the principles of categorization mentioned above).

Option 1 can be easily dismissed because children learn both types of languages on roughly the same time scale. If the two sets of features differed in innateness, the presence of an already established feature set would make the learning task much quicker in the innate feature language than in the language with features which must be learned.

Option 2 is logically possible but absurd. It would mean that every child is born knowing the feature set for both types of languages, yet the only children which ever use both sets would be the tiny group of bilingual/bimodal children of deaf parents.

Option 3 is not completely impossible. For example, both sign and speech are assumed to use place or location features. One might group other features as manner, articulator shape, and choice of articulator, for both sign and speech. If this were the case, then it must be assumed that children then elaborate these basic innate categories into the specific features for their language type. So in a sense this could be called a hybrid system, where the basic elements are innate, and the details are learned. Note that if this

option were correct, the innate knowledge required is unlikely to be specific to the language faculty, because the categories of place, shape, articulator, and manner are so general that they can be used for many non-linguistic activities as well.

Since options 1 and 2 can be dismissed, this leaves only options 3 and 4. In both cases, features are learned, although option 3 allows for some basic innate, but not language-specific, knowledge.

Essentially the same arguments and reasoning applies to hierarchical structures, temporal relationships, and phonological constraints.

4.2 The tools of a phonologist

There are two important tools that the phonologist can use to determine what must be included in the phonological model: minimal pairs and systematic gaps.

Minimal pairs. Minimal or near-minimal pairs are important in determining the phonological features of a language. Sometimes models will not recognize the same sets of minimal pairs. For example, IMPROVE and GET-WORSE are a minimal pair in the Channon (2002a) model but not in the Liddell and Johnson (1989) model. In this volume, Israel and Sandler discuss an emerging language with very few minimal pairs and suggest that this is because in this language the phonological system is in development, allowing individualized phonetic properties that would not be tolerated in a more conventionalized sign language. Hansen uses minimal pairs to find features for her model, which has a primary division between movement and non-movement segments, with allophones of the same feature in the different segmental environments.

Systematic gaps and counterexamples. Systematic gaps and the related concepts of overgeneration and undergeneration are important in determining the correctness of a proposed phonological model. A model that overgenerates would accept sets of signs as being well-formed which are systematically missing from the language (a systematic gap). An example of a systematic gap in sign languages is that there are no non-compound signs with a sequence of more than three body contacts. For example, contacting the ear then the jaw then the forehead and then the palm of hand does not occur in a sign, even though this is a legal sequence for a series of signs (see Channon 2002a, 2002b for further discussion). A complete and correct phonological model of signs must explain this systematic gap, as well as others.

Channon uses systematic gaps in her work to argue that some features must have a dynamic interpretation (like *pathshape* features) because complex pathshapes are systematically missing (in non-classifier signs). Mak and Tang use the absence of signs where only orientation repeats or only aperture change repeats to motivate a node for local movement at which repetition features can be inserted.

Of course, a model can also undergenerate – it can fail to accept well-formed signs. The test for undergeneration is via counterexamples, particularly systematic groups of counterexample signs, and especially those with documented frequent use in the language over multiple generations. A model is unlikely to be overturned on the basis of one or two signs. It is reasonable to assume that special constraints or more complex representations might be needed for a few signs, particularly if the signs are rare. Especially in sign languages, due to cultural factors, it may also be that there has been "outside interference": inappropriate material imposed on the language which has not (yet) been integrated and modified as required by the phonology, phonetics and iconicity of the language. (This may be the case for some fingerspelling alphabets, for example.) It is also crucial in this respect to remember that iconicity must be considered when testing a model since many apparent iconicity counterexamples or systematic gaps are fully explained when iconicity is taken into account (see van der Hulst and van der Kooij 2006 for further discussion of this last point).

5. Conclusion

The attempt here has been to suggest that the study of the form of signs must make reference to and rely on three forces: iconicity, phonetics and phonology, each of which involves an interplay between innate capacity and learning. There do appear to be innate characteristics or abilities of human beings which assist us in recognizing and producing the signs of the language. These are characteristics such as the ability to imitate, the ability to produce and understand partial and distorted imitations, the preference for efficient and easy articulations, the need to see signs clearly, limitations on what we can understand or do at the same time, the ability to perceive characteristics of an object, the ability to organize information hierarchically and temporally and the ability (indeed the need) to categorize. These are all limitations and abilities with innate roots, but none of them seem to be specific to language. Many aspects of language arise from the combined forces of these innate abilities and from learning.

It may be that the role of iconicity in sign languages, which is clearly much greater, and far more systematic, than in spoken languages, has altered the development of sign languages away from the historic model of speech. That is, speakers inherit a language full of arbitrary relationships between form and meaning. What is arbitrary is easily changed, with the result that the many histories of different cultures have produced many different spoken languages. In sign languages, iconicity (given that it comes so easily and naturally to humans) perhaps curtails the rate, degree or kind of change. It may be that there is a substrata of a deeply rooted system of iconic material which, when compared to spoken languages, causes sign languages to more closely resemble each other phonetically, phonologically, morphologically and syntactically.

The study of sign languages is essential to linguistics no longer just because of its parallels to spoken languages, but also and perhaps more importantly because of the differences. A full understanding of the human capacity for language requires detailed study of both modalities.

It is not to be expected that this book will resolve the large questions we have pondered in this introduction. We look forward to our databases, including SignTyp, growing larger and adding more languages, to more studies of the interaction of iconicity with the other elements of language, and how best to integrate it into a phonological model, to a better understanding of the role of non-manual information and temporal sequencing. In the meantime, we hope you will enjoy and find useful our small steps forward in this book.

Finally, we would like to express our gratitude to the excellent editorial team who has supported this publication: Nicholas Palfreyman (editorial assistant), Robin Arora (copyeditor), Jennifer Webster (language index and subject index), and Ulrike Zeshan as the series editor coordinating this project. We are grateful for everyone's hard work in seeing this project through to publication.

RACHEL CHANNON
HARRY VAN DER HULST

Notes

1. This material is based upon work supported by the National Science Foundation under Grant No. 0544944 to Harry van der Hulst and Rachel Channon. Any opinions, findings, conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

2. An interesting counterexample is shown in Fischer and Gong's photo of JSL numerals where the numbers 1 through 4 follow this pattern but the number 5 is a fist with the thumb extended.

3. This formulation presupposes that the forms of linguistic signs do indeed have a phonological structure which is independent of the phonetic substance. For those who no longer believe in phonological structure, phonetic constraints directly specify this substance in terms of its articulatory and auditory properties. We will return to this issue in the next section and put it aside for now.

References

Battison, Robbin
  1978   Lexical borrowing in American Sign Language. Silver Spring, MD: Linstok.

Brentari, Diane and Carol Padden
  2001   A Language with Multiple Origins: Native and Foreign Vocabulary in American Sign Language. *In Foreign Vocabulary in Sign Language: A Cross-linguistic Investigation of Word Formation.* Diane Brentari, ed., 87-119. Mahwah, NJ: Lawrence Erlbaum Associates.

Channon Crain, Rachel
  1996   Representing a sign as a single segment in American Sign Language. In Green and Motopanyane (ed.), Proceedings of the 13th Eastern States Conference on Linguistics, 46-57. Cornell University, Ithaca NY.

Channon, Rachel
  2002a   Signs are single segments: Phonological representations and temporal sequencing in ASL and other sign languages. University of Maryland at College Park Dissertation. http://www.ling.umd.edu/publications/dissertations/

Channon, Rachel
  2002b   Beads on a String? Representations of repetition in spoken and signed languages. In R. Meier, K. Cormier, & D. Quinto-Pozos, (eds.), Modality and Structure in Signed and Spoken Languages. Cambridge, UK: Cambridge University, pp. 110-148.

Channon, Rachel
  2004   The Symmetry and Dominance Conditions Reconsidered. Proceedings of Chicago Linguistic Society, Vol. 40:1, pp 44-57.

Chomsky, Noam
  1965   Aspects of the Theory of Syntax. Cambridge MA: MIT Press.

Liddell, Scott and Johnson, R. E.
  1989   American Sign Language: The phonological base. Sign Language Studies, 64, 195-277.

Van der Hulst, Harry
  1995   Head-dependency relations in the representation of signs. In H. Bos & T. Schermer (eds.). *Sign language research 1994. Proceedings of the 4th European congress on Sign language research.* Münich 1-3 September 1994. Hamburg: Signum Press, 11-38

Van der Hulst, Harry and Els van der Kooij
  2006   Phonetic implementation and phonetic pre-specification in sign language phonology. In: Cathie Browman et al. (eds.). *Papers in Laboratory Phonology 9.* Berlin: Mouton de Gruyter, 265-286.

Van Gijn I., Kita, S. and Harry van der Hulst
  (ms)   The non-linguistic status of the Symmetry Condition in signed language: Evidence from a comparison of signs and spontaneous co-speech gesture.